National Park Service
U.S. Department of the Interior

Indiana Dunes National Lakeshore
Indiana

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FINAL WHITE-TAILED DEER MANAGEMENT PLAN / ENVIRONMENTAL IMPACT STATEMENT

April 2012

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UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
FINAL WHITE-TAILED DEER MANAGEMENT PLAN/ENVIRONMENTAL IMPACT STATEMENT

Indiana Dunes National Lakeshore, Lake, Porter, LaPorte Counties • Indiana

This Final White-Tailed Deer Management Plan/Environmental Impact Statement describes four alternatives for the management of deer at Indiana Dunes National Lakeshore, as well as the environment affected by the alternatives and the environmental consequences of implementing these alternatives. The purposes of this plan and environmental impact statement are as follows:

- Describe a scientifically based system of checks and balances, such as monitoring and active management, to ensure that the deer population at the national lakeshore does not preclude long-term conservation of sensitive plant and animal populations.
- Determine how to manage deer populations to prevent degradation of national lakeshore resources.
- Identify and share with neighboring citizens and local governments the best technical information and expertise on deer management.
- Identify and maintain a deer impact level that is in balance with other components of the ecosystem and other national lakeshore values.
- Facilitate public support, education, and appreciation for maintaining the integrity of that ecosystem.

Because the local deer population threatens to become a dominant negative influence on ecosystem components within the national lakeshore, such as sensitive vegetation or other wildlife, the time for preventive action is now. Although national lakeshore staff conducts certain resource management actions to protect resources, such as sensitive plant species, no specific deer management plan exists, and the impact of an uncontrolled deer population on these resources would compromise the national lakeshore's purpose of preserving the exceptional biodiversity found within its boundaries.

Under alternative A (no action), current deer management actions—including limited fencing, limited use of repellents, and inventorying and monitoring efforts—would continue. No new deer management actions would be taken. Alternative B includes all actions described under alternative A, as well as incorporating nonlethal actions to reduce deer numbers in the national lakeshore. The additional actions would include constructing additional small-scale and new large-scale exclosures and using repellents more extensively in areas where fenced exclosures are not appropriate or feasible. Phasing in nonsurgical reproductive control of does would occur when a fertility control agent that supplies three to five years' efficacy is federally approved and becomes available. Alternative C includes all actions described under alternative A and would also incorporate a direct reduction of the deer herd size, where appropriate, through sharpshooting and capture/euthanasia. Alternative D includes all actions described under alternative A, as well as a combination of specific lethal and nonlethal actions from alternatives B and C. These actions would include reducing the deer herd through sharpshooting, capture/euthanasia, and nonsurgical reproductive control of does, as described in alternative B, to maintain lower herd numbers over the long term.

This document addresses the potential environmental consequences of the alternatives on vegetation, soils and water quality, white-tailed deer and deer habitat, other wildlife and wildlife habitat, sensitive and rare species, archeological resources, cultural landscapes, visitor use and experience, visitor and employee health and safety, soundscapes, socioeconomic conditions, and national lakeshore management and operations. Under alternative A, no action would be taken to reverse the expected long-term growth in the deer population, and damage to vegetation is likely. The analysis indicates that in the long term, impairment to vegetation, white-tailed deer, other wildlife and habitat, and sensitive and rare species could result if alternative A were to be implemented.

Alternative D is the preferred alternative because it is most likely to protect the biological and physical environment by ensuring an immediate reduction in the deer herd that could be sustained with proven methods over the life of the plan. Alternative D is also the most effective way to protect, preserve, and enhance the natural processes within the national lakeshore to maintain a viable deer population, given that there would be little, if any, uncertainty about implementing the selected methods to maintain low deer numbers. An assessment of Alternative D showed that implementation of the preferred alternative would cause no impairment to natural, cultural, or other valued resources at the national lakeshore.

A 30-day no-action period will follow release of this *Final White-Tailed Deer Management Plan/Environmental Impact Statement*. Following the 30-day period, the alternative or actions constituting the approved plan will be documented in a record of decision that will be signed by the Regional Director of the Midwest Region. For further information, contact Randy Knutson, Wildlife Biologist, Indiana Dunes National Lakeshore, 1100 N. Mineral Springs Rd., Porter, IN 46304; phone: 219-395-1550; randy_knutson@nps.gov.

SUMMARY

PURPOSE OF AND NEED FOR ACTION

The purposes of this plan and environmental impact statement are as follows:

- Describe a scientifically based system of checks and balances, such as monitoring and active management, to ensure that the deer population at the national lakeshore does not preclude long-term conservation of sensitive plant and animal populations.
- Determine how to manage deer populations to prevent degradation of national lakeshore resources.
- Identify and share with neighboring citizens and local governments the best technical information and expertise on deer management.
- Identify and maintain a deer impact level that is in balance with other components of the ecosystem and other national lakeshore values.
- Facilitate public support, education, and appreciation for maintaining the integrity of that ecosystem.

Because the local deer population at the Indiana Dunes National Lakeshore threatens to become a dominant negative influence on ecosystem components within the national lakeshore, such as sensitive vegetation or other wildlife, the time for preventive action, in the form of a deer management plan, is now. Although national lakeshore staff implements certain resource management actions to protect resources, such as sensitive plant species (see "Related Laws, Policies, Plans, and Constraints" in chapter 1 for a list of related plans), no specific deer management plan exists, and the impact of an uncontrolled deer population on these resources would compromise the national lakeshore's purpose of preserving the exceptional biodiversity found within its boundaries. A deer management plan should address the effect of overabundant deer populations on the restoration and viability of sensitive plant communities within the national lakeshore, the effect of overabundant deer populations on sensitive animal species within the national lakeshore, and the overall health of the local deer herd.

National Lakeshore Purpose

The 1966 enabling legislation states that the national lakeshore "shall be permanently preserved in its present state, [and] no development or plan for the convenience of visitors shall be undertaken therein which would be incompatible with the preservation of the unique flora and fauna or the physiographic conditions now prevailing" (Public Law 89-761). Therefore, the purposes of the national lakeshore were designated as the following:

- Preserve, maintain, and restore the integrity and character of the natural resources and processes and protect cultural resource values.
- Provide educational, inspirational, and recreational opportunities compatible with preserving natural and cultural resource values.
- Inspire in the public an appreciation of and a sense of personal stewardship for national lakeshore resources.
- Interpret, encourage, and conduct scientific research in the tradition of pioneer investigators.

National Lakeshore Significance

The following statements of significance explain why the national lakeshore is important to natural and cultural heritage:

The national lakeshore contains exceptional biological diversity and outstanding floral richness, resulting from the combination of complex geological processes and the convergence of several major North American life zones.

- The national lakeshore's cultural resources represent the cultural evolution of northern Indiana from prehistoric times to the present day.
- The national lakeshore's extensive reach of undeveloped dunes provides recreational, educational, and inspirational opportunities within a one-hour drive of a major metropolitan area.
- The national lakeshore offers outstanding opportunities for scientific research because of the diversity and complexity of its natural systems and provides a dynamic laboratory for early plant succession and faunal studies.
- The presence of heavy industry, long-standing transportation corridors, residential use areas, and natural areas at the national lakeshore offers an outstanding opportunity to show visitors how these elements interrelate.
- The dunes provide a striking physical and inspirational relief to the surrounding flat and highly developed landscape.

Objectives in Taking Action

Objectives define what must be achieved for an action to be considered a success. Alternatives selected for detailed analysis must meet all objectives, thereby fully resolving the purpose of and need for action.

Using the national lakeshore's enabling legislation, mandates, and direction in other planning documents, as well as National Park Service (NPS) servicewide objectives, management policies, and the Organic Act, national lakeshore staff identified the following management objectives relative to deer management at Indiana Dunes National Lakeshore.

Management Methodology

- Determine a science-based, well-informed, and defensible vegetation impact level that would serve as a threshold for taking management action within the national lakeshore.
- Develop and implement an adaptive management approach (Porter and Underwood 1999) for maintaining a viable deer population within Indiana Dunes National Lakeshore.

Wildlife and Wildlife Habitat

- Maintain a healthy white-tailed deer population within the national lakeshore while protecting other national lakeshore resources.
- Protect lower-canopy and ground-nesting bird habitat from unacceptable adverse impacts from overabundant deer browsing.
- Protect the habitat of sensitive and rare species from unacceptable adverse impacts related to deer browsing.

Vegetation

- Ensure that deer browsing does not preclude the conservation of vegetation and sensitive plant populations.
- Prevent deer-browsing impacts from leading to the decline or extirpation of rare plant species.

Visitor and Employee Health and Safety

- Reduce the potential for health and safety impacts related to overabundant deer.

Visitor Experience

- Provide opportunities for the public to experience a balanced, functioning Indiana Dunes National Lakeshore ecosystem where deer are not the driving force and to understand the natural role of deer in the ecosystem.

Cultural Resources

- Re-create and manage historically accurate cultural landscapes. This objective includes maintaining deer impact and visibility at an acceptable level to achieve the desired historical landscape.

Regional Landscape-level Changes

White-tailed deer (*Odocoileus virginianus*) live throughout Indiana, although historically, the deer population declined dramatically after the Europeans arrived, and by 1884, deer were becoming quite rare. Deer were reintroduced in Indiana in 1934 and, by 1966, were present in all counties in the state. Lack of natural predators and habitat alterations that resulted in favorable conditions for deer led to rapid population increase in Indiana. The Indiana Department of Natural Resources (IDNR) now estimates the statewide deer population at 300,000 animals, with 100,000 taken annually by hunters. This growth has placed increasing demands on natural resources and open space in the region and often results in a negative impact on other natural resources, such as vegetation and wildlife.

Eastern national park units, such as Indiana Dunes National Lakeshore, have been managed for scenic, scientific, and historic landscapes, which constitute excellent habitat for deer. In these units, deer populations have greatly increased, with surveys indicating that numbers have exceeded 100 deer per square mile (deer/mi^2) in some areas. Researchers have established that such a high density can have a negative impact on plant and animal species and, further, that overabundant deer can greatly alter the composition and structure of forest communities. Excessive deer populations have caused regeneration failures and shifted ground flora. Long-term alterations of vegetation structure and composition by excessive deer browsing also negatively impact rare plant species, bird communities, and the endangered Karner blue butterfly.

Where deer browsing is not controlled, deer expand their diets to include plant species that they might not consume when vegetation is plentiful, ultimately browsing on nearly all vegetation within reach. All herbaceous species and most shrub species are eliminated, leading to a visible browse line. Deer browsing has also been shown to lead to a decline in the richness of nesting bird species. Specific national lakeshore resources at risk from overabundant deer include sensitive vegetation communities and wildlife. Indiana Dunes National Lakeshore has more vascular plant species than most parks in the national park system. Of the 123 state-listed plant species within the national lakeshore, one is also federally listed. In addition, about 113 species of birds are considered regular nesters at the national lakeshore. Decline of the national lakeshore's sensitive vegetation could affect visitor satisfaction, as many visitors hope to see rare plant species when visiting national lakeshore units.

ALTERNATIVES CONSIDERED

Under alternative A (no action), current deer management actions—including limited fencing, limited use of repellents, and inventorying and monitoring efforts—would continue. No new deer management actions would be taken. Alternative B includes all actions described under alternative A, as well as incorporating nonlethal actions to reduce deer numbers in the national lakeshore. These added actions would include constructing additional small-scale and new large-scale exclosures and using repellents more extensively in areas where fenced exclosures are not appropriate or feasible. Phasing in nonsurgical reproductive control of does would occur when a fertility control agent that supplies three to five years' efficacy is federally approved and becomes available. Alternative C includes all actions described under alternative A and would also incorporate a direct reduction of the deer herd size, where appropriate, through sharpshooting and capture/euthanasia. Alternative D includes all actions described under alternative A, as well as a combination of specific lethal and nonlethal actions from alternatives B and C. These actions would include reducing the deer herd through sharpshooting, capture/euthanasia, and nonsurgical reproductive control of does, as described in alternative B, to maintain lower herd numbers over the long term. Recent monitoring of indicator plants has shown that deer are causing negative effects that warrant control measures in management zones of the East Unit.

ENVIRONMENTAL CONSEQUENCES

The following summary of environmental consequences considers the actions being proposed and the cumulative effects from occurrences inside and outside the national lakeshore. It addresses the potential environmental consequences of the actions for vegetation, soils and water quality, white-tailed deer, other wildlife and wildlife habitat, sensitive and rare species, archeological resources, cultural landscapes, visitor use and experience, visitor and employee health and safety, soundscapes, socioeconomic resources, and national lakeshore management and operations.

TABLE S-1: COMPARISON OF ALTERNATIVES

	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Preferred Alternative: Combined Lethal and Nonlethal Actions
Management Actions	Continue limited use of fencing and repellents, plus inventorying and monitoring efforts, throughout the national lakeshore where needed. No new deer management actions would be taken.	All actions under alternative A, plus: Preserve vegetation by installing additional fences or increasing application of repellents. Protect priority areas of sensitive resources from deer browsing, taking into account the palatability of the plant, listed status, and population size. Use repellents in moderate- and low-priority areas and where installing a fence is undesirable. Implement reproductive control of does.	All actions under alternative A, plus: Sharpshoot to reduce the deer population in areas of the national lakeshore documented to have substantial browse impacts. Donate meat, if possible.	All actions under alternative A, plus a combination of techniques from alternatives B and C: Use fencing and repellents to protect small populations of sensitive plant species, small plant restoration projects, or areas that cannot be managed by other means. Use direct reduction to prevent unacceptable resource damage (initially and periodically, as needed). Apply reproductive controls to limit population growth.
Reduction in Deer Population	None, other than natural sources of mortality.	Potential reduction in deer population if reproductive controls could be applied throughout the national lakeshore but only after the first several years of treatment or until natural mortality exceeded reproduction and reduced the population. Population reduction would be gradual.	Initially remove an estimated 581 deer, with fewer deer in subsequent years. To maintain the population at target levels (15 deer/mi^2), remove an estimated 70 to 100 deer annually.	Initially similar to alternative C. Potential for future reductions through reproductive control used as a population maintenance tool.
Time Required to Achieve Desired Objectives	Controls immediately prohibit deer from browsing but in small areas only; controls are not fully effective at meeting national lakeshore objectives.	Fencing would immediately prohibit deer from browsing in certain areas, but several years would be required for vegetation regrowth. Reproductive control is not likely to contribute to achieving a healthy and sustainable ecosystem.	Immediate reduction. May take at least three years to reach density goal; could be longer, depending on such factors as deer becoming more evasive, changes in reproduction and mortality rates, and immigration from outside the national lakeshore boundaries.	Varies by methods used. See alternatives B and C.
Handling of Deer	None.	No physical handling of deer is required to drive them out of fenced areas. With telemetry dart application, physical handling of deer is required to administer reproductive control agent. The dart is then recovered, the doe marked, the control agent administered, and the doe released.	No capture required for sharpshooting activities.	Same as alternative B for reproductive control.
Monitoring	Continue monitoring vegetation impact and deer population level; expand as necessary to correlate vegetation impact levels with deer population levels.	Continue monitoring as described under alternative A, plus monitor plants for signs of recovery within exclosures. For reproductive control, monitor treated deer using additional spotlight surveys to determine effectiveness.	Continue monitoring as described in alternative A. In addition, monitor and evaluate vegetation for five years to document any changes in deer-browsing impact that might result from reduced deer numbers and to determine if the removal-density goals should be continued or modified.	Same as alternatives B and C.
Regulatory Considerations	No specific regulatory requirements. Application rate restrictions would apply to different repellents that could be used.	Application rate restrictions may apply to different repellents that could be used. Veterinarian prescription required pursuant to the Animal Drug Use and Clarification Act for off-label use of reproductive controls in does. Additional requirements could be prescribed by a veterinarian (e.g., meat withdrawal period, marking). Follow Public Health guidelines for chronic wasting disease (CWD).	No prohibitions on spotlights or suppression devices that could be used, along with night vision equipment, to reduce disturbance to the public. Any necessary ATF permits would be obtained. Coordinate as needed with state/local/nonprofit/private entities to donate meat.	Same as alternatives B and C.
CWD Testing	Coordinate testing with the state and conduct opportunistically when CWD is more than 60 miles from the national lakeshore. Targeted removal and testing of animals with clinical signs of CWD when CWD is less than 60 miles from the national lakeshore.	Same as alternative A.	Same as alternative A. Under this alternative, a statistically valid sample may be reached sooner than under alternative A, given increased opportunities for testing.	Same as alternative A. Under this alternative, a statistically valid sample may be reached sooner than under alternative A, given increased opportunities for testing.
Education	Continue existing educational programs	Add educational and public programs about deer management activities.	Add educational and public programs about deer management activities.	Add educational and public programs about deer management activities.
National Lakeshore Closure/ Restricted Access	None.	Restrict access within exclosures or in areas of active reproductive control.	Close areas or restrict access during reduction activities; minimize closures or restrictions by conducting activities during periods around dawn and dusk and in winter.	Same as alternatives B and C.
Adaptive Management	None.	Relocate vegetation paired plots, change action thresholds (including indicator species) or deer-density goals, possibly change repellent use and number and locations of exclosures, possibly change reproductive control agent and its application procedures.	Relocate vegetation paired plots, change action thresholds or deer-density goals, or possibly change implementation procedures for direct reduction.	Same as alternatives B and C.
Estimated Cost (15-Year Plan)	$350,825	$11,283,971	$988,325 to $1,190,825	$2,631,130 to $2,877,931

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TABLE S-2: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Combined Lethal and Nonlethal Actions (Preferred)
Vegetation	The deer population would remain in excess of the recommended density for sustaining the natural reproduction of native national lakeshore vegetation and would likely remain high or increase over time, adversely affecting native plant abundance and diversity. As long as the deer population remained high or increased, overall effects would include decreased ability of plants to reproduce naturally, which in turn, would lead to decreased native plant diversity, increased opportunity for exotic plants, and decreased abundance of native plants. Some benefits would be gained from such management actions as maintaining small fenced areas and applying repellents in selected areas; however, the benefits would not protect or affect the majority of the national lakeshore. Some benefits could also be gained after periodic declines in deer population from disease or lack of available food; however, such population declines would not last long enough for native plant communities to recover fully. The impact of large numbers of deer browsing on a very large percentage of the national lakeshore's native vegetation and, thus, limiting natural plant reproduction would be adverse, long term, and major. Past, present, and future actions, when combined with the continued pressure on plant reproduction expected under this alternative, would result in both adverse and beneficial impacts, with adverse, long-term, major cumulative effects. Because alternative A would not reverse the expected long-term density or growth in the deer population, damage to vegetation would likely continue.	Under alternative B, overall, approximately 7 percent of the national lakeshore's native vegetation would benefit from constructing exclosures over the life of this plan, and doubling the use of repellents would help protect small areas. Remaining vegetation within the national lakeshore would continue to be adversely affected by deer browsing over the long term until reproductive controls became effective and the deer population decreased. However, because the benefits of reproductive control would not be fully realized within the life of this plan, overall impact on vegetation would be adverse, long term, and major as native vegetation decreased in abundance and diversity in the majority of the national lakeshore. Past, present, and future activities, when combined with the continued pressure on native vegetation expected under this alternative, would result in both adverse and beneficial effects. Over the long term, cumulative impact would be adverse and moderate to major. Alternative B would provide continued protection of certain areas of the national lakeshore over the long term, would protect 7 percent of the national lakeshore, and would introduce reproductive controls that could reduce deer numbers gradually over an extended period of time.	Enhancing native plant reproduction by quickly reducing deer-browsing pressure under alternative C and by maintaining a smaller deer population through sharpshooting would result in beneficial, long-term effects because native vegetation throughout the national lakeshore could recover. In the short term, implementation of alternative C would result in moderate impacts on vegetation as a quick reduction in deer numbers would support an increase in plant reproduction. Although a smaller deer herd would reduce the amount of browsing that could lead to extirpation of rare plant species, some rare plant species may continue to decline without additional fencing and repellents, increasing the potential for extirpation of some species. As deer numbers are further reduced over the long term, native plant diversity and abundance would increase, resulting in a reduction of adverse impact to minor levels. Under alternative C, less than 1 percent of the national lakeshore's vegetation would be affected by trampling at bait stations, shooting sites, or disposal sites; placement of these sites would be in previously disturbed areas free of sensitive vegetation. Therefore, adverse impacts of these actions would be short term and negligible. Past, present, and future activities, when combined with the reduced browsing stress on native vegetation and subsequent increase in plant diversity and abundance, would result in beneficial, long-term cumulative impacts.	Enhancing native vegetation reproduction by quickly reducing deer-browsing pressure under alternative D and by maintaining a smaller deer population through the use of reproductive control and sharpshooting would result in beneficial, long-term impacts because native vegetation could recover throughout the national lakeshore. In the short term, implementation of alternative D would result in moderate impact on vegetation as a quick reduction in deer numbers would support an increase in plant reproduction. As deer numbers are further reduced over the long term, native plant diversity and abundance would increase, resulting in a reduction of adverse impact to minor levels. Under alternative D, less than 1 percent of the national lakeshore's vegetation would be affected by trampling at shooting, treatment, or disposal sites. Therefore, the adverse effects of these actions would be short term and negligible. Past, present, and future activities, when combined with the reduced browsing stress on native vegetation and subsequent increase in plant diversity and abundance, would result in beneficial, long-term cumulative impacts.
Soils and Water Quality	Adverse, long-term, negligible impacts on soils and water quality could result from soil erosion and sedimentation resulting from loss of vegetation from increased deer browsing, assuming continued growth of the deer population under alternative A. The potential for adverse, long-term, negligible impacts on water quality could result from increased fecal loading from the deer population. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Past, present, and future activities both inside and outside the national lakeshore, when combined with the continued pressure from deer browsing expected under this alternative, would result in adverse, short- and long-term, minor to moderate impacts on soils and water quality.	Adverse, long-term, and minor impacts on soils and water quality could occur if deer displaced by the small area protection fencing and large area exclosures concentrated in other areas of the national lakeshore and neighboring areas, resulting in increased loss of vegetation in those areas and a potential increase in soil erosion. These impacts would gradually shift to beneficial in the long term as revegetation occurred in the large exclosures, potentially reducing soil erosion. Beneficial long-term impacts would also result from decreased loss of vegetation, as reproductive control of the deer population would gradually reduce deer numbers over time. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Beneficial, long-term effects occurring inside the national lakeshore would offset cumulative impact only slightly.	Beneficial, long-term impact on soils and water quality would result from rapidly reducing the number of deer in the national lakeshore and maintaining a sustainable population of 15 deer/mi^2 after the third year of implementation. Vegetative ground cover would be able to reestablish, helping reduce soil erosion and sediment loading in the national lakeshore's creeks. Fecal loading in surface waters from the deer population would be reduced. Adverse, long-term, moderate impact on groundwater quality could result from animal disposal pits placed in areas of unknown soil type, bedrock type, and water table level. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Any beneficial impact occurring inside the national lakeshore would not offset adverse cumulative impacts.	Impacts on soil and water quality would be beneficial and long term as a result of rapidly reducing the number of deer in the national lakeshore and maintaining a population of 15 deer/mi^2 after the third year of implementation. Vegetative ground cover would be able to reestablish, helping reduce soil erosion and sediment loading in the national lakeshore's creeks. Fecal loading in surface waters from the deer population would be reduced. Adverse, long-term, moderate impact on groundwater quality could result from animal disposal pits. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Any beneficial effects occurring inside the national lakeshore would not offset adverse cumulative impact.
White-Tailed Deer and Deer Habitat	Alternative A would provide no control on the growth of the deer population, resulting in adverse, long-term, major impact on deer and their habitat. These effects would continue because of excessive deer browsing and the continued high density of the population. Past, present, and future activities, when combined with the continued pressure on vegetation resources and deer habitat expected under this alternative, would result in adverse, long-term, major cumulative impact. Because alternative A would not reverse the expected adverse habitat impacts, they would likely continue or worsen in Indiana Dunes National Lakeshore and would occur over the long term.	Impact on deer under alternative B would be adverse, long term, and major. Actions such as the use of fencing and exclosures and increased use of repellents would help maintain plant diversity in only very limited areas; because the effect of reproductive control on the deer population would not be seen for many years, the overall long-term effect of alternative B would be expected to remain at major adverse levels for the life of this plan. Past, present, and future activities, when combined with continued pressure on vegetation resources and deer habitat expected under this alternative, would result in adverse, long-term, moderate to major impact. Because alternative B would provide for reproductive control of the deer herd and a potential for gradual reduction in deer herd numbers over an extended period, impacts may diminish at some point beyond the life of the plan.	The relatively rapid reduction of the deer herd and the resulting regeneration of forage under alternative C would result in beneficial effects on deer habitat and would reduce adverse impact to negligible or minor levels over the long term as the deer population decreased. Adverse impact would still range from minor to moderate while habitat recovered. Past, present, and future activities, when combined with the reduced browsing pressure expected under this alternative, would result in long-term, beneficial cumulative impact on deer.	Implementing long-term deer population reduction and management through the use of sharpshooting and reproductive control under alternative D would have long-term and beneficial effects, and adverse impacts on deer habitat would be reduced to negligible or minor levels over the long term as the deer population decreased. Reproductive controls, with the current technology, would help maintain adverse impacts at lower population levels. Past, present, and future activities, when combined with the reduced pressure on deer habitat expected under this alternative, would result in beneficial, long-term cumulative impacts on deer.

Impact Topic	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Combined Lethal and Nonlethal Actions (Preferred)
Other Wildlife and Wildlife Habitat	Habitat for wildlife species other than white-tailed deer would continue to be adversely affected by a large deer population and related browsing, resulting in a loss of ground/shrub habitat, decreased habitat diversity, and increased abundance of nonnative plants. A few predator species would benefit from a large deer population and a more open understory and ground cover, enabling them to see and catch prey more easily. However, the impact of large numbers of deer browsing on vegetation would adversely affect a large percentage of habitats for other wildlife (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles), resulting in adverse, long-term, and potentially major impact, depending on the species. Past, present, and future activities, combined with the continued pressure on ground/shrub habitat expected under this alternative, would result in both adverse and beneficial impacts, with adverse, long-term, major cumulative effects. Because alternative A would not reverse the expected long-term continued growth of the deer population, wildlife habitat would likely continue to be degraded.	Approximately 7 percent of the national lakeshore vegetation would benefit from constructing fencing and exclosures and increased use of repellents over the life of the plan. The remaining habitat, however, would continue to be subject to a high degree of deer browsing, adversely affecting both ground- and shrub-layer habitat for many other species of wildlife until reproductive controls took effect and reduced the deer population (more than 15 years). Overall, impact on other wildlife would be adverse and long term and would range from negligible (e.g., snapping turtles, spotted salamanders) to potentially major (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles), depending on the species. Past, present, and future activities, combined with the continued pressure on wildlife habitat expected under this alternative, would result in both adverse and beneficial effects, with adverse, long-term, moderate to major cumulative effects on other wildlife. Because alternative B would provide continued protection of certain areas of the national lakeshore over the long term and would introduce reproductive controls that could reduce deer numbers over an extended period of time, impacts may diminish at some point beyond the life of the plan.	Impact on other wildlife species and habitat would be beneficial and long term as a result of rapid reductions in deer numbers in the national lakeshore, thereby reducing deer-browsing pressure on vegetation and allowing increased abundance and diversity of other wildlife that depend on ground/shrub habitat, such as ovenbirds, wood frogs, eastern hognose snakes, and box turtles. Adverse, long-term effects would be reduced to negligible or minor levels over time. Human disturbances from trampling at bait stations, shooting from designated sites, or disposing of deer carcasses would be temporary and isolated within the national lakeshore. Therefore, the adverse impact of these actions on other wildlife species would be short term and negligible. Past, present, and future activities, combined with the reduced browsing pressure on ground/shrub habitat expected under this alternative, would result in long-term, beneficial cumulative impact on other wildlife.	Impact on other wildlife would be long term and beneficial because of rapidly reduced deer numbers in the national lakeshore, resulting in decreased browsing pressure on habitat and allowing increased abundance and diversity of other wildlife that depend on ground/shrub habitat, such as ovenbirds, wood frogs, eastern hognose snakes, and box turtles. Long-term management of the deer population would be implemented through the use of sharpshooting or reproductive control, resulting in continued, long-term, beneficial effects by maintaining the population at desired levels. Over time, the present adverse effects would be reduced to negligible or minor levels. Other wildlife would be temporarily affected by trampling at bait stations, shooting from designated sites, the application of reproductive control techniques, or disposal of deer carcasses. The adverse impact of these isolated actions on other wildlife would be short term and negligible. Past, present, and future activities, combined with the reduced pressure on habitat expected under this alternative, would result in beneficial, long-term cumulative effects on other wildlife.
Sensitive and Rare Species	Impacts on federal- and state-listed wildlife and plant species under alternative A would be both beneficial and adverse. Beneficial effects would result from maintaining fencing around known individual plants and rare plant communities and from establishing fencing around newly discovered rare plants in the national lakeshore. Overall, adverse, long-term, moderate to major impact on listed plant and wildlife species from excessive deer browsing and the resulting suppression of new, viable populations of sensitive and rare species in the national lakeshore would be expected. Past, present, and future activities, combined with the continued pressure on federal- and state-listed plant and wildlife species expected under this alternative, would result in both adverse and beneficial impact. Adverse cumulative impact would be long term and moderate to major. Because alternative A would not reverse the expected long-term high density or continued growth in the deer population, damage to vegetation and habitat would likely continue.	Impacts on federal- and state-listed plant and wildlife species under alternative B would be adverse, long-term, and moderate to major until reproductive controls on the national lakeshore deer herd were effective. Placing and maintaining exclosures would protect sensitive vegetation in about 7 percent of the national lakeshore over the life of the plan. These areas would include sensitive and rare plants, resulting in beneficial, long-term effects. However, adverse, long-term, minor to moderate impact from deer browsing would continue outside the exclosures. Past, present, and future activities, combined with the continued pressure on listed plant and wildlife species expected under this alternative, would result in both beneficial and adverse effects. Adverse cumulative impact would be long term and minor to moderate.	Impact on listed species under alternative C would be both beneficial and adverse. Beneficial effects would be expected as a result of a relatively rapid reduction in deer density and browsing pressure on native plant communities and federal- and state-listed species. Some deer browsing would continue even if the herd density was maintained at targeted levels. Potential impact on palatable sensitive plant species occurring outside fenced areas would be adverse, long term, and minor. Past, present, and future activities, combined with the continued pressure on federal- and state-listed species expected under this alternative, would result in both beneficial and adverse impact. Adverse cumulative effects would be long term and minor.	Impact on federal- and state-listed species under alternative D would be both beneficial and adverse. Beneficial impact would be expected as a result of reducing deer density and browsing pressure on listed plant species in the national lakeshore. Some deer browsing would continue, even with herd density maintained at targeted levels, but vegetation recovery would occur more rapidly than it would under alternative B. Potential impact on palatable sensitive plant species occurring outside fenced areas would be adverse, long term, and minor. Past, present, and future activities, combined with the continued pressure on federal- and state-listed plant species and wildlife habitat, would result in both beneficial and adverse effects. Adverse cumulative impact would be long term and minor.
Archeological Resources	Installing small-area protection fencing and maintaining the large-area exclosure to protect individual plant groupings would result in adverse, long-term, negligible impacts on national lakeshore archeological resources; however, the limited extent and location of potential disturbance associated with the fences and exclosures would minimize this likelihood. Furthermore, fences would be located so as to avoid direct impacts on archeological resources. Cumulative impact would be negligible to minor, resulting from ground disturbance.	Installing small-area protection fencing and large-area exclosures with multiple support posts could result in some ground disturbance that could affect unknown archeological resources. Locating fences and exclosures away from known resources and monitoring in potentially sensitive areas would result in adverse, long-term, negligible to minor impact. As in alternative A, installing small-area protection fences around individual plant groupings could result in adverse, long-term, negligible impact to national lakeshore archeological resources. Cumulative impact would be adverse, long term, and negligible.	Sharpshooting activities would have no direct impact on archeological resources. Bait stations and burial pits would not be placed on known archeological resources. As in alternative A, installing small fences could result in adverse, long-term, negligible impact on national lakeshore archeological resources. Cumulative impact would be adverse, long term, and negligible to minor to national lakeshore archeological resources, resulting from ground disturbance.	Reducing the deer population via sharpshooting and the use of reproductive controls would have no direct impact on archeological resources. Bait stations would not be placed on known archeological resources. Installing small-area fences or up to one large exclosure every other year could result in adverse effects, which would be offset by monitoring. Cumulative impact would be adverse, long term, and negligible, resulting from ongoing ground disturbance.
Cultural Landscapes	Continued growth of the deer population and the associated ongoing decline in the abundance and diversity of the native plant communities and decimation of crops would result in an adverse, long-term, minor impact to the cultural landscape. The use of small-area protection fencing and repellents to protect naturally occurring trees and other vegetation within or near the cultural landscape could result in beneficial, long-term, minor effects on these parts of the cultural landscape's vegetation. Adverse, long-term, minor cumulative effects would result from the ongoing decline of native plant communities as a result of deer browsing and crop decimation, despite benefits from the use of this alternative's protective measures and exotic species control.	The use of additional fencing and exclosures would allow regeneration of native woody plant populations outside of the cultural landscape but would not inhibit crop damage from deer within the cultural landscape, resulting in adverse, long-term, minor effects. Deer repellents would be used to protect specific landscaped areas and crops, resulting in beneficial, long-term, minor effects. The use of reproductive controls, if implemented, could also result in further beneficial, long-term, minor effects over the long term by reducing the deer population and subsequent browsing and crop decimation. Beneficial, long-term, minor cumulative impact would result from some regeneration of native plant populations, the control of nonnative species, and crop protection.	Reduced browsing pressure and crop damage from sharpshooting would allow native plant populations to regenerate throughout the national lakeshore, and small fenced areas and repellents would help protect other character-defining vegetation within the cultural landscape. These actions would result in beneficial, long-term, moderate impact on Chellberg Farm and component cultural landscapes. Cumulative effects would be beneficial, long term, and moderate, resulting from crop protection and regeneration of native plant populations, which would benefit the forested landscape component.	Reducing the deer populations via sharpshooting and the use of reproductive controls would have no impact on the cultural landscape. Bait stations would not be placed within the boundaries of the cultural landscape. Installing small-area fences or up to one large exclosure every other year could result in adverse effects, which would be offset by monitoring. Cumulative impact would be primarily beneficial, long term, and moderate.

Impact Topic	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Combined Lethal and Nonlethal Actions (Preferred)
Visitor Use and Experience	Overall impact on visitor use and experience under this alternative would be negligible for beach users, who are the majority of national lakeshore visitors. Visitors who appreciate seeing deer would experience negligible beneficial effects; amateur botanists, birdwatchers, butterfly watchers, and people seeking other wildlife in their natural habitat would experience negligible to moderate adverse impact, depending on the extent of increased browse pressure and the type of species affected. Implementing the no-action alternative may result in continuation of high levels of visitor satisfaction; however, visitors would not be able to experience a balanced, functioning ecosystem unless deer numbers are reduced. Cumulative impact would be both beneficial and adverse and would range from negligible to minor, depending on the visitor's goals.	Wildlife viewers, amateur botanists, and other visitors would experience beneficial minor to moderate impact related to increased sightings of species protected by fencing, exclosures, and repellents and negligible to minor adverse impact reactions to visual intrusions and disruptions. Cumulative impact would also be both beneficial and adverse and range from negligible to minor, depending on the visitor's goals.	Adverse impact on visitors would be short term and result from required national lakeshore closures or negative responses to sharpshooting activities and would range from negligible to moderate. Beneficial results from a decrease in browse impacts include the ability to experience a wider range of natural resources in the long term. Cumulative impact would be both adverse and beneficial, ranging from negligible to moderate, as well, depending on visitors' beliefs and reasons for coming to the national lakeshore.	Adverse impact on visitors would be short term and result from required national lakeshore closures or negative responses to sharpshooting activities and would range from negligible to moderate. Beneficial effects would result from a decrease in browse impact on natural resources. Cumulative impact would be adverse and beneficial, ranging from minor to moderate.
Visitor Health and Safety	Impact related to increasing deer–vehicle collisions would be adverse, long term, and negligible. Indirect effects related to possible Lyme disease transmission would be adverse, long term, and negligible. Cumulative impact related to improved road safety and hunting on adjacent lands would be primarily adverse, long term, and negligible to minor.	Deer–vehicle collisions and the possibility of disease transmission could increase in the short term, until reproductive controls take effect. Hunters on neighboring lands could experience the indirect effects of treating deer with reproductive controls. Overall impact on visitor health and safety would be adverse, long term, and negligible. Cumulative impact would be primarily adverse, long term, and minor.	Impact on visitor health and safety as a result of using firearms within the national lakeshore would be adverse, primarily for local residents. However, safety measures would be taken to offset potential risks, and sharpshooting would occur when visitation is low and residents are likely to be indoors, resulting in adverse, short-term, minor impacts. Impact intensity would diminish in the long term as the need to continue sharpshooting diminishes. Cumulative impact would be adverse, minor to moderate, and short term, diminishing in intensity in the long term.	Impact on visitor health and safety as a result of using firearms would be adverse, primarily for local residents. However, safety measures would be taken to offset potential risks, resulting in adverse, short-term, minor impacts. Impact intensity would diminish in the long term as the herd size decreases. Cumulative impacts would be adverse, moderate, and short term, diminishing in intensity in the long term.
Employee Health and Safety	Impact would be adverse, long term, and negligible to minor under this alternative. Cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore; these impacts would be adverse, long term, and minor to moderate, as the national lakeshore is not meeting its current safety goal.	Impact would be adverse, long term, and negligible to minor under this alternative. Cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore; these impacts would be adverse, long term, and moderate, as the national lakeshore is not meeting its current safety goal.	Impact would be adverse, long term, and negligible to minor, as adequate training and safety precautions would be applied to all sharpshooting activities. Cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore, as well as increased use of firearms in the region; these effects would be adverse, long term, and moderate.	Impact would be adverse, long term, and negligible to minor, as adequate training and safety precautions would be applied to all sharpshooting activities, as well as administration of reproductive controls. Cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore, as well as increased use of firearms in the area; these impacts would be adverse, long term, and moderate.
Soundscapes	No or negligible adverse impact on soundscapes would occur under alternative A. Cumulative impact would be minor to moderate and adverse in the short and long term because of the variety and abundance of noise sources that already exist around and within the national lakeshore, including the use of firearms for removing deer on neighboring lands.	Impact on soundscapes would be short term, negligible to minor, and adverse under alternative B because of intermittent construction and spraying activities. The degree of the impact would vary by location. However, even though individual construction and spraying events would be short term, they would continue indefinitely into the future, resulting in a long-term, negligible to minor adverse impact. Cumulative impact resulting primarily from the variety and abundance of existing noise sources and the continuation of hunting on neighboring lands would be minor to moderate and adverse in the short and long term.	Impact on soundscapes from sharpshooting would be short term and long term and adverse, primarily affecting local residents because sharpshooting would occur primarily at night and during off-peak visitation seasons. Perception of the intensity of the impact would vary depending on several factors, including attenuation levels, distance from the source, and attitude toward the action, resulting in minor to moderate impact on individuals experiencing the sound. Cumulative impact would be adverse, short term and long term, and moderate. However, these effects would be expected to decrease in the long term as deer populations in all affected areas decrease and the need for direct reduction decreases, as well.	Overall impact on soundscapes under this alternative would be short term, adverse, and minor to moderate, particularly resulting from the use of firearms. Perception of impact intensity would vary depending on several factors, particularly the reaction to firearms. However, long-term impact would be expected to decrease as the overall herd population decreases, reducing the need for direct reduction. Given the planned continuance of hunting on neighboring lands and the urban, industrialized nature of the national lakeshore's surroundings, cumulative impact would be adverse, short term and long term, and moderate.
Socioeconomics	Continuing to exceed the carrying capacity for deer population would result in additional damage to landscaping, vegetation, and crops (corn and soybeans) on agricultural and other private and state lands adjacent to the national lakeshore as a result of increased deer browsing. This additional damage would result in adverse, long-term, minor to moderate impact on residents and farmers. The extent of agricultural damage and the degree of impact depend on the farmers' crops, location relative to the national lakeshore, and whether deer would use private lands within their existing home range and/or expand or shift their home range as browse became scarcer within the national lakeshore. Large fluctuations in annual deer populations could result in varying impacts. Landowners would also incur additional costs for fencing, repellents, managed hunts, and other forms of deer control to protect their crops and landscaping. Cumulative impact would be adverse, short term and long term, and moderate because of crop and landscaping damage and would include the costs of local deer removal efforts and the economic impact of combined hunting expenditures on the local economy.	Under alternative B, reproductive controls (if successful) would allow for only a gradual reduction in the number of deer; further, there could be some displacement of deer from the national lakeshore because of exclosures, which could result in slightly greater per-acre damage to landscaping, vegetation, and field crops (e.g., corn and soybeans) on adjacent private lands than under alternative A. Adverse, long-term effects on farmers would be moderate. The extent of damage and degree of impact would depend on such factors as the location of the crop relative to the national lakeshore, deer feeding habits, and whether deer would use private lands within their existing home range and/or expand or shift their home range as browse became scarcer within the national lakeshore. Over the long term, reproductive controls could lessen adverse browsing impacts. Potential large annual fluctuations in the deer population and the presence of exclosures could render short-term impacts more severe than under alternative A, resulting in adverse, short-term, moderate impacts on farmers and other landowners. Landowners would also incur additional costs for fencing, repellents, hunting, and other forms of deer control to protect their crops, vegetation, and landscaping. Cumulative impact would be adverse and moderate over the short and long term.	The reduction of the existing deer population in both the short and the long term could result in fewer deer leaving the national lakeshore and browsing on crops, vegetation, and landscaping on adjacent lands, assuming that these lands are within the home range of the national lakeshore's deer population. The degree of reduction in crop damage is unknown; however, the reduction would most likely be measurable, reducing adverse effects on farmers and other landowners to minor over the short and long term by increasing harvested yield, preserving landscaping, and preserving vegetation in the state park. A corresponding decline in costs for fencing, repellents, hunting, and other forms of deer control to protect crops and other vegetation could also occur. Cumulative impact would be beneficial compared to alternative A; adverse impact would be reduced to minor over the short and long term.	Sharpshooting would affect crop and landscaping damage to the same degree as alternative C. Therefore, crop and landscaping damage would be reduced, resulting in beneficial effects compared to alternative A. Deer-browsing impact would continue at some level, but adverse impact on farmers and other landowners from improved harvest yields and preserved landscaping and vegetation would be reduced to negligible or minor levels over the short and long terms. Costs to farmers and other landowners for fencing, repellents, and other forms of deer control could also decline. Cumulative impact would be beneficial compared to alternative A, and adverse impact would be reduced to minor.

Impact Topic	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Combined Lethal and Nonlethal Actions (Preferred)
National Lakeshore Management and Operations	Alternative A would result in negligible long-term impacts on national lakeshore management and operations, as national lakeshore staff continues creating and monitoring small-area protection fencing and applying repellents in limited situations. Cumulative impact on national lakeshore management and operations would be long term and negligible to minor.	Alternative B would result in minor to possibly major long-term adverse impact on national lakeshore management and operations because of increased deer management activities, particularly erecting a large number of exclosures, monitoring and maintaining them, and administering reproductive control of does. Cumulative impact would be adverse, long term, and major.	Under this alternative, the national lakeshore would experience short-term, adverse, and minor to moderate effects. Long-term effects would also be adverse and moderate, as associated costs accrue each year. However, the need to establish small fences and apply repellents to protect plant species may diminish as the deer population decreases, offsetting a small portion of costs associated with deer management. Cumulative impacts would be adverse, short or long term (depending on the number of years required to implement deer management actions), and moderate.	Impact would be similar to alternative B, but on a smaller scale, as fewer fences and exclosures would be constructed and reproductive control would be used only as a maintenance tool. Impact would also be most similar to alternative C, because sharpshooting would be implemented in the same manner, resulting in adverse, long-term, and moderate effects. Cumulative impact would be adverse, short or long term, and moderate.

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Chapter 1

PURPOSE OF AND NEED FOR ACTION

CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

This chapter explains what this plan intends to accomplish and why the National Park Service (NPS) is taking action at this time. This W*hite-Tailed Deer Management Plan/Environmental Impact Statement* presents three action alternatives for managing white-tailed deer, and it assesses the effect of continuing the current management framework (alternative A, the no-action alternative) and implementation of any of the three action alternatives. At the end of the decision-making process, the selected alternative will become the white-tailed deer management plan and will guide future actions for 15 years. Brief summaries of both purpose and need are presented here. Additional information is available in the "National Lakeshore Background" section of this chapter.

PURPOSE OF THE PLAN/ENVIRONMENTAL IMPACT STATEMENT

The purposes of this plan and environmental impact statement (EIS) are as follows:

- Describe a scientifically based system of checks and balances, such as monitoring and active management, to ensure that the deer population at the national lakeshore does not preclude long-term conservation of sensitive plant and animal populations.
- Determine how to manage deer populations to prevent degradation of national lakeshore resources.
- Identify and share with neighboring citizens and local governments the best technical information and expertise on deer management.
- Identify and maintain a deer impact level that is in balance with other components of the ecosystem and other national lakeshore values.
- Facilitate public support, education, and appreciation for maintaining the integrity of that ecosystem.

NEED FOR ACTION

A deer management plan is needed for the national lakeshore to ensure that the local deer population does not become a dominant force within the national lakeshore that negatively influences ecosystem components, such as sensitive vegetation or other wildlife.

Because the local deer population at the Indiana Dunes National Lakeshore threatens to become a dominant negative influence on ecosystem components within the national lakeshore, such as sensitive vegetation or other wildlife, the time for preventive action, in the form of a deer management plan, is now. Although national lakeshore staff implements certain resource management actions to protect resources, such as sensitive plant species (see "Related Laws, Policies, Plans, and Constraints" in chapter 1 for a list of related plans), no specific deer management plan exists, and the impact of an uncontrolled deer population on these resources would compromise the national lakeshore's purpose of preserving the exceptional biodiversity found within its boundaries. A deer management plan should address

- the effect of overabundant deer on the restoration and viability of sensitive plant communities within the national lakeshore
- the effect of overabundant deer on sensitive animal species within the national lakeshore
- the overall health of the local deer herd

Objectives in Taking Action

Objectives define what must be achieved for an action to be considered a success. Alternatives selected for detailed analysis must meet all objectives and thereby resolve the purpose of and need for action.

Using the national lakeshore's enabling legislation, mandates, and direction in other planning documents, as well as NPS servicewide objectives, management policies, and the Organic Act, national lakeshore staff identified the following management objectives relative to deer management at Indiana Dunes National Lakeshore.

Management Methodology

- Determine a science-based, well-informed, and defensible vegetation impact level that would serve as a threshold for taking management action within the national lakeshore.
- Develop and implement an adaptive management approach (Porter and Underwood 1999) for maintaining a viable deer population within Indiana Dunes National Lakeshore.

Wildlife and Wildlife Habitat

- Maintain a healthy white-tailed deer population within the national lakeshore while protecting other national lakeshore resources.
- Protect lower-canopy and ground-nesting bird habitat from unacceptable adverse effects from overabundant deer.
- Protect habitat of sensitive and rare species from unacceptable adverse impact related to deer browsing.

Vegetation

- Ensure that deer browsing does not preclude conserving vegetation and sensitive plant populations.
- Ensure that deer browsing does not lead to the decline or extirpation of rare plant species.

Visitor and Employee Health and Safety

- Reduce the potential for health and safety impacts related to overabundant deer.

Visitor Experience

- Enable the public to experience a balanced, functioning Indiana Dunes National Lakeshore ecosystem where deer are not the driving force and to understand the natural role of deer in the ecosystem.

Cultural Resources

- Ensure that vegetation contributing to the national lakeshore's cultural landscape is protected from the adverse effects of deer behavior (browsing, trampling, seed dispersal).

PROJECT SITE LOCATION

The study area for this plan and EIS is Indiana Dunes National Lakeshore in its entirety (see Figure 1 on page 7). The national lakeshore is approximately 50 miles southeast of Chicago, IL, in the counties of Lake, Porter, and LaPorte in northwest Indiana's industrial–urban community. It encompasses 25 miles of Lake Michigan's southern shoreline and is bordered by Michigan City on the east and Gary on the west. The national lakeshore covers approximately 15,000 acres, including the 2,182-acre Indiana Dunes State Park, managed by the IDNR.

Cowles Beach area

Since the creation of the national lakeshore, development has increased to the point that most of its boundary now consists of homes, farms, roads, and businesses. As shown in Figure 1, residential communities, open rural areas, light and heavy industry, and agricultural lands exist within or adjacent to the national lakeshore's boundary (NPS 1993a). The national lakeshore is primarily divided into two large lakefront units by an industrial complex that includes two steel companies, a public service company, and the Port of Indiana. The national lakeshore's East Unit covers more than 8,000 acres (approximately 12 square miles) of land east of the Port of Indiana, and the West Unit covers 3,600 acres (approximately 5.5 square miles) of land west of the Port of Indiana. Pinhook Bog, the Heron Rookery, Hobart Prairie Grove, Calumet Prairie, and Hoosier Prairie are small, noncontiguous satellite units within the national lakeshore, with resources that differ from the lakefront units (NPS 1997a). (The Hoosier Prairie is owned and managed by the Indiana Division of Nature Preserves, and management of deer in this area is not included in this plan.) These smaller units are geographically separated from the East and West Units by major road and rail corridors, residential development, agricultural fields, and industrial development. It is believed that few deer successfully move between the smaller and larger national lakeshore units, given the distance, food availability, barriers caused by roads and traffic, and development.

NATIONAL LAKESHORE BACKGROUND

History of Indiana Dunes National Lakeshore

The legislation that authorized Indiana Dunes National Lakeshore in 1966 resulted from a movement that began in 1899. Three individuals helped make Indiana Dunes National Lakeshore a reality: Henry Cowles, a botanist from the University of Chicago; Paul H. Douglas, senator for the state of Illinois; and Dorothy R. Buell, an Ogden Dunes resident and teacher. In 1899, Henry Cowles published in the *Botanical Gazette* an article titled "Ecological Relations of the Vegetation on Sand Dunes of Lake Michigan" that brought international attention to the intricate ecosystems existing on the dunes (NPS n.d.c; NPS 2001c).

Despite this new awareness, a struggle between industry and preservation hampered development of Indiana Dunes National Lakeshore. In 1916, the region was booming with industry in the form of steel mills and power plants. The newly formed Prairie Club proposed that a portion of the Indiana dunes be protected from these commercial interests and maintained in its pristine condition for the enjoyment of the people. On October 30, 1916, only two months after the NPS was established (August 25, 1916), the Service's first director held hearings in Chicago to gauge public sentiment on a

"Sand Dunes National Park." Four hundred people attended and 42 people spoke in favor of the proposal; there were no opponents (NPS n.d.c, 2001c).

When the United States entered the First World War, national priorities changed and revenues were targeted for national defense. However, after a 10-year petition by the state of Indiana to preserve the dunes, Indiana Dunes State Park opened to the public in 1926. The state park was still relatively small in size and scope, and the push for a national park continued. A "Save the Dunes Council" was established in 1952 to help preserve the land (NPS n.d.c, 2001c).

Area politicians and business owners wished to maximize economic development by obtaining federal funds to construct a Port of Indiana, which would link the Great Lakes to the Atlantic Ocean shipping lanes via the St. Lawrence Seaway. As a result, the Save the Dunes Council began a nationwide drive to buy the land it sought to preserve. The Council's first success was the purchase of 56 acres in Porter County, the Cowles Tamarack Bog (NPS n.d.c, 2001c).

In 1961, President Kennedy took a stand on the national lakeshore, outlining a program to link the nation's economic vitality to a movement for conservation of the natural environment. This program became known as the Kennedy Compromise, 1963–1964. The Kennedy Compromise entailed creating a national lakeshore and a port to satisfy industrial needs. Then-Senator Paul H. Douglas of Illinois worked tirelessly to save the dunes, earning him the title of "the third senator from Indiana." In 1966, Douglas ensured that construction of the highly desired Burns Waterway Harbor (Port of Indiana) could occur only with the authorization of Indiana Dunes National Lakeshore (NPS n.d.c, 2001c).

Congress designated Indiana Dunes National Lakeshore as a unit of the national park system on November 5, 1966 (Public Law 89-761) (NPS 1993a). While the 1966 authorizing legislation included only 8,330 acres of land and water, four subsequent expansion bills for the national lakeshore (1976, 1980, 1986, and 1992) increased its size to more than 15,000 acres (NPS n.d.c, 2001c).

Overview of the National Lakeshore's Ecosystem

Biological diversity is one of the most important features of the national lakeshore. This diversity is many times greater than that of most areas of similar size because the national lakeshore is in several ecological transition zones, including where the northern conifers meet the temperate hardwood forests of the northern and eastern United States and the tallgrass prairies of the Midwest (NPS 1997a). Indiana Dunes National Lakeshore contains more than 1,445 species of vascular plants, of which 1,135 are native. The national lakeshore thus ranks third highest with respect to floristic diversity within all national park system units (NPS 1995c). This exceptional biological diversity was a primary reason for establishing the national lakeshore (see "Indiana Dunes National Lakeshore's Purpose and Significance" on page 5) (NPS 1997a).

Four national natural landmarks (NNLs), as well as one national historic landmark, exist within the boundaries of the national lakeshore (NPS 1995c), including Pinhook Bog, Cowles Bog, Hoosier Prairie, and Dunes Nature Preserve (NPS 2006a). (Hoosier Prairie and Dunes Nature Preserve are managed by other agencies.) The NNL program (administered by the NPS) recognizes and encourages conservation of outstanding examples of the country's natural history. It is the only natural areas program of national scope that identifies and recognizes the best examples of biological and geological features in both public and private ownership. The goals of the NNL program are to encourage the preservation of sites that illustrate the geological and ecological character of the United States, enhance the scientific and educational value of sites thus preserved, strengthen public appreciation of natural history, and foster a greater concern for the conservation of the nation's natural heritage. Many NNL sites are the best remaining examples of biological and geological features in the United States and possibly the world; such natural resources are irreplaceable. To date, fewer than 600 sites have been granted the NNL designation (NPS 2006a).

Designation as an NNL imposes no new land use restrictions, although participation in the NNL program involves a voluntary commitment on the part of the landowner(s) to retain the integrity of the NNL property as it was when designated. The NPS can terminate NNL status if stewardship results in a compromise of the values being recognized (NPS 2006a).

The national lakeshore's position in the midst of an urban and industrial setting, as well as increased visitation, has resulted in potential threats to its ecosystem. For example, the number of sensitive and rare plant species that have been extirpated from the national lakeshore has increased from 16 to 25 since 1986. Recognition of such threats occurred early in the national lakeshore's development. An extensive program was instituted in 1976 to monitor environmental conditions and carry out research to allow for effective management of these resources (NPS 1995c).

Indiana Dunes National Lakeshore's Purpose and Significance

Congress establishes national park system units to fulfill specified purposes reflecting a park's unique and significant resources. A park's purpose, as established by Congress, is the fundamental building block for its decisions to conserve resources while providing for the enjoyment of future generations.

Legislative Intent

Congress established Indiana Dunes National Lakeshore as a unit of the national park system on November 5, 1966, (Public Law 89-761) in order to "preserve for the educational, inspirational, and recreational use of the public certain portions of the Indiana Dunes and other areas of scenic, scientific, and historic interest and recreational value in the State of Indiana."

Purpose

The enabling legislation further states that the "National Lakeshore shall be permanently preserved in its present state, and no development or plan for the convenience of visitors shall be undertaken therein which would be incompatible with the preservation of the unique flora and fauna or the physiographic conditions now prevailing." Therefore, the purposes of the national lakeshore were designated as the following:

- Preserve, maintain, and restore the integrity and character of the natural resources and processes and protect cultural resource values.
- Provide educational, inspirational, and recreational opportunities compatible with preserving natural and cultural resource values.
- Inspire in the public an appreciation of and a sense of personal stewardship for national lakeshore resources.
- Interpret, encourage, and conduct scientific research in the tradition of pioneer investigators.

Significance


Cypripedium acaule

The following statements of significance explain why the national lakeshore is important to natural and cultural heritage:

- The national lakeshore contains exceptional biological diversity and outstanding floral richness resulting from the combination of complex geological processes and the convergence of several major North American life zones.
- The national lakeshore's cultural resources represent the cultural evolution of northern Indiana from prehistoric times to the present day.
- The national lakeshore's extensive reach of undeveloped dunes provides recreational, educational, and inspirational opportunities within a one-hour drive of a major metropolitan area.
- The national lakeshore offers outstanding opportunities for scientific research because of the diversity and complexity of its natural systems and provides a dynamic laboratory for early plant succession and faunal studies.
- The presence of heavy industry, long-standing transportation corridors, residential use areas, and natural areas at the Indiana Dunes National Lakeshore offers an outstanding opportunity to show visitors how these elements interrelate.
- The dunes provide a striking physical and inspirational relief to the surrounding flat and highly developed landscape.

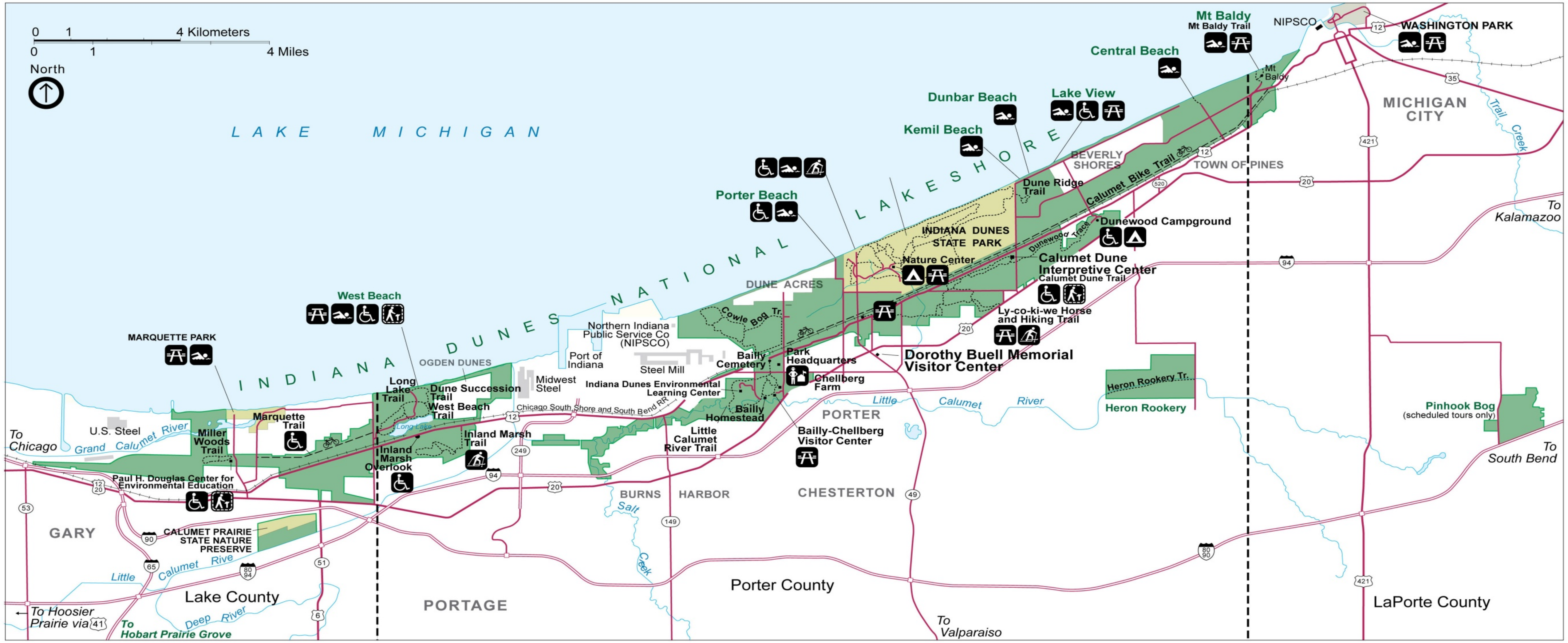
Mission Goals

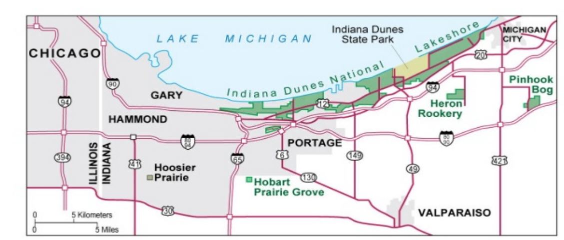
Indiana Dunes National Lakeshore's mission goals were created to support its overall purpose and to protect the resources that define its significance. Of the goals identified as important for managing national lakeshore resources and providing for visitor use and enjoyment, the following relate to deer management (NPS 1997d):

- The national lakeshore's natural and cultural resources and associated values are protected, restored, and maintained in good condition and managed within their broader ecosystem and cultural context.
- The national lakeshore contributes to knowledge about natural and cultural resources and associated values; management decisions affecting resources are based on scholarly and scientific information.

The national lakeshore is important to the area's natural and cultural heritage.

FIGURE 1: INDIANA DUNES NATIONAL LAKESHORE LOCATION





Campground	Swimming area	Cross-country ski trail	National Lakeshore	Hiking trail
Ranger station	Picnic area		State Park or Nature Preserve	Bicycle trail
Self-guiding trail	Wheelchair accessible			

Indiana Dunes National Lakeshore
White-tailed Deer Management Plan/EIS

Figure 1
Indiana Dunes National Lakeshore Location

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SCIENTIFIC BACKGROUND: DEER AND ECOSYSTEM MANAGEMENT

Deer Management Issues and Research Overview

The focus of this analysis is to develop deer management methods and strategies for Indiana Dunes National Lakeshore in cooperation with local, state, and regional entities, as well as other federal agencies. A science team consisting of scientists and other specialists from a variety of state and federal government organizations has helped to define components of the planning process. The team evaluated scientific literature and research on deer management, established a monitoring protocol for national lakeshore deer populations and other national lakeshore resources, and established resource thresholds at which deer management strategies would be implemented. The science team also addressed the possibility and implications of chronic wasting disease (CWD) infecting the national lakeshore's deer herd. Monitoring protocols and impact thresholds are components of all action alternatives evaluated in this analysis, helping to ensure that the deer population at the national lakeshore becomes a balanced component of a functioning ecosystem, not a dominant feature or driving force that causes impairment to other national lakeshore resources and values.

Regional Landscape-level Changes

White-tailed deer occur throughout Indiana, as well as the contiguous United States (with the exception of portions of the Southwest) (NPS 2002c). Before European settlement, North American white-tailed deer populations are estimated to have been between 23 and 24 million, or about 8 to 11 deer/mi^2 (McCabe and McCabe 1984). The deer population declined dramatically in the eastern United States after the Europeans arrived. White-tailed deer were found throughout the Indiana Territory but were probably wiped out by 1900 (Mumford and Whitaker 1982). By 1884, reports from within the state indicated that deer were becoming quite rare.

White-tailed deer were reintroduced in Indiana in 1934; by 1966, they were present in all counties in the state. Lack of natural predators and habitat alterations that resulted in favorable conditions for deer led to rapid population increase in Indiana and across the United States. The IDNR now estimates the statewide deer population at 300,000 animals, with 100,000 taken annually by hunters. This growth has placed increasing demands on natural resources and open space in the region and often results in a negative impact on other natural resources, such as vegetation and wildlife.

Eastern national park system units, such as the Indiana Dunes National Lakeshore, have been managed to allow for preservation and rehabilitation of scenic, scientific, and historic landscapes. The result is a mix of forest, shrub, and grassland that constitutes excellent habitat for white-tailed deer. For the aforementioned reasons, the deer population has greatly increased and currently exceeds 100 deer/mi^2 (40 deer/km^2) in some areas (Porter 1991). Researchers have established that such a high deer density can have a negative impact on plant and animal species (Alverson 1988; Anderson 1994; Augustine and Frelich 1998; DeCalesta 1994; McShea 2000; McShea and Rappole 2000).

Numerous authors have suggested that overabundant white-tailed deer can greatly alter the composition and structure of forest communities (Hough 1965; Frelich and Lorimer 1985; Alverson 1988; Strole and Anderson 1992; Balgooyen and Waller 1995; Redding 1995; Rooney and Dress 1997; Webster and Parker 1997; Augustine and Jordan 1998; Augustine and McNaughton 1998; Van Deelen 1999; Parker et al. n.d.). For example, excessive deer populations have caused regeneration failures and shifted ground-flora composition toward grasses and sedges in forests of the Allegheny Plateau in Pennsylvania (Marquis 1994; Horsley and Marquis 1983; Tilghman 1989; Trumbull et al. 1989). In an Ohio nature preserve, intense deer browsing of 155 to 181 deer/mi^2 (60 to 70 deer/km^2) was shown to be a more influential factor in determining seedling longevity and mortality than environmental gradients or climate factors (Boerner and Brinkman 1996). Reduced densities of woody regeneration and changes in the composition of ground-layer vegetation also have been observed in Indiana state parks with high deer populations (Webster and Parker 1997; Parker et al. n.d.). Long-term alterations of vegetation structure and composition by excessive deer browsing also negatively impact rare plant species (Miller et al. 1992), bird communities (Casey and Hein 1983; DeCalesta 1994), and the endangered Karner blue butterfly (Miller et al. 1992). Deer have become a major force in determining the structure of the natural community in some forest ecosystems (Waller and Alverson 1997).

If deer browsing is not controlled, the increasing impact leads to development of a “browse line.” The effect extends 1 to 2 meters from the ground up. As food becomes scarce, deer expand their diets to include plant species that they may not consume when vegetation is plentiful, ultimately resulting in browsing on nearly all vegetation within reach. All herbaceous (nonwoody) species and most shrub species are eliminated, leading to a visible browse line.

Deer browsing has also been shown to lead to a decline in nesting bird species richness. In oak hickory forest, deer feeding on acorns can depress eastern chipmunk (*Tamias striatus*) and white-footed mouse (*Peromyscus leucopus*) population numbers during low acorn mast years (McShea 2000). Increasing understory density and diversity by reducing deer density (McShea and Rappole 2000) can reverse the changes in bird communities and benefit migrant bird species.

Documentation of Deer Damage at Indiana Dunes National Lakeshore

To monitor damage from browsing, Indiana Dunes National Lakeshore has established three 20-square-meter fenced areas in several areas throughout the national lakeshore. These are near Howes Prairie (just west of the state park), within the Heron Rookery, and west of Beverly Shores. In the Cowles Bog area, one large-area exclosure comprising approximately 2 acres protects the only white cedar (*Thuja occidentalis*) population in Indiana, in addition to other sensitive plant species. The Cowles Bog exclosure is the only area that currently shows an obvious deer browse line (NPS 2003d).

Fencing deer out of the only population of northern white cedar in Indiana

One-meter-square plots have also been fenced at select known sites of rare vegetation that tend to be desirable to deer. These plots yield secondary benefits to the rare plant species by affording them protection. Preliminary monitoring data from plots located in the Dunewood deer management zone (in the national lakeshore’s East Unit) in spring 2006 show enough damage from deer browse to warrant taking management action (see “Indicator Species and Thresholds for Taking Action” in chapter 2). Other deer monitoring includes annual spotlight surveys (1991 to present) and several aerial infrared surveys of deer populations within the national lakeshore and adjacent communities.

Population and Ecological Characteristics of White-Tailed Deer at Indiana Dunes National Lakeshore

Since industrial and residential development in the 20th century, little hunting has occurred in the area of the national lakeshore. Hunting has not been permitted within the national lakeshore since it was established in 1966 and is not allowed in most national park system units in the eastern United States, because it is usually not authorized by a park’s enabling legislation. As a result of park management policies on hunting, changes in habitat, and dramatic declines in predator populations because of development, deer density can exceed 100 deer/mi^2 in many parks (Porter 1991). Growing deer populations are in conflict with resource management objectives (Porter 1992), including the requirements of such federal legislation as the Endangered Species Act, Clean Water Act, and National Environmental Policy Act (NEPA). Many entities, including federal and state agencies and local communities, have taken management actions to control deer populations to protect valuable resources and promote safety and visitor experience.

Deer density in sections of the East Unit of the national lakeshore has been estimated to be as high as 98 deer/mi^2 according to aerial infrared surveys. Numerous studies have demonstrated that deer densities this high can have unacceptable negative impact on plant and animal species, inconsistent with the national lakeshore's preservation mandate (Alverson 1988; Anderson 1994; Augustine and Frelich 1998; DeCalesta 1994; McShea 2000; McShea and Rappole 2000).

The community of Ogden Dunes, which is surrounded by the national lakeshore's West Unit, has not implemented deer management strategies. The communities of Dune Acres and Beverly Shores, as well as Indiana Dunes State Park, which are all surrounded by the national lakeshore's East Unit, have all implemented some type of deer management policy (NPS 2003d) (see "Deer Management by State and Other Federal Agencies and Local Communities" on page 13).

Impact from high deer density is greater in the national lakeshore's East Unit than the West Unit, resulting in a greater need for deer management in the East Unit. The East Unit may not tolerate browsing as well as other units because of the types of plant species located there. The West Unit is browsed less intensely than the East Unit, as vegetation of the West Unit is more open and contains oak savannas. Deer-browsing problems have not been observed at the Pinhook Bog unit (NPS 2003d). The Heron Rookery, a geographic satellite unit, contains ephemeral springs that support browse desired by deer.

The national lakeshore conducts prescribed burns each year—approximately three in the spring and two in the fall. The burns affect deer movements because the woodland understory is burned.

Effects of White-Tailed Deer on Ecosystem Diversity at Indiana Dunes National Lakeshore

Specific national lakeshore resources at risk from overabundant deer include sensitive vegetation communities and wildlife. Indiana Dunes National Lakeshore has more vascular plant species than most parks in the national park system. Of the 123 state-listed plant species within the national lakeshore, 1 is also federally listed. In addition, about 113 species of birds are considered regular nesters at the national lakeshore (Brock 1997), and many species, particularly ground- and intermediate-canopy nesters, are affected by deer browsing on vegetation (McShea and Rappole 2000). Decline of the national lakeshore's sensitive vegetation could affect visitor satisfaction, as many visitors hope to see rare plant species when visiting national lakeshore units.


Sandhill crane

The National Lakeshore's Current Deer Management Actions

Existing planning documents for Indiana Dunes National Lakeshore do not address deer management issues; thus, no substantial deer management actions have been implemented. Deer management efforts have been undertaken by nearby

Indiana Dunes State Park and the neighboring communities of Dune Acres and Beverly Shores. The NPS has received increasing pressure from these entities and others to control the deer population within the national lakeshore. Without management, deer populations are expected to continue to exceed carrying capacity.

Recommended Ecosystem Diversity Thresholds

Intense deer browsing on vegetation is a concern for NPS managers. The impact of intense deer browsing includes loss of plant species, which may cause a change in the diversity and structure of plant communities, and potential damage to wildlife. Biological diversity in eastern forests has declined as deer seek out and consume highly preferred plant species. A density of 21 deer/mi^2 appears too high for maintaining the diversity of all plants and animal species in northern hardwood forests (Alverson 1988). Deer population density as low as 10 deer/mi^2, may prevent regeneration of woody species such as white cedar, and of some herbaceous species, in northern Wisconsin (Alverson 1988). Large-flowered trillium (*Trillium grandiflorum*) is a plant species common to the Great Lakes region and is favored by deer. To maintain large-flowered trillium stem heights and flowering plants in deciduous forests in northeastern Illinois, a density of 10 to 16 deer/mi^2 is recommended (Anderson 1994). High deer density can skew trillium populations toward small plants and can lead to eradication of trillium and other sensitive forbs (Augustine and Frelich 1998).

Authority to Manage Deer

The NPS has broad authority to manage wildlife and other natural resources within the boundaries of units of the national park system. See, generally, 16 USC § 1 (NPS "shall promote and regulate the use of Federal areas known as national parks… by such means and measures as conform with the fundamental purpose of the parks… to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations"). In defining this discretion, the 10th Circuit Court of Appeals overturned a district court decision, holding in part that the NPS "need not wait until the damage through overbrowsing has taken its toll on park plant life… before taking preventative action" (*New Mexico State Game Commission v. Udall*, 410 F.2d 1197, 1201 [10th Cir. 1969]). This discretion has been reinforced over time. In *United States v. Moore*, 640 F.Supp. 164, 166 (S.D. W.VA. 1986), the Court found that Congress had given the secretary great discretion in regulating and controlling wildlife within the national park system. This discretion is further defined by NPS management policy.

NPS *Management Polices 2006*, section 4.4.2, states, "[w]henever possible, natural processes will be relied upon to maintain native plant and animal species and influence natural fluctuations in populations of these species. The Service may intervene to manage populations or individuals of native species only when such intervention will not cause unacceptable impacts to the populations of the species or to other components and processes of the ecosystems that support them." In addition, the policy restricts management to times when certain conditions exist. One such condition is that "a population occurs in an unnaturally high or low concentration as a result of human influences (such as loss of seasonal habitat, the extirpation of predators, the creation of highly productive habitat through agriculture or urban landscapes) and it is not possible to mitigate the effects of the human influences." Because deer populations at Indiana Dunes National Lakeshore are increasing at a rate that reflects the absence of effective predation and the presence of high-quality habitat in the national lakeshore and surrounding areas, policy permits active management of the species.

However, as part of any animal population management action, the NPS is required to follow an established planning process, including provisions for public review and comment. Section 4.4.2 of the NPS *Management Policies* also requires that parks "assess the results of managing plant and animal populations by conducting follow-up monitoring or other studies to determine the impacts of the management methods on nontargeted and targeted components of the ecosystem." This strategy is described in this plan, including specific thresholds for taking action and end points on management actions.

Other Deer Management Efforts

Deer Management Efforts within the National Park Service

Other national park system units have been involved in deer management planning efforts. Gettysburg National Military Park and Eisenhower National Historic Site completed a white-tailed deer management plan and EIS in 1995, and approved management strategies are now being implemented. Likewise, Catoctin Mountain National Park in Maryland and Valley Forge National Historical Park in Pennsylvania are now implementing deer management strategies. Deer management planning and environmental review efforts are currently being undertaken at Cuyahoga Valley National Park in Ohio and Rock Creek Park in the District of Columbia.

Deer Management by State and Other Federal Agencies and Local Communities

The Wildlife Services program of the Animal and Plant Health Inspection Service (APHIS) within the U.S. Department of Agriculture (USDA) has been involved in evaluating and/or implementing a number of deer management plans on federal properties in the eastern United States. Studies conducted for New Jersey and Virginia concluded that direct reduction of the deer population was the preferred alternative (USDA 2000a, 2000b). In Pennsylvania, the resulting management plan included a wide range of management options to assist landowners with damage control (USDA 2003).

Local communities and other entities surrounding Indiana Dunes National Lakeshore have taken action regarding white-tailed deer management within their boundaries. A 16-member Dunes Region Deer Study Committee was formed in February 1999 to "develop recommendations for the IDNR, other land holding agencies, and communities for managing deer along the Lake Michigan shoreline" (Case and Seng 1999). The areas of specific concern included Indiana Dunes State Park, Indiana Dunes National Lakeshore, and the towns of Dune Acres and Beverly Shores. The committee meetings resulted in the recommendation of sharpshooting and controlled hunts (firearms and bow). The community of Dune Acres was the first to implement a deer management program in the area, followed by Indiana Dunes State Park and the community of Beverly Shores.

Dune Acres

Beginning in 1997, Dune Acres implemented deer management controls using sharpshooters, with 50 deer taken the first year and between 0 and 25 deer taken in the following years. According to annual deer surveys conducted by Dune Acres, in early 2003, the number of deer had not noticeably changed and appeared to be concentrated near the residential area (Ceperich 2003a). Dune Acres, with assistance from IDNR, takes an annual assessment of deer damage to determine the number of deer to remove the following year. IDNR provides a special deer damage control permit to allow the use of rifles; however, the permit does not allow for the use of silencers or shooting at night. These efforts, which have been keeping the deer population constant, are expected to continue indefinitely into the future (R. Tittle, Dune Acres resident, pers. comm. 2003).

Indiana Dunes State Park

Excessive browsing by deer in Indiana's state parks was first reported in 1969 (IDNR 2001a). Browsing damage to Brown County State Park was assessed in 1990 and led to the formation of a Deer Study Committee in 1992. A report on the condition of Brown County State Park's vegetation, submitted in 1993, recommended action that resulted in removal of 392 deer (IDNR 2001a). (The report studied vegetative impacts of deer, not the health of the deer herd [J. Mitchell, IDNR, pers. comm. Sept. 13, 2005].) The Indiana State Legislature passed a law in 1995 directing the IDNR to take action in any or all state parks whenever a given species was causing or was likely to cause ecological damage. This law resulted in expansion of vegetation studies to several other parks in 1995. Vegetation assessments were used to make an annual recommendation on deer reduction from 1995 to 1999. Indiana Dunes State Park had its first reduction in 1998; by 1999, 17 parks had at least one reduction. A recommendation was issued in 2000 to use deer removed per hunter effort, or per square mile of park area, as a measure to determine which parks needed further deer herd reduction. For parks that have implemented reduction efforts, data on the reduction of any given year are now viewed by the state as a better indicator than vegetation analysis for monitoring the remaining deer population. These data also provide the tool for maintaining a long-term balance between deer and the parks' habitats (IDNR 2001a).

The IDNR recruited Dr. George Parker, a Purdue University forest ecologist, to develop the program that measured the damage to state parks and to create a schedule for deer herd reductions. Dr. Parker's program has been used each year to determine the need for reduction in each park (IDNR 2002a). On April 4, 2002, Dr. Parker presented his evaluation of the nine-year program, stating that most parks are now in a "maintenance phase," during which the goal is to keep the deer herd at a level compatible with a park's ecosystem. Initially, the goal was to substantially reduce the size of the herd to a level that the park could support without causing damage to the ecosystem. An updated model would be used for parks in the maintenance phase, which includes Indiana Dunes State Park (IDNR n.d.a). Under this system, the decision about deer removal would be made each January so that parks could be hunted the following fall, if necessary (IDNR 2002b). Reductions would occur when the previous year's removal rate exceeded 16 deer/mi^2 of deer habitat, or 0.2 deer removed per hunter effort (firearm reductions), in order to achieve deer-density goals. Whenever a year's removal rate fell below the criteria, no removal would occur the following year, but removal would be implemented after skipping a year.

Beverly Shores

In 2000, the town of Beverly Shores and the Humane Society of the United States (HSUS) applied to the IDNR for a permit to study whether reproductive control would be an effective method to control the town's deer population. The IDNR issued the permit in November 2000 but with restrictions that the HSUS claimed would render the study "ineffective and nearly impossible to complete." The HSUS sued the IDNR over the restrictions, but the case was dismissed in 2002. On December 6, 2002, the HSUS asked an administrative law judge to modify the original permit because a more effective deer control method had been found (Russell 2002; U.S. Sportsmen's Alliance 2002). However, the HSUS discontinued pursuit of the study and has not reapplied for a permit (J. Mitchell, IDNR, pers. comm. Sept. 14, 2005).

The town of Beverly Shores applied for a permit to control deer by sharpshooting in 2000. The town received approval from the IDNR in January 2001, but the permit was blocked in the courts until too late in the season to mount an effective removal; only one deer was shot. As a consequence, two members of the Beverly Shores town council abandoned their support for the town-administered deer removal effort, advocating that individual property owners be permitted to shoot deer on their own property (Beglin and Drake 2001).

Beverly Shores permitted sharpshooters to reduce the deer herd before hunting was permitted; bow hunting by resident invitation began in the 2001–2002 season and has continued since then (Sederberg 2002). During the 2000–2001 and 2001–2002 deer-hunting seasons, the town temporarily suspended its ban on firing weapons and allowed residents to allow bow hunters on their property (*Chesterton Tribune* 2003). However, in January 2003, the town council voted against another deer hunt, despite having already received permits allowing it (Ceperich 2003b), because five landowners requested individual out-of-season permits for their properties. The IDNR approved three of the permits for 10 deer each, but these permits were never used; when the landowners asked the town board for a variance to allow the discharge of bows outside of the regular hunting season, they were denied (L. Byer, IDNR, pers. comm. Sept. 20, 2005). The decision was immediately reversed during a special meeting that permitted hunting in the community (Ceperich 2003b). Hunting in 2003 was carried out exclusively with bow and arrow on sites of at least 30,000 square feet and with the permission of the landowners (Kasarda 2003a).

In 2000, after the town board voted in favor of a reduction in deer population to reduce depredation of native plant communities, the Citizens Coalition of Beverly Shores sued the IDNR for allowing the deer cull. The suit was lost in November 2001. The coalition then filed a lawsuit to prevent four families from allowing bow hunters on their properties; that suit was lost in 2003. Soon after, the families named in the suit filed a countersuit, citing malicious prosecution and abuse of process. In April 2004, the coalition's president and his lawyer agreed to pay the families $26,900 (*Chicago Wilderness Magazine* 2004; Kasarda 2003b).

In July 2005, a Beverly Shores couple was found guilty on two counts each of hunter harassment. The husband was also found guilty of a third and more serious offense of intimidation. The couple was accused of harassing hunters during a town-sanctioned deer kill in 2001 by driving through the town honking their horn and allowing their dog to bark. They are considering appealing the case, which would be the first legal challenge to the state's hunter harassment law, prohibiting interference with the legal taking of game animals. Another resident was charged with two counts of hunter harassment after hunters accused her of firing gunshots and attempting to scare deer as they hunted on a neighboring property in 2001 (Kasarda 2005a, 2005b).

The number of deer taken each year at the areas described above is shown in Table 1.

TABLE 1: REGIONAL WHITE-TAILED DEER REMOVAL NUMBERS FOR ENTITIES SURROUNDING INDIANA DUNES NATIONAL LAKESHORE

White-Tailed Deer Removal			
Year	Dune Acres	Indiana Dunes State Park	Beverly Shores
	Number of Deer	Number of Deer	Number of Deer
1997-1998	50	0	0
1998-1999	0	201	0
1999-2000	19	117	0
2000-2001	<10*	102	1
2001–2002	25	53	~70
2002–2003	25	No hunt	53
2003–2004	30	99	144
2004–2005	50	48	107

*Cull permit was for 10 deer.
~ Estimate; exact number not known.
Source: NPS 2003d; L. Byer, IDNR, pers. comm. Sept. 20, 2005, and Sept. 13, 2005.

Indiana Dunes State Park is mostly enclosed by a fence that is too high for deer to jump. However, the fence has some breaches and is not entirely continuous. Beverly Shores amended a fencing ordinance to allow residents to fence for deer, but none of the communities within the boundaries of the national lakeshore is surrounded by fencing. Deer can move freely between these communities and the national lakeshore (NPS 2003d).

Other Ecosystem Management Issues

Role of Invasive Exotic Plant Species

Invasive (nonnative or exotic) plant species are a serious threat to the vegetation at Indiana Dunes National Lakeshore (Table 2). Disturbance to vegetation by excessive deer browsing could create opportunities for invasive plants to become established or further spread within the national lakeshore. The national lakeshore is working to reduce the population of these undesirable species, with a goal of eventually eliminating them. Periodically, NPS staff mechanically treats and removes invasive species throughout NPS lands, sometimes in conjunction with prescribed burning in prairie areas. (Prescribed fire does not occur in Pinhook Bog or the Heron Rookery.) Mechanical removal can include pulling, cutting, sawing, limbing, and applying herbicides to stumps. Intensive programs to remove purple loosestrife (*Lythrum salicaria*), garlic mustard (*Alliaria petiolata*), and an invasive hybrid cattail (*Typha* x *glauca*) are underway.

National lakeshore staff has released galerucella beetles (*Galerucella calmariensis*) as a means of biological control of purple loosestrife. Studies have shown that galerucella eat only purple loosestrife, and once the plant is no longer available, the beetle dies. This method of controlling the spread of purple loosestrife has been successful in certain areas of the national lakeshore, but it would take years to substantially impact the entire population. Other methods of control include cutting or pulling plants and applying herbicides (NPS n.d.g).

TABLE 2: INVASIVE SPECIES AT INDIANA DUNES NATIONAL LAKESHORE

Common Name	Scientific Name	Treatment Method
Tree of heaven	Ailanthus altissima	Cut and herbicide stump or foliar herbicide application to saplings and resprouts
Garlic mustard	Alliaria petiolata	Pull, foliar herbicide application, or scorch
Japanese barberry	Berberis thunbergii	Pull, cut and herbicide stump, or foliar herbicide application
Oriental bittersweet	Celastrus orbiculatus	Cut and herbicide stump
Spotted knapweed	Centaurea maculosa	Foliar herbicide application
Thistle	Cirsium sp.	Foliar herbicide application
Olive	Eleagnus sp.	Cut and herbicide stump
Burning bush	Euonymus alatus	Cut and herbicide stump
Common baby's breath	Gypsophila paniculata	Not treated to date
Dame's rocket	Hesperis matronalis	Pull
Honeysuckle	Lonicera sp.	Cut and herbicide stump or foliar herbicide application to saplings and resprouts
Purple loosestrife	Lythrum salicaria	Biological control and foliar herbicide application
Sweet clover	Melilotus sp.	Pull or foliar herbicide application
Reed canary grass	Phalaris arundinacea	Foliar herbicide application
Common reed	Phragmites australis	Foliar herbicide application
Japanese knotweed	Polygonum cuspidatum	Cut and herbicide stump
Buckthorn	Rhamnus sp.	Cut and herbicide stump
Black locust	Robinia pseudoacacia	Cut and herbicide stump or foliar herbicide application to saplings and resprouts
Multiflora rose	Rosa multiflora	Cut and herbicide stump or foliar herbicide application
Narrow-leaved cattail	Typha angustifolia	Foliar herbicide application

Role of Pests and Disease

Gypsy Moth

In conjunction with the state and the U.S. Forest Service, NPS staff monitors the national lakeshore for gypsy moths (*Lymantria dispar*). Gypsy moth caterpillars feed on the leaves of particular hardwood trees and can cause complete defoliation of a tree, affecting the vigor and general health of forests and shade trees and leading to tree death, subsequently altering wildlife habitat and affecting water quality and quantity. A contractor-applied product called Disrupt® II is a controlled-release pheromone dispenser designed to lower mating of gypsy moths by disrupting normal male flight orientation to females. This reduction in mating helps suppress the larval (caterpillar) population that causes damage by feeding on the leaves of hardwoods and evergreens. Disrupt® II is recommended for small gypsy moth populations.

Disrupt® II was applied throughout the national lakeshore by crop duster four times, once each in 1999, 2002, 2003, and 2004. Spraying took place in June or July, with successful results. The pheromone will be applied again on an as-needed basis.

Asian Longhorn Beetle and Emerald Ash Borer

The national lakeshore's East and West Units are divided by an industrial area that includes the Port of Indiana at Burns Harbor, part of a statewide system of ports and foreign trade zones. Because international shipments arrive at this harbor, NPS staff monitors the national lakeshore for the Asian longhorned beetle (*Anoplophora glabripennis*) and the emerald ash borer (*Agrilus planipennis*), two pest species that have arrived in the region from overseas.

Trees infested by Asian longhorned beetles were first found in New York in 1996 and then in Chicago in 1998 (USDA 2004a). The Chicago Harbor, an international shipping port approximately 35 miles from Indiana's Burns Harbor, could have been the entryway for the beetle into the area.

Native to China and Korea, the Asian longhorned beetle has caused widespread mortality of poplar, willow, elm, and maple throughout vast areas of China. So far, the only way to stop the spread has been to cut down and remove infested trees. Detection of infested trees has largely depended on visual examination. NPS staff monitors the national lakeshore for the Asian longhorned beetle, but no formal pest management plan addressing this insect exists.

The emerald ash borer is a recently reported (summer 2002) beetle from Asia that attacks and kills ash (*Fraxinus* spp.) trees in southern lower Michigan; adjacent Windsor, Canada; and locations in Ohio and Indiana, including Porter County. The Michigan Department of Agriculture and the USDA have placed a quarantine on counties in southeast Michigan to reduce the likelihood of transporting the beetle outside the currently infested area. Additional quarantine areas exist in Ohio and Indiana (USDA 2006a), as well as the national lakeshore.

Larvae feed in the phloem and outer sapwood, eventually girdling and killing branches and entire trees. On April 21, 2004, the emerald ash borer was confirmed in Indiana and has been found in LaGrange and Steuben counties, directly east of the national lakeshore. Indiana implemented a quarantine for emerald ash borers in these counties. Lake County, which includes the western end of the national lakeshore, is under evaluation, as symptoms have appeared there (IDNR n.d.b). Indiana Dunes National Lakeshore has no formal pest management plan for this new arrival but is monitoring for its presence on NPS land.

Role of Fire

In presettlement days, naturally occurring fires cleared the dead wood and maintained the national lakeshore's prairie and savanna habitats. During the years when fire suppression was the rule, a great many of these open habitats were lost or substantially altered. Not only did this response reduce habitat diversity, but it reduced plant and animal diversity, as well (NPS n.d.c).

Wildland fire played a substantial role in shaping the natural landscape of the area. Although the frequency of fires before settlement is not certain, the area burned often, perhaps every four to eight years. Vegetation and fire frequency are affected by proximity to Lake Michigan. Fires occurred most often in the western end of the national lakeshore, where spread from the west was not blocked by the lake and where lake-effect humidity is lowest (NPS 2005b).

The black oak vegetation complex experiences the majority of wildland fires at the national lakeshore, undergoing one of the largest fires reported since the national lakeshore was established. Multiple fire starts on a given day are not unusual. Upland oak–hickory forests are more fire sensitive than black oak forests, but where more mesic species (those that are adapted to an environment having a balanced supply of moisture) are present, fires occur less frequently. Pockets of cattail and other marsh grasses have contributed to large fires in the past, and frequent fires sweeping from the Great Marsh have advanced into the dunes, where they were eventually stopped by geographic features and cooler, moister air near the lake (NPS 2005b).

Inland marsh prescribed fire

NPS staff responds to an average of 35 wildland fires annually within the national lakeshore. Wildland fires on NPS lands burned an average of 263 acres per year within a 10-year period. The majority of these fires were less than 1 acre in size and were human-caused (NPS 2005b).

Although the national lakeshore's current *Fire Management Plan* (2005) calls for suppression of all wildland fires, prescribed fire is used in support of ecosystem management objectives to maintain and/or restore plant communities, cycle nutrients, reduce or remove exotic plants, manage habitat for wildlife, and protect and enhance cultural landscapes. Prescribed fire, in combination with mechanical and chemical treatments, can also be used to accomplish resource management goals, such as helping to eradicate invasive species (NPS 2005b). Today, the national lakeshore's prescribed burn program is restoring the area's prairies and savannas and helping to maintain critical habitat for the endangered Karner blue butterfly (NPS n.d.c).

The staff uses mechanical means to reduce hazard fuel levels, either independently or in combination with prescribed burning. However, before selecting prescribed burning, other management options are considered, such as cutting, scattering, and chipping (NPS 2005b).

One of the strategic objectives of the national lakeshore's *Fire Management Plan* is to use prescribed fire to accomplish resource management objectives, such as restoring and maintaining oak savannas or creating wildlife habitat. This objective supports the following goals of this deer management plan:

- Protect vegetation, sensitive plant populations, and rare plant species.
- Protect lower-canopy and ground-nesting bird habitat.
- Protect habitat of sensitive and rare species.

The *Fire Management Plan* includes several more detailed, fire-related vegetation management objectives and overall vegetation management objectives specific to particular vegetation communities.

Role of Great Marsh Restoration

The national lakeshore is restoring portions of an extensive wetland complex called the Great Marsh, which is south of the primary dunes in the eastern half of the national lakeshore. Concerted efforts to drain the Great Marsh occurred in the late 19th and early 20th centuries, resulting in numerous ditches of various sizes. Photographs from as recently as the 1930s and oral history from senior residents depict a vast expanse of native species represented by sedges, grasses, rushes, and shallow marsh forbs, punctuated infrequently by woody vegetation. Today, the Great Marsh is a mix of upland and wetland weedy trees and forbs commingling within a substrate of compromised hydrology. One of the national lakeshore's primary goals is to return this ecosystem—to the extent possible—to the conditions that existed before substantial human alterations began. A North American Wetlands Conservation grant provided funding to initiate restoration of the Great Marsh's hydrology. By plugging ditches, restoring the area's hydrology, removing invasive plants, and planting native species, the national lakeshore is re-creating this diverse ecosystem. Approximately 500 acres of the Great Marsh is targeted for native botanical resource restoration. Because wetlands naturally filter contaminated water, restoring the Great Marsh would also help improve the area's water quality (NPS n.d.c; n.d.h).

Role of Home Site Restoration

When Indiana Dunes National Lakeshore was established in 1966, nearly 1,000 commercial buildings and home sites were included within the national lakeshore's boundary. A number of historic structures were preserved, and some other buildings were renovated to create office space, interpretive centers, and other facilities. However, the majority of these buildings are being removed to restore the natural areas that were once present. Resource managers collect seeds from a variety of native plants within the national lakeshore to ensure that these areas are planted with native species of local genotype (NPS n.d.c).

DESIRED CONDITIONS

This section defines the desired conditions for Indiana Dunes National Lakeshore, which are connected to this plan's purpose, need, and objectives. The following objectives were factored into the desired condition of attaining a healthy and sustainable ecosystem by

- maintaining a healthy white-tailed deer population while protecting other national lakeshore resources
- protecting lower-canopy and ground-nesting bird habitat from unacceptable adverse effects of overabundant deer
- protecting habitat of sensitive and rare species from unacceptable adverse effects related to deer browsing
- ensuring that deer browsing does not preclude conserving vegetation and sensitive plant populations
- preventing deer-browsing impact from leading to the decline or eradication of rare plant species

A Sustainable Deer Population

Deer are a natural part of the ecosystem and play an important role in it. One of the objectives of this plan (under "Management Methodology" on page 2) is to maintain a sustainable white-tailed deer population in the national lakeshore (other objectives protect other national lakeshore resources). Therefore, a definition of "sustainable white-tailed deer population" is needed to ensure that actions taken under this plan meet the objective. For this plan, a sustainable deer population is defined as one that allows the perpetuation of a healthy and sustainable ecosystem while maintaining a healthy deer population in the national lakeshore.

A Healthy and Sustainable Ecosystem

Meeting the objectives above would help resolve the need to take action, which includes preserving the exceptional species richness found within the national lakeshore's boundaries. Once such desired conditions are reached, deer management actions would focus on maintenance activities designed to maintain a sustainable deer population within an ecosystem that approximates natural conditions. Therefore, a definition of "natural conditions" was needed to clearly identify when the goal is met and when transition into maintenance activities can occur.

As defined for this plan, an ecosystem that approximates natural conditions is an ecological community that has the ability to maintain species richness. Species richness encompasses structures and functions of an ecosystem and would be achieved through self-sustaining ecosystem maintenance over time.

Several factors contribute to the biological integrity of an ecosystem. Although excessive deer browsing can be a negative factor, the roles of other negative factors (such as exotic plant species) and factors that can be positive or negative (such as fire and pests) have also shaped and defined the national lakeshore's current ecosystem. Therefore, the effect of deer browsing on the biological integrity of an ecosystem cannot be evaluated in seclusion; the evaluation must also consider those factors that are included in the assessment of cumulative impacts in Chapter 4: Environmental Consequences.

SCOPING PROCESS AND PUBLIC PARTICIPATION

Scoping is an "early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action."

NEPA regulations (40 CFR 1500-1508) require an "early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action." To determine the scope of issues to be analyzed in depth in this plan, meetings were conducted with national lakeshore staff and other parties associated with preparing this document.

The issue statements developed by the interdisciplinary team are presented below. These issues formed the basis for the impact topics discussed in chapters 3 and 4 of this EIS.

Issues and Impact Topics

Vegetation

At certain a population level, deer browsing and activity patterns may adversely affect native plant communities, including populations of sensitive plant species. Not only plant species that deer particularly favor but the overall structure of plant communities can be affected by browse lines or the affinity of deer for certain species. Some forest understory species are at risk of being eradicated from the national lakeshore, particularly *Trillium* spp., because deer prefer it and it occurs in isolated patches.

Deer activity may also create conditions that favor the increase of invasive nonnative plants through disturbance and transportation of seeds to uninfested areas (Vellend 2002). Further, deer activity hinders efforts to contain nonnative plants once they have taken hold.

Continued deer browsing could both damage and benefit vegetation in wetland areas. The national lakeshore contains some cattail marsh areas that were historically sedge meadows. Deer paths in these areas allow other plant species to survive by reducing competition and allowing light to penetrate to the soil. On the other hand, deer feeding in wetland areas may have a negative impact on some rare wetland plant species and may hinder restoration efforts.

Using bait to attract deer to a particular area could result in a disproportionate impact to vegetation in areas near established bait piles. In addition, activities that result in fencing off deer to vegetation would result in decreased browse pressure in the enclosure and beneficial impacts on vegetation.

Soils

Deer-browsing pressure may result in loss of ground cover, which could increase the potential for soil erosion, possibly resulting in sedimentation in the national lakeshore's creeks. Effective deer management could protect vegetative cover, thus aiding in soil retention and reducing erosion, sedimentation in streams, and velocity of water from runoff.

Water Quality

Water quality is an issue of concern because of the many sources of contamination in the watershed. The potential for contamination is exceptionally high at the national lakeshore because of the proximity of heavy industry, transportation corridors, and agricultural lands. As described, water quality and quantity could be affected by loss of ground cover; a reduction of vegetative cover by deer browsing could result in lower water quality, whereas activities to manage deer would protect ground cover, and reduced browsing could improve or maintain water quality.

Increased amounts of deer fecal material also could affect water quality. In addition, deer management activities that remove vegetation could result in increased erosion and sedimentation.

Wildlife and Wildlife Habitat

At certain levels, deer populations have adverse effects on other wildlife and habitat through browsing. A number of bird species at Indiana Dunes National Lakeshore depend on lower-canopy or ground-level nesting habitat. Deer browsing has been shown to cause a reduction in abundance and diversity of these species (DeCalesta 1994). Deer browsing can lead to a 27-percent decline in the richness and abundance of nesting bird species (i.e., number of species) and a 37-percent decline in the number of individual birds (DeCalesta 1994). Deer can also have an impact on small mammal populations through competition for food, such as acorns (McShea 2000).

Diseases to which deer are susceptible could affect other wildlife species or the health of the deer population. An outbreak of CWD, which is typically fatal, would require quick implementation of management actions and cooperation with the IDNR and the Centers for Disease Control and Prevention (CDC) to protect the deer population. Although CWD infects elk, white-tailed deer, mule deer, and moose, it is not known to infect livestock or humans at the present time (USGS 2003).

CWD has been detected in deer in Rockford, IL, which is approximately 80 miles from the national lakeshore. White-tailed deer appear more susceptible than mule deer and elk to CWD, with a greater percentage of the herd becoming infected. Positive cases of CWD were first confirmed in free-ranging populations in western states. CWD has been found in white-tailed deer herds in Colorado, Wyoming, and Nebraska, where deer occur at densities of approximately 2 to 5 deer/mi^2. In contrast, infected deer in Wisconsin were found at approximately 35 animals per square mile after the 2003–2004 hunting season (WDNR 2005). As of June 2008, CWD has been found in West Virginia, Illinois, and New York. No one knows how rapidly CWD infects white-tailed deer at these densities or what long-term effect this disease would have on a herd (WDNR 2005).

Deer management activities could also affect other wildlife and wildlife habitat. The use of bait piles could provide an additional food source for some species, while fencing could restrict access to certain wildlife habitat. In addition, the presence of increased human activities during specific time periods and associated noise could result in temporary behavior changes and avoidance of management areas.

Sensitive and Rare Species

Habitat for sensitive and rare wildlife may be vulnerable to impact from high levels of deer browsing. The Karner blue butterfly (*Lycaeides melissa samuelis* Nabokov), for example, in the larval stage has a single food source—wild lupine (*Lupinus perennis*). Heavy deer browsing on wild lupine in one area was shown to have consumed 90 percent of lupine plants (Packer 1994). If lupine abundance were to decrease, so would Karner blue butterfly abundance. Deer can also be an incidental predator on Karner blue butterfly larvae while browsing on lupine (Schweitzer 1994). The national lakeshore contains 123 species of state-listed rare or sensitive plant species, 1 of which is also federally listed, that could be negatively affected by overbrowsing. Seeds of the Pitcher's thistle (*Cirsium pitcheri*), which is listed as threatened both federally and at the state level, are subject to predispersal and postdispersal herbivory. Predispersal herbivores include the artichoke plume moth larvae (*Platyptilia carduidactyla*), ground squirrels, goldfinches (*Spinus tristis*), and deer. Similarly, Phillips and Maun (1996) found that simulating intense deer herbivory in greenhouse-grown plants reduced the dry weight of the plant root. Pitcher's thistle plants may respond to intense herbivory by decreasing or delaying flowering or by having lower survivorship or decreased growth. Limited fencing as a deer management activity could provide some protection for these listed plant species.

Archeological Resources

Approximately 240 prehistoric archeological sites have been identified within the national lakeshore, which are currently interpreted as seasonal campsites, focusing on the variety of resources available in the dune and wetland ecosystems. Certain deer management actions called for under the alternatives in this plan have the potential to affect archeological resources, primarily building fences for vegetation exclosures and spraying chemical repellents.

Cultural Landscapes

In some cases, the presence and activities of deer may affect the historical accuracy of a given site by creating conditions that differ from the historical situation. A high level of deer activity may affect the ability of the national lakeshore to maintain historically accurate cultural landscapes, particularly Chellberg Farm. The farm's garden and cornfield are important historical components that have been substantially damaged by deer and raccoon feeding. The farm dates to the late 19th century, when deer populations were extremely low if not already extirpated, which is dramatically different from the current situation. Certain deer management activities that result in the construction of fences or the alteration of the landscape may have the potential to impact designated cultural landscapes.

Visitor Use and Experience

If deer management activities were to decrease the number of deer in the national lakeshore, chance sightings by visitors would also decrease. Some visitors may view deer sightings as an integral part of their visits. Deer management actions may decrease the potential for visitors to observe deer in the national lakeshore, causing lower visitor satisfaction. However, visitors who come to the national lakeshore to watch birds or search for rare plants may be less satisfied as deer numbers increase and rare plants and birds decrease.

When the national lakeshore is conducting deer management actions, visitor access to areas of concern would be restricted for certain periods of time. Visitor access restrictions may reduce visitor satisfaction during these times.

Visitor and Employee Health and Safety

Overabundant deer can create problems for the health and safety of both NPS employees and the public. Specific issues are described below.

Health-related issues involve exposure to Lyme disease, which could affect employees, visitors, or area residents. Lyme disease is an infection caused by *Borrelia burgdorferi*, a type of bacterium called a spirochete that is carried by deer ticks that commonly feed on white-tailed deer. An infected tick can transmit the spirochete to the humans and animals it bites.

In areas where deer have become accustomed to people, some visitors perceive them as tame animals and may become injured when they come in close contact. Deer that have been fed by residents of nearby communities can pose a threat to visitors because these animals may approach people for food. Visitors enjoy seeing wildlife and may offer food to animals that have learned to beg. Deer could potentially injure someone attempting to feed them.

Vehicle collisions with deer are a concern for the public in the national lakeshore. Increased numbers of deer result in increased chances for and frequency of vehicle collisions, which can cause injury or fatality to visitors or employees.

Implementing certain deer management alternatives also could affect the safety of NPS employees and the public. Employees could become injured while constructing fences or administering some types of deer management activities. In particular, any proposed lethal action (sharpshooting) poses risks to employees and the public (visitors and local residents). Deer management activities would need to be conducted so as to ensure the safety of national lakeshore visitors and employees.

Soundscapes

Certain deer management strategies—use of firearms, for example—may cause disturbance to soundscapes. Peak sound levels from rifles and shotguns can range from 152 decibels (dB) to 170 dB for the person discharging the firearm (Musani n.d.). However, 55 dB is commonly considered the threshold for defining noise in terms of day/night sound levels in urban areas (Schomer 2001). In addition, gunfire may arouse a negative response in some people because of unpleasant associations with guns and what they represent (Truax 1999). Noises of an impulsive nature (such as gunfire) may cause a startle reflex even at low dB levels (WHO 1980). Therefore, impacts from firearms could affect local residents, national lakeshore visitors, and wildlife.

Socioeconomic Impacts Related to Deer Damage

Excessive deer browsing, resulting in crop and landscape plant damage to neighboring lands, has led local communities and the state park in the national lakeshore boundaries to take action to manage white-tailed deer on their lands. A 16-member Dunes Region Deer Study Committee was formed in February 1999 to "develop recommendations for the IDNR, other land holding agencies, and communities for managing deer along the Lake Michigan shoreline" (Case and Seng 1999). The areas of specific concern included Indiana Dunes State Park, Indiana Dunes National Lakeshore, and the towns of Dune Acres and Beverly Shores. The committee recommended sharpshooting and controlled hunts (firearms and bow). In addition, local farmers with land adjacent to the national lakeshore have received deer damage control permits to hunt deer on their property.

National Lakeshore Management and Operations

Impact to National Lakeshore Operations from Increased Management Needs

Depending on the actions implemented, deer management may require additional resources. These could include building and maintaining fencing, administering reproductive controls, engaging in direct reduction, or conducting deer population surveys. NPS staff would also collect and send specimens from dead deer to a lab to be tested for CWD. (Deer would not be killed solely for this purpose.)

Conflict with State and Local Ordinances and Policies Regarding Deer Management

Some state and local governments have taken action, or are considering taking action, to manage deer populations within their jurisdictions. Although the national lakeshore may not be a part of these local actions, consistency with state and local plans must be evaluated.

The communities of Dune Acres and Beverly Shores, along with Indiana Dunes State Park, have taken action to manage deer populations within their boundaries. The proximity of the national lakeshore to these communities may mean that management actions undertaken at the national lakeshore benefit these entities.

Other Issues Considered but Eliminated from Further Consideration

The following issues were reviewed and subsequently eliminated from further discussion because potential deer management strategies would cause few, if any, changes to these resources:

- Geohazards — No effects related to deer management would occur from geohazards because no such hazards exist in the national lakeshore.
- Air Quality — Section 118 of the 1963 Clean Air Act (42 USC 7401 et seq.) requires a park unit to meet all federal, state, and local air pollution standards. Further, the Clean Air Act (CAA) provides that the federal land manager has an affirmative responsibility to protect air quality–related values (including visibility, plants, animals, soils, water quality, cultural resources, and visitor health) from adverse pollution impacts. NPS *Management Policies 2006* (NPS 2006b) directs parks to seek the best air quality possible in order to "preserve natural resources and systems; preserve cultural resources; and sustain visitor enjoyment, human health, and scenic vistas."

  The Indiana Dunes (as well as the states of Indiana and Illinois) has been designated a Class II airshed in accordance with the CAA. Under the CAA, as amended in 1990, the counties constituting the Chicago consolidated metropolitan statistical area were designated as an ozone nonattainment area, with a classification of severe nonattainment of the ozone standard. Through advances in technology and regulatory programs, substantial reductions in ozone-causing pollutants in the entire Lake Michigan region have occurred. However, because the area is impacted by ozone transport from upwind areas, additional local control measures cannot, by themselves, bring the area into attainment (Indiana Government n.d.).

  Deer management activities as described under the proposed alternatives would minimally affect air quality, and no long-term effects on air quality are anticipated. eliminatedAlthough applying repellents and firing guns can create odors and a small amount of fugitive emissions, these actions would be very limited and short term. Measures to limit drift or excess use would be followed during application of any repellents. For these reasons, air quality has been eliminated as an issue.

- Marine or Estuarine Resources — No marine or estuarine resources exist within Indiana Dunes National Lakeshore.
- Energy Resources — No effects on energy resources are anticipated under this plan because none of the proposed actions would affect energy resources.
- Prime or Unique Farmland — No prime or unique farmland exists with the national lakeshore's boundaries. Effects on agricultural lands that border the national lakeshore are addressed under the "Socioeconomics" discussion.
- Geothermal Resources — No geothermal resources exist within the national lakeshore's boundaries.
- Paleontological Resources — No known paleontological resources exist within the national lakeshore's boundaries.
- Floodplains — The NPS *Procedural Manual #77-2: Floodplain Management* (NPS 2003f) provides agency-specific guidance for implementing Executive Order 11988, Floodplain Management. According to the guideline, an action class and applicable regulatory floodplain must be identified for a proposed action that is either subject to possible harm from flooding or has the potential for adverse floodplain impacts. Deer management actions are not expected to affect the national lakeshore's floodplains, and possible flood events are not expected to affect deer management actions.
- Historic Structures — Although the national lakeshore does contain several historic structures, they would not be affected by deer browse or by proposed actions related to managing deer.
- Museum Collections — None of the proposed actions would affect museum collections.
- Ethnographic Resources — No ethnographic resources or issues have been identified at Indiana Dunes National Lakeshore that would be affected by deer management activities.
- Indian Sacred Sites — Because no tribes ever settled within the national lakeshore, and no tribes make claims to the area, this plan would not restrict access to ceremonial use of Indian sacred sites.
- Environmental Justice — The actions under this plan are not expected to have a disproportionate or significant adverse effect on any low-income or minority populations in the area.
- Social Values — This plan is not expected to have an adverse effect on the social values of national lakeshore visitors.
- Nonnative Species — Although the role of exotic plant species is important to deer management for the reasons described above (see "Role of Invasive Plant Species" on page 16), this problem is being addressed separately as the national lakeshore takes management actions and applies necessary treatments. Exotic plant management actions are evaluated in this plan as a cumulative effect in Chapter 4: Environmental Consequences.

RELATED LAWS, POLICIES, PLANS, AND CONSTRAINTS

NPS Organic Act

By enacting the NPS Organic Act of 1916, Congress directed the U.S. Department of the Interior and the NPS to manage units of the national park system "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 USC 1). The Redwood National Park Expansion Act of 1978 reiterates this mandate by stating that the NPS must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 USC 1 a-1).

Despite these mandates, the Organic Act and its amendments afford the NPS latitude when making resource decisions regarding visitor use and resource preservation. Through these acts, Congress "empowered [the NPS] with the authority to determine what uses of park resources are proper and what proportion of the park's resources are available for each use" (*Bicycle Trails Council of Marin v. Babbitt,* 82 F.3d 1445, 1453 [9th Cir. 1996]).

Nevertheless, courts have consistently interpreted the Organic Act and its amendments to stress resource conservation. *Michigan United Conservation Clubs v. Lujan,* 949 F.2d 202, 206 (6th Cir. 1991) states, "Congress placed specific emphasis on conservation." In *National Rifle Ass'n of America v. Potter*, 628 F. Supp. 903, 909 (D.D.C. 1986), the court stated, "In the Organic Act Congress speaks of but a single purpose, namely, conservation." NPS *Management Policies 2006* (NPS 2006b) also recognizes that resource conservation takes precedence over visitor recreation. The policy dictates, "when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant" (NPS 2006b).

Because conservation remains predominant, the NPS seeks to avoid or minimize adverse effects on park resources and values. However, the NPS has discretion to allow negative effects when necessary (NPS 2006b, sec. 1.4.3).

While some actions and activities have negative effects, the NPS cannot allow an adverse impact that constitutes impairment to a resource (NPS 2006b, sec. 1.4.3). Actions that impair park resources are prohibited unless a law directly and specifically allows for such actions (16 USC 1a-1). An action constitutes an impairment when, in the professional judgment of the responsible manager, its effects "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS 2006b, sec. 1.4.4). To determine impairment, the NPS must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts" (NPS 2006b, sec. 1.4.4). Therefore, this plan assesses the effects of the management alternatives on national lakeshore resources and values, and it determines whether these effects would cause impairment. The impairment determination for the preferred alternative is included in appendix A of this EIS.

An impact on any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment when it has a major adverse effect on a resource or value whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park, (2) identified as key to the natural or cultural integrity of the park, or (3) identified as a goal in the park's general management plan or other relevant NPS planning documents.

NPS Management Policies 2006

Several sections from NPS *Management Policies 2006* (NPS 2006b) are relevant to deer management in Indiana Dunes National Lakeshore, as described below.

NPS *Management Policies 2006* instructs park units to maintain, as parts of the natural ecosystems of parks, all native plants and animals by "preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur" (NPS 2006b, sec. 4.4.1).

Furthermore, the NPS "will adopt park resource preservation, development, and use management strategies that are intended to maintain the natural population fluctuations and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks" (NPS 2006b, sec. 4.4.1.1).

Whenever the NPS identifies a possible need for reducing the size of a park plant or animal population, the decision will be based on scientifically valid resource information obtained through consultation with technical experts, literature review, inventory, monitoring, or research (NPS 2006b, sec. 4.4.2.1). The science team, as previously discussed, was assembled to complete this task.

Section 4.4.2 of the NPS *Management Policies 2006* also states:

> Whenever possible, natural processes will be relied upon to maintain native plant and animal species, and to influence natural fluctuations in populations of these species. The [NPS] may intervene to manage individuals or populations of native species… when at least one of the following conditions exists:

Management is necessary

- Because a population occurs in unnaturally high or low concentration as a result of human influences (such as loss of seasonal habitat, the extirpation of predators, the creation of highly productive habitat through agriculture or urban landscapes) and it is not possible to mitigate the effects of the human influences
- To protect specific cultural resources of parks
- To protect rare, threatened, or endangered species (NPS 2006b, sec. 4.4.2)

Section 4.4.2.1 of the NPS *Management Policies 2006* states:

> Where visitor use or human activities cannot be modified or curtailed, the NPS may directly reduce the animal population by using several animal population management techniques, either separately or together. These techniques include relocation, public hunting on lands outside the park or where legislatively authorized within a park, habitat management, predator restoration, reproductive intervention, and destruction of animals by NPS personnel or their authorized agents. Where animal populations are reduced, destroyed animals may be left in natural areas of the park to decompose unless there are human safety concerns regarding attraction of potentially harmful scavengers to populated sites or trails or other human health and sanitary concerns associated with decomposition. (NPS 2006b)

Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decisionmaking

NPS Director's Order #12 and its accompanying handbook (NPS 2001a) lay the groundwork for how the NPS complies with NEPA. Director's Order #12 and the handbook set forth a planning process for incorporating scientific and technical information and establishing an administrative record for NPS projects.

Director's Order #12 requires that impacts on park resources be analyzed in terms of their context, duration, and intensity. It is crucial for the public and decisionmakers to understand the implications of those impacts in the short and long term, cumulatively, and in context, based on an understanding and interpretation by resource professionals and specialists.

Natural Resources Reference Manual, NPS 77

The *Natural Resource Reference Manual* 77, (http://www.nature.nps.gov/rm77/) which supersedes the 1991 *NPS 77: Natural Resource Management Guideline*, provides guidance for NPS employees responsible for managing, conserving, and protecting the natural resources found in national park system units.

Impairment Standard

NPS *Management Policies 2006* (sec. 1.4) requires analysis of potential effects to determine whether or not proposed actions would impair a park's resources and values.

The fundamental purpose of the national park system, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values. However, the laws give NPS the management discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of the park. That discretion is limited by the statutory requirement that NPS must leave resources and values unimpaired unless a particular law directly and specifically provides otherwise.

The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values (NPS 2006b).

Whether an impact meets this definition depends on the particular resources that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts.

An impact on any park resource or value may, but does not necessarily, constitute impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park
- key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park
- identified in the park's general management plan or other relevant NPS planning documents as being of significance

An impact would be less likely to constitute an impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and it cannot be further mitigated.

Impairment may result from visitor activities; NPS administrative activities; or activities undertaken by concessioners, contractors, and others operating in the park. Impairment may also result from sources or activities outside the park.

Impairment findings are not necessary when considering visitor experience, socioeconomics, public health and safety, environmental justice, land use, park operations, and so on, because impairment findings relate only to park resources and values. The determination of impairment for the deer management preferred alternative is found in appendix A.

OTHER LEGISLATION, COMPLIANCE, AND NPS POLICY

In addition to the Organic Act, NPS is governed by laws and regulations. These include those described in the following paragraphs.

Migratory Bird Treaty Act of 1918

The Migratory Bird Treaty Act of 1918 implements various treaties and conventions among the United States, Canada, Japan, Mexico, and the former Soviet Union to protect migratory birds. Under the treaty, signatories agree to forswear the following activities, unless permitted by regulation:

> pursue, hunt, take, capture or kill, possess, offer for sale or sell, purchase, transport, or export, at any time, or in any manner, any migratory bird, included in the terms of this Convention… for the protection of migratory birds… or any part, nest, or egg of any such bird. (16 USC 703)

Executive Order 13186 (2001) defines the responsibilities of federal agencies to protect migratory birds and directs executive departments and agencies to take certain actions to further implement the act. Each federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations is directed to develop and implement, within two years, a memorandum of understanding with the U.S. Fish and Wildlife Service (USFWS) that shall promote the conservation of migratory bird populations.

National Historic Preservation Act of 1966, as Amended

Section 106 of the National Historic Preservation Act requires that federal agencies consider the effects of their undertakings on properties listed or potentially eligible for listing on the National Register of Historic Places. All actions affecting the national lakeshore's cultural resources must comply with this legislation.

National Environmental Policy Act, 1969, as Amended

Section 102(2)(c) of NEPA requires that an EIS be prepared for major federal actions that may significantly affect the quality of the human environment.

Endangered Species Act of 1973, as Amended

The purpose of the Endangered Species Act (ESA) is to conserve "the ecosystems upon which endangered and threatened species depend" and to conserve and recover listed species. "Endangered" means a species is in danger of extinction; "threatened" means a species is likely to become endangered. The law also requires federal agencies to consult with the USFWS to ensure that the actions they take, including actions chosen under this deer management plan, do not jeopardize listed species or designated critical habitat.

Code of Federal Regulations, Title 36

Title 36 of the Code of Federal Regulations provides the regulations "for the proper use, management, government, and protection of persons, property, and natural and cultural resources within areas under the jurisdiction of the National Park Service" (36 CFR 1.1(a)).

Code of Federal Regulations, Title 43

Title 43 of the Code of Federal Regulations, part 24, describes the four major systems of federal lands administered by the Department of the Interior. Section 24.4(f) states, "Units of the national park system contain natural, recreation, historic, and cultural values of national significance as designated by Executive and Congressional action." In describing appropriate activities, the section further states, "[a]s a general rule, consumptive resource utilization is prohibited."

In addition, section 24.4(i) instructs all federal agencies of the Department of the Interior, among other things, to "[p]repare fish and wildlife management plans in cooperation with State fish and wildlife agencies and other Federal (non-Interior) agencies where appropriate." It also directs agencies to "[c]onsult with the States and comply with State permit requirements… except in instances where the Secretary of the Interior determines that such compliance would prevent him from carrying out his statutory responsibilities."

Executive Order 11990, Protection of Wetlands

This executive order directs NPS to avoid, to the extent possible, the long- and short-term adverse effects associated with destroying or modifying wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

RELATIONSHIP TO OTHER PLANNING DOCUMENTS FOR INDIANA DUNES NATIONAL LAKESHORE

The following plans for Indiana Dunes National Lakeshore were considered in the development of this plan.

Statement for Management, Indiana Dunes National Lakeshore, 1993

This document contains information about the national lakeshore's purpose and significance, influences on national lakeshore resources, major issues, and management objectives of the national lakeshore. This document mentions abundant deer as a potential threat to stability of the natural ecosystem.

Indiana Dunes National Lakeshore General Management Plan, 1997

The 1997 General Management Plan combines NPS's 1992 West Unit General Management Plan Amendment, 1991 Little Calumet River Corridor Plan, and 1997 East Unit General Management Plan Amendment. It defines the management philosophy and goals for national lakeshore decisionmaking and problem solving for 20 years following the plan.

Indiana Dunes National Lakeshore Strategic Plan, 1997

This plan identifies mission goals representing the future (20+ years) for the national lakeshore. It includes formulation of long-term goals under each mission goal and estimation of costs associated with implementation of the strategic plan.

RELATED PLANS, POLICIES, AND ACTIONS

Plans, policies, and actions defined or taken by other agencies or organizations could also affect actions proposed under this plan.

Other Deer Management Actions

As previously mentioned, surrounding entities have implemented deer management controls through deer removal efforts. Efforts have taken place at Indiana Dunes State Park, as well as the communities of Dune Acres and Beverly Shores. The Shirley Heinze Land Trust, which preserves and protects the unique ecosystems of the Indiana dunes region through acquiring and restoring environmentally significant properties, owns a parcel that requires deer management measures. Therefore, the trust is allowing hunting on the parcel during deer season. The national lakeshore is within IDNR's Chesterson and Michigan City urban management zones. These zones allow more liberal hunting policies and offer an incentive for hunters to remove additional deer from these areas by increasing the bag limit for the area during the hunting season. The provision does not override any local ordinances restricting shooting of firearms and bows. Hunters must obtain permission from landowners to hunt on their property (IDNR 2007). Future implementation of these control efforts has the potential to affect deer management efforts undertaken by the national lakeshore.

Transportation Plans and Projects

The Northwestern Indiana Regional Planning Commission (NIRPC) developed a draft "Connections 2030 Regional Transportation Plan," a three-county transportation plan to guide how federal highway and transit funds are used in northwest Indiana, as well as a Pedestrian and Bicycle Plan, which was adopted in January 2005 (NIRPC n.d.a). These plans could affect transportation, development, or congestion in the area, a result that could further impact habitat if additional development occurred or could affect the number of collisions between deer and vehicles.

Future transportation projects could impact national lakeshore resources either directly through construction activity or indirectly through changing traffic patterns. The Interstate 80/94 corridor is the most highly traveled truck route in Indiana, and transportation in the area may affect wildlife, visitor enjoyment, air quality, and other national lakeshore resources. In addition, several state and county roadways are in the vicinity of the national lakeshore. The Indiana Department of Transportation publications website (n.d.) lists ongoing and future road projects in the 2000–2025 *Long Range Plan*. The following transportation projects are among those listed for the LaPorte District that could affect national lakeshore resources:

- additional travel lanes to State Road 149 from Lenburg Road to U.S. 20 in Burns Harbor
- new road construction of U.S. 421 from Interstate 80/90 (toll road) to Interstate 94
- additional travel lanes to State Road 49 from Interstate 94 to Oak Hill Road in Chesterton
- additional travel lanes to U.S. Highway 6, 0.4 miles east of State Road 51 to Scottsdale Road, 2.4 miles west of State Road 149

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Chapter 2
ALTERNATIVES

CHAPTER 2: ALTERNATIVES

This chapter describes the various possible actions that could be implemented for current and future deer management in the Indiana Dunes National Lakeshore. NEPA requires federal agencies to explore a range of reasonable alternatives and to analyze what impacts these alternatives could have on the human environment (which NEPA defines as the natural and physical environment and the relationship of people with that environment). The analysis of environmental impacts is presented in Chapter 4: Environmental Consequences and is summarized in a table near the end of this chapter.

The alternatives under consideration must include a no-action alternative, as prescribed by the NEPA regulations at 40 CFR 1502.14. The no-action alternative in this document is the continuation of current management with no major changes to current management actions.

The interdisciplinary planning team developed three action alternatives, taking into consideration feedback from the public and the science team during the planning process. These alternatives meet, to a large degree, the management objectives for the Indiana Dunes National Lakeshore, as well as the purpose of and need for action, as expressed in chapter 1. Because these action alternatives would meet the national lakeshore's objectives and would be technically and economically feasible, they are considered "reasonable."

INTRODUCTION AND OVERVIEW OF ALTERNATIVES

This chapter describes the alternatives developed by the interdisciplinary team for this *Final White-Tailed Deer Management Plan/Environmental Impact Statement*, as well as the background information used in setting a deer-density goal. It presents an action threshold for implementing the preferred alternative, based on support of a healthy and sustainable ecosystem. All alternatives were developed to meet this plan's purpose, need, and objectives. Inputs from the science team and the public were considered and used to refine the preliminary alternatives as the planning process progressed.

The alternatives selected for detailed analysis are briefly described below. This description is followed by a description of the national lakeshore's deer-density goal and the threshold for taking action, which are needed to fully understand the action alternatives (i.e., alternatives B, C, and D). Next, detailed descriptions of each alternative are presented, followed by a discussion of adaptive management and how it would be applied to the alternatives. The remainder of the chapter addresses alternatives that were considered but eliminated from detailed analysis and, finally, the selection of the agency's environmentally preferred alternative.

No-Action Alternative

Alternative A: No Action (Existing Management Continued) — Under alternative A (no action), current deer management actions would continue, including the use of limited protection fencing and an exclosure, limited use of repellents, and careful inventorying and monitoring. No new deer management actions would be taken.

Action Alternatives

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control — Alternative B would include all actions described under alternative A above but would also incorporate nonlethal actions to protect vegetation and to gradually reduce deer numbers in the national lakeshore. The additional actions would include the construction of additional small-area protection fences, which would measure less than 4 square meters (referred to throughout this document as "fencing" or "fences") and large-area exclosures (referred to throughout this document as "exclosures"). There would be more extensive use of repellents in areas where fences or exclosures would not be appropriate or feasible. In addition, reproductive control of does would be phased in when a federally approved fertility control agent is available for application to free-ranging populations that would provide multiyear efficacy (i.e., three to five years).

The three action alternatives incorporate nonlethal actions, lethal actions, or a combination of actions to reduce the deer herd size.

Alternative C: Lethal Action—Sharpshooting — Alternative C would include all actions described under alternative A above, but it would also incorporate a direct reduction of the deer herd size through sharpshooting, along with capture and euthanasia in areas where sharpshooting would not be appropriate.

Alternative D: Combined Lethal and Nonlethal Actions — Alternative D would include all the actions described under alternative A, but it would also incorporate a combination of specific lethal and nonlethal actions from alternatives B and C. These actions would include direct reduction of the deer herd (as described in alternative C), along with capture and euthanasia in areas where sharpshooting would not be appropriate. This would be combined with phasing in of reproductive control of does (similar to alternative B) for longer-term maintenance of lower herd numbers when there is a federally approved fertility control agent available for application to free-ranging populations that provides multiyear efficacy (i.e., three to five years).

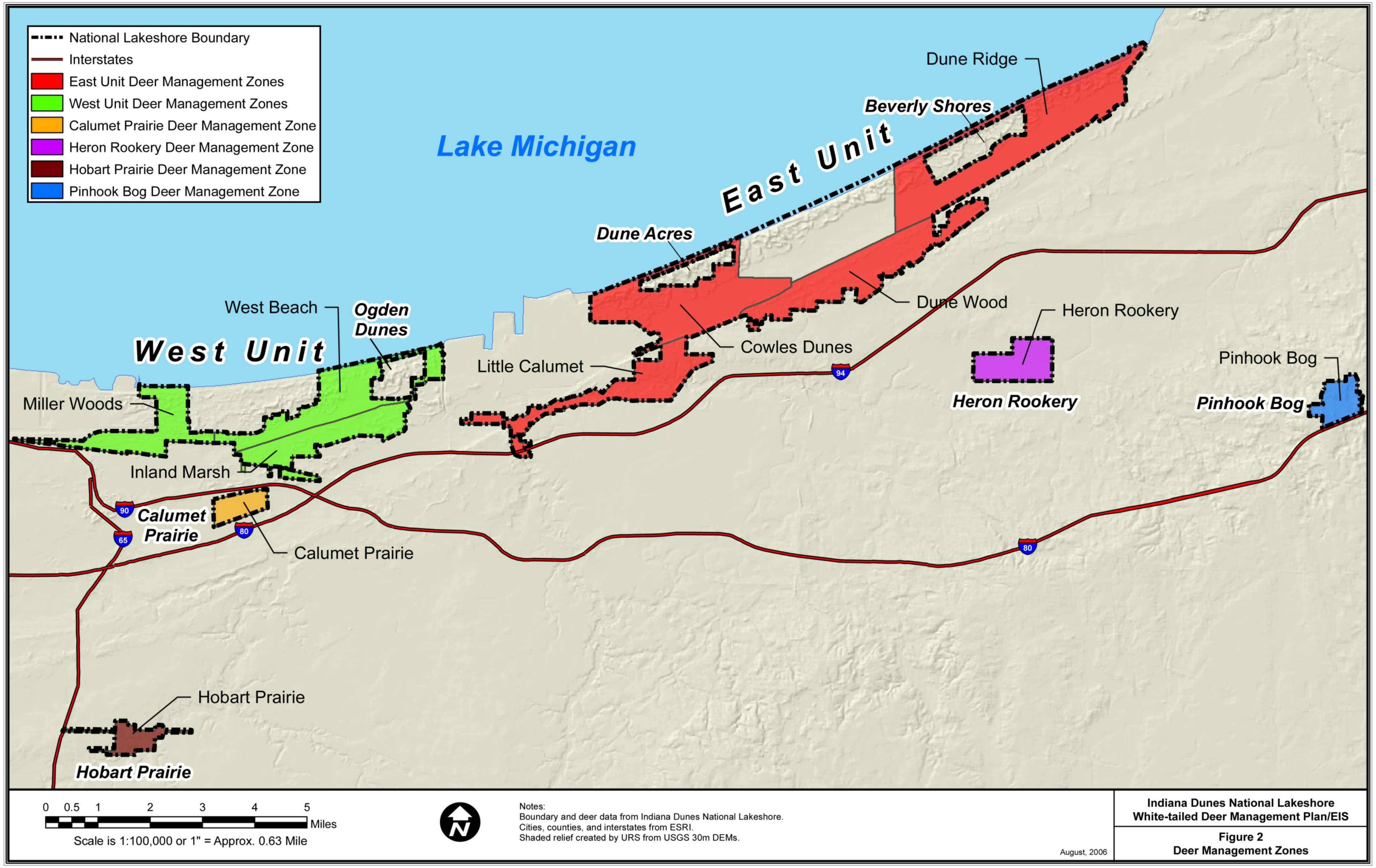
DEER-DENSITY GOAL AND THRESHOLDS FOR TAKING ACTION UNDER ALTERNATIVES B–D

The action alternatives (i.e., B, C, and D) include actions that would promote a healthy and sustainable ecosystem and protect, conserve, and restore native species and cultural landscapes. Before an action alternative may be implemented, the national lakeshore must first determine (1) where an action needs to be implemented; (2) when action needs to be taken (i.e., when damage to resources reaches unacceptable levels); and (3) how many deer would need to be removed or treated (for the action alternatives). The following discussion describes the deer management zones established within the national lakeshore, the deer-density goal (which would be used to determine the number of deer that would be removed), and the threshold for taking action (which is related to vegetation damage from deer browsing).

Deer Management Zones

Deer management actions may be implemented independently within individual national lakeshore units, which were described in chapter 1 (e.g., Heron Rookery or West Unit). The national lakeshore's East and West Units were further subdivided into deer management zones due to their large size and varied landscapes, with four zones in the East Unit and three in the West Unit (see Figure 2). The east zones are identified from west to east as Little Calumet (1,245 acres), Cowles Dunes (2,122 acres), Dune Wood (1,826 acres), and Dune Ridge (2,816 acres). The three west zones from west to east are identified as Miller Woods (1,042 acres), West Beach (1,407 acres), and Inland Marsh (1,089 acres). These zone boundaries were defined along existing divides, such as road corridors and residential communities. For clarity in this document, discussions regarding deer management activities are referred to as deer management zones rather than units (e.g., the Cowles Dune zone, Dune Ridge zone, Heron Rookery zone).

FIGURE 2: DEER MANAGEMENT ZONES



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Initial Deer-Density Goal

The science team discussed the topic of deer density, specifically the appropriate density that would allow protection of rare and endangered plants. This density would then be used as an appropriate goal under any of the action alternatives that require a reduction in deer numbers as a part of the management action. A number of researchers have estimated a maximum deer density for the successful reproduction of various species, such as trillium (*Trillium grandiflorum*) (Anderson 1994; Augustine and Frelich 1998), hardwood seedlings (Drake and Palmer 1991), and intermediate canopy–nesting songbirds (DeCalesta 1994). Anderson (1994) documented that a deer density less than or equal to 10 to 16 deer/mi^2 is required to maintain reproductive trillium populations in northeastern Illinois deciduous forests. Augustine and Frelich (1998) found that deer in deciduous forest habitat focus their grazing on large reproductive trillium plants; therefore, trillium population structure was skewed toward small plants. Additionally, where deer densities were greater than 10 to 20 deer/mi^2, deer consistently caused more than 50-percent reduction in trillium reproduction during the growing season. It was also noted that individual plants need protection from deer browsing for at least two growing seasons to show a dramatic increase in flowering rates and leaf area after experiencing high deer densities (greater than 10 to 20 deer/mi^2). DeCalesta (1994) found that deer densities greater than 20 deer/mi^2 had a substantial negative effect on songbird populations, specifically ground-nesting birds.

This research indicates that, with densities of more than 20 deer/mi^2, wildlife can be affected by the changes in plant availability. The research also indicates that, with densities less than 10 deer/mi^2, sensitive species, such as trillium, reproduce normally. However, other researchers have found that some deer browsing may be beneficial to tallgrass-prairie-forb diversity (Anderson et al. 2005). Because deer are a native species and a natural component of this ecosystem, elimination of deer from the national lakeshore is not this plan's goal.

After much discussion on selecting an initial deer-density goal, the science team recommended using a range of 10 to 20 deer/mi^2, with 15 deer/mi^2 selected as the initial density goal. The team suggested that a range would be appropriate for the initial goal, and the suggested range is supported by recent findings and research for minimal impacts on sensitive plant species within the national lakeshore. This goal would be used in conjunction with the existing deer density to determine the initial number of deer to be reduced within each management zone. For example, if the current density in a zone is 70 deer/mi^2, the national lakeshore would subtract the density goal (15 deer/mi^2) from that to get the number of deer/mi^2 to remove (in this case, 55 deer/mi^2). This goal may be adjusted, based on the results of vegetation and deer population monitoring, as described in the "Adaptive Management" section on page 70.

Indicator Species and Thresholds for Taking Action

To meet this plan's purpose and objectives and to effectively manage the national lakeshore's deer population, it is necessary to determine at what point the national lakeshore should implement the selected alternative. Thresholds would define a level of deer-browse damage that must be met or exceeded to trigger subsequent management actions. Therefore, several plant species have been identified as indicators of deer-browse impacts, and they would be monitored to determine when action should be taken. These "indicator plants" have either been documented in the literature as deer-browse indicators or have life-history characteristics similar to other documented deer-browse indicator species and are expected to provide similar results. Thresholds for taking action are based on a number of factors, including the relative abundance of the identified indicator species within the national lakeshore and the availability of research on species found in the national lakeshore, as described below. If vegetation monitoring warrants a change in the deer-density threshold, the national lakeshore would notify the public of such a change.

Indicator Species

The intent of identifying a number of different indicator species is to provide at least one or two species, or a group of species, within each deer management zone that could be monitored based on habitat and species present within that zone. Habitat varies widely within the national lakeshore, so identifying only two or three species as indicators would not provide adequate representation of deer impacts throughout the entire national lakeshore.

The species that would be monitored and used as deer-browse indicators are primarily herbaceous because the majority of the federally listed and state-listed plant species within the national lakeshore are herbaceous plants. Additionally, literature about the influence of deer on Midwestern forest communities indicates that the herbaceous layer is the first that is affected by deer-browse pressure (Westoby 1974; Gillingham and Bunnell 1989; Strole and Anderson 1992). The aforementioned sources list 14 species that may be used as potential deer-browse indicators for the national lakeshore. These include sweet cicely (*Osmorhiza claytoni*), white baneberry (*Actaea pachypoda*), jack-in-the-pulpit (*Arisaema atrorubens*), 4 trillium species (*Trillium cernuum macranthum*, *T. flexipes*, *T. grandiflorum*, *T. recurvatum*), 2 Solomon's seal species (*Polygonatum canaliculatum*, *P. pubescens*), 2 false Solomon's seal species (*Smilacina racemosa*, *S. stellata*), 2 Canada mayflower species (*Maianthemum canadense*, *M. canadense interius*), and lupine (*Lupinus perennis occidentalis*). Each of these species, individually or with a group, would be monitored following the protocol described in appendix B, "Indicator Species Descriptions," and summarized in Table 3.

Alternate species have been identified for each deer management zone that would also be monitored (in the short term) to determine if they show similar response to deer pressure. These are species that have been suggested in the literature as potential indicators; however, specific research or documentation on their use as indicators of deer browsing was not available. Therefore, alternate species would not initially be used to define action thresholds but would be monitored to identify their potential use as deer-browsing impact indicators in the future. Alternate species include bellwort (*Uvularia perfoliata*), raspberry and blackberry (*Rubus* spp.), oak (*Quercus* spp.), and black cherry (*Prunus serotina*).


Trillium grandiflorum

During the first few years of monitoring, alternate species could be monitored concurrently with indicator species to establish appropriate stem heights or other characteristics that could be used as action thresholds. These alternate species could be monitored in the same paired plots and transects[1] with indicator species, if present, or additional paired plots or transects could be established to collect data on alternate species. After five years of monitoring, indicator species or characteristics used as indicators of excessive deer-browsing impacts may be modified using the adaptive management process, as further explained in the "Adaptive Management" section on page 70.

[1] A transect is a randomly placed line along which individual plants of a species or species group are sampled.

At least one indicator species or species group[2] within each of the deer management zones would be used to determine when to implement action. More than one species/species group may be used in the larger deer management zones (greater than 1,000 acres). The indicator species identified for each zone were based on two factors:

The likelihood that the indicator species would be present in quantities large enough to provide reliable monitoring data

The existence of specific research that supports a species' response to deer-browse pressure (preferred over that for species whose response to deer-browse pressure has not been specifically documented)

Generally, federally listed or state-listed species were not selected as indicator species for several reasons, primarily because listed species may not provide adequate abundance and distribution for sufficient monitoring opportunities. One species of trillium is state-listed as endangered. However, other unlisted trillium species are also present and more abundant for sampling; therefore, all five trillium species would be used together as the indicator. Lupine is relatively abundant in the national lakeshore and was selected to indicate potential impacts on the Karner blue butterfly (on the state and federal endangered lists), which depends on this plant.

See appendix B for a complete description of each species or group of species that has been identified as an indicator species for the national lakeshore, how it would be monitored, and the specific threshold that would be used to determine when actions would be implemented. This information is also summarized in Table 3.

Thresholds for Taking Action

After two years of monitoring data for the selected indicator species are collected within each deer management zone, the findings would be compared to the action thresholds listed in Table 3 for each indicator species. Management decisions would be implemented at the deer management zone level, meaning that management actions could be implemented in one zone but not another, based on the monitoring data. Where multiple indicator species or species groups are being monitored in any given zone, action would be initiated when one or more of the species or groups reaches or exceeds the threshold of impact from deer browsing (as defined in Table 3).

Under the selected management alternative (except no action), the threshold for taking action to protect the national lakeshore's herbaceous vegetation would occur when the majority (at least 50 percent) of any of the open plots or transects for a given indicator species or species group within a zone shows specific deer-browsing impacts. For example, if six plots were monitored for trillium in a deer management zone and only two of those plots indicated average plant heights of less than 5 inches (13 centimeters), no action would occur (two of six plots is nearly 33 percent of the total plots). If three or more of the plots indicated an average plant height of less than 5 inches (13 centimeters), action would be triggered because the 50-percent action threshold would be met.

[2] Two groups of species were identified based on previous research and similar life histories. One group includes sweet cicely, white baneberry, and jack-in-the-pulpit; the second group includes mayflower, Solomon's seal, and false Solomon's seal. When used as a group, at least one species within the group must meet the defined threshold before action would be taken. Methods for group monitoring are provided in appendices B and C.

TABLE 3: PLANTS TO BE MONITORED AND USED AS INDICATOR SPECIES FOR TAKING ACTION

Deer Management Zone	Indicator Species	Indicator of Deer Impact	Monitoring Method	Action Threshold
East Little Calumet—1,246 ac. Cowles Dunes—2,122 ac. Dune Wood—1,827 ac. Dune Ridge—2,816 ac.	Sweet cicely, white baneberry, jack-in-the-pulpit	Mature basal stem height < 17 in (42 cm[a]) Mature basal stem height < 10 in (25 cm[a]) Mature stem height < 15 in (37 cm[a])	Transect	When the mean height in at least 50% of the transects/plots for any of these species/species groups within a deer management zone is below the designated indicator height, action would begin within that deer management zone.
	Trillium	Mature basal stems < 5 in (13 cm) in height[b]	Paired plots[c]	
	Lupine	Plant height < 12 in (30 cm)	Paired plots[c]	
West Miller Woods—1,042 ac. West Beach—1,408 ac. Inland Marsh—1,090 ac.	Lupine	Plant height < 12 in (30 cm)	Paired plots[c]	When the mean height in at least 50% of the plots for any of these species/species groups within a deer management zone is below the designated indicator height, action would begin within that deer management zone.
	Canada mayflower, Solomon's seal, false Solomon's seal	Mature basal stem height < 3 in (8 cm) Mature basal stem height < 6 in. (16 cm). Mature basal stem height < 4 in (10 cm)	Paired plots[c]	
Pinhook Bog 404 ac.	Trillium	Mature basal stems < 5 in (13 cm) in height[b]	Paired plots[c]	When the mean height in at least 50% of the plots for this species is below the designated indicator height, action would begin within this deer management zone.
Heron Rookery 655 ac.	Trillium	Mature basal stems < 5 in (13 cm) in height[b]	Paired plots[c]	When the mean height in at least 50% of the plots for this species is below the designated indicator height, action would begin within this deer management zone.
Hobart Prairie Grove 331 ac.	Sweet cicely, white baneberry, jack-in-the-pulpit	Mature basal stem height < 17 in (42 cm[a]) Mature basal stem height < 10 in (25 cm[a]) Mature basal stem height < 15 in (37 cm[a])	Transect	When the mean height in at least 50% of the transects for this species group is below the designated indicator height, action would begin within this deer management zone.
Calumet Prairie 308 ac.	Lupine	Plant height < 12 in (30 cm)	Paired plots[c]	When the mean height in at least 50% of the plots for any of these species/species groups within a deer management zone is below the designated indicator height, action would begin within that deer management zone.
	Canada mayflower, Solomon's seal, false Solomon's seal	Mature basal stem height < 3 in (8 cm) Mature basal stem height < 6 in (16 cm) Mature basal stem height < 4 in (10 cm)	Paired plots[c]	

[a] Documented indicator from Webster and Parker (2000).
[b] Documented indicator from Augustine and Frelich (1998) and Anderson (1994).
[c] After five years of monitoring data are compiled for a species, the monitoring can be completed in transects to lessen the cost of paired-plot maintenance.
Plant height—The measurement of height of individual stems in each plot. The entire plant height is used for lupine.
Basal stem height—The measurement from the ground to the first flower, not the entire height of the plant. This measurement is used for all the species except lupine.
Mature—The adult individual plant. Mature plants would always be measured prior to immature plants.
Mean—The average measurement for each plot or transect.
Individual—The number of aerial stems, even when the species spreads by rhizomes (such as Canada mayflower, Solomon's seal, and false Solomon's seal).

List of scientific names with the common names from this table:
Sweet cicely (*Osmorhiza claytoni*) Trillium (*Trillium cernuum macranthum, T. flexipes, T. grandiflorum, T. recurvatum*)
White baneberry (*Actaea pachypoda*) Canada mayflower (*Maianthemum canadense, M. canadense interius*)
Jack-in-the-pulpit (*Arisaema atrorubens*) Solomon's seal (*Polygonatum canaliculatum, P. pubescens*)
Lupine (*Lupinus perennis occidentalis*) False Solomon's seal (*Smilacina racemosa, S. stellata*)

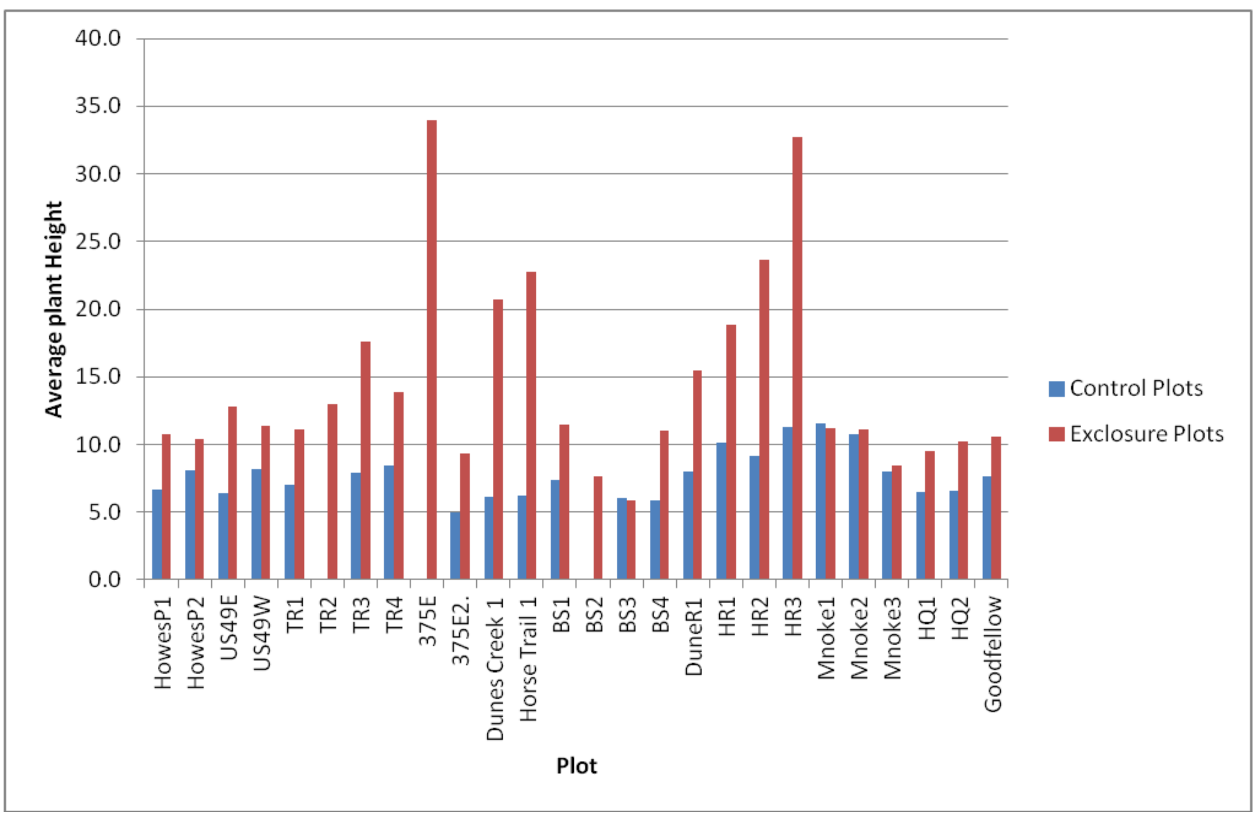
Indicator Species Monitoring for 2009

Following the recommendations of the science team, monitors use multiple sampling plots to monitor deer impacts on indicator plant species in each management zone. The plots are paired 1-meter squares with a control plot (open to deer) and a fenced plot (protected from deer). The protected plot (deer exclosure) has fencing with large enough gaps to allow the entry of other animals, such as rabbits and woodchucks, but to exclude deer. Monitoring data have been collected and analyzed for the 26 trillium monitoring plots that have been installed to date. Additional plots would be installed to provide monitoring data for all deer management zones. Indicator species for other management zones are being studied but have not been established. To ensure that the monitoring program's quality is maintained and that monitoring data are up to date, the NPS will work with U.S. Geological Survey (USGS) scientists. These ongoing analyses will ensure that the current protocols continue to provide an accurate representation of deer impacts on the landscape.

Data from 2009 sampling of the 26 trillium plots indicated an unacceptable level of impact in the Dune Wood management zone (see Figure 3). The average trillium height for all eight control plots was shorter than the recommended action threshold of 13 centimeters, and the average height for six of the eight exclosure plots was taller than the action threshold.

The control plots in the Heron Rookery management zone showed similar unacceptable levels of impact, with the average trillium stem height from exclosure plots taller than the action threshold. Stem heights in the control plots in the Cowles Dunes, Dune Ridge, and Little Calumet management zones were all shorter than the recommended height, indicating an unacceptable level of deer impact. However, the exclosure plots for these zones have not shown the same recovery after fencing as that of the Dune Wood plots. The plants in the exclosures may be utilizing the additional energy gained from decreased deer-browse pressure to produce more flowers rather than a taller stem. (Although flowering is not one of the indicators recommended by the science team, it is notable that the flowering of plants in the Dune Ridge management zone was markedly different between unfenced and fenced plots. None of the trillium plants [0 percent] in the control plots was flowering compared to 41 percent trillium flowering in the exclosure plots.)

FIGURE **3**: 2009 TRILLIUM PLOT DATA



The 2009 vegetation monitoring indicated that action should be taken in the Dune Ridge, Dune Wood, Cowles Dunes, Little Calumet, and Heron Rookery management zones. The NPS has not collected enough data for the remaining management zones on which to base a control decision.

ALTERNATIVE A: NO ACTION (EXISTING MANAGEMENT CONTINUED)

Under the no-action alternative, the Indiana Dunes National Lakeshore would continue to implement deer population monitoring, including distance sampling, as well as activities to protect native plant species, such as creating small-area protection fencing and maintaining one existing large-area exclosure, Current inventorying and monitoring efforts would continue to record rare plant species and sensitive plant population regeneration and deer population numbers within the national lakeshore. Educational and interpretive activities would continue to inform the public about deer ecology and national lakeshore resource issues. No additional deer management activities would occur under this alternative. Because alternative A includes no measures to reduce the white-tailed deer population or to control population growth, it is assumed that the population would increase over the life of this plan (15 years). The amount of increase is unknown; however, population growth is expected to follow past trends recorded in neighboring areas, with numbers fluctuating annually due to such factors as weather, deer health, removals outside the national lakeshore (hunting, deer control permits), and food availability. The no-action alternative serves as the baseline for analyzing and comparing the effects of the action alternatives.

The no-action alternative serves as the baseline for analyzing and comparing the effects of the action alternatives.

Current Actions

Fencing and Exclosures

Small areas containing rare plants and habitat would continue to be fenced with small-area fencing to preserve an individual plant or colony. A small area would typically be less than 43 square feet (4 square meters), and fencing would consist of a 3- to 4-foot-high woven-wire fence with netting or other covering over the top. Currently, two small-area fences exist within the national lakeshore for plant protection.

The national lakeshore includes 123 state-listed plant species, 1 of which is also federally listed. The locations and habitats of these rare plants are scattered throughout the national lakeshore. As additional rare understory plant species are found within the national lakeshore, they would be evaluated for protection with additional small-area protection fencing. Evaluation would include federally listed or state-listed status, palatability of the plant, and its range within the national lakeshore. Protection would be provided to the most rare and most palatable plants. Up to five new small-fenced areas would be added annually for plant protection under this alternative. Use of additional exclosures for monitoring is described in the "Monitoring, Data Management, and Research" section below.

Currently, one large-area exclosure (protection fencing for white cedar) exists within the national lakeshore for plant protection. This exclosure would continue to be maintained under this alternative. Other small-area fenced plots (three 20-square-meter exclosures) are used for plant monitoring.

Limited Application of Repellents

Repellents work by reducing the attractiveness and palatability of treated plants to a level lower than that of other available forage. Repellents are more effective on less palatable plant species than on highly preferred species (Swihart and Conover 1991). Repellent performance seems to be negatively correlated with deer density, meaning that the higher the abundance of deer, the less likely the repellent is to be effective. Success with repellents is measured as a reduction in damage; total elimination of damage should not be expected (Craven and Hygnstrom 1994).

Deer-repellent products are generally either odor based or taste based. Odor-based repellents incorporate a smell that is supposed to be offensive to deer, such as human hair, soaps, garlic, rotten eggs, blood meal, or seaweed, and they tend to work best in areas where deer have not adapted to close human interaction. Taste-based repellents incorporate a taste that is offensive to deer, such as hot pepper juice. These repellents tend to work in areas where deer have adapted to close human interaction and where odor-based repellents are not effective.

Both repellent types exist in chemical and organic forms. The organic repellents are biodegradable and are expected to be the least harmful to the environment. Some of the most recently available products, such as Plantskydd®, Liquid Fence®, and Deer Busters®, have the longest residence time (period of effectiveness between applications). Many other brands are also commercially available (Deer Blocker®, Gempler's®, Havahart Deer Off®, Scoot Deer®, and Deer Scram®). Different brands may provide different results; therefore, national lakeshore staff would experiment with the available products to determine which works best in each application area. Both types of repellents can have a short residence time when applied to plant material and must be monitored and applied frequently to retain their effectiveness. Many commercial repellents indicate that they persist after normal rain events, with varying persistence of one to six months.

Under alternative A, repellent use in the national lakeshore would continue to be minimal and would be applied to new restoration plantings (plugs) to allow the new plants a chance to become established. The national lakeshore plants approximately 30,000 plugs annually in restorations. This would require about 1 gallon of repellent per year, assuming two applications on each plug. The national lakeshore would continue to try different repellents in similar situations as a means to minimize deer browsing on restorations. Increased use of repellents may also occur in cultural landscape areas and near the visitor center, where existing or future fencing may be undesirable.

Encouragement of Deer Management outside the National Lakeshore

Deer management outside the national lakeshore would continue to be encouraged to make deer management efforts within the national lakeshore more effective. This would be done through cooperative efforts with other management agencies. Hunting occurs outside the national lakeshore in many areas. Direct reduction of deer also occurs in Beverly Shores and in the Indiana Dunes State Park. Dune Acres has a sharpshooting program in place to decrease deer numbers.

Testing for Chronic Wasting Disease (Deer Health Check)

CWD is in the family of diseases known as the transmissible spongiform encephalopathies (TSEs) or prior diseases. Other TSEs include scrapie in sheep, bovine spongiform encephalopathy (BSE, or mad cow disease), and Creutzfeldt-Jakob disease (CJD) in humans. CWD causes brain lesions that result in progressive weight loss, behavioral changes, and eventually, death in affected deer, elk, or moose. There is currently no evidence that the disease is transmissible to humans or domestic livestock; however, models indicate that the disease could limit populations of deer and elk (Miller et al. 2000; Gross and Miller 2001) and could result in profound impacts on the recreational value of these species.

Generally, the NPS has identified two levels of action pertaining to CWD, based on risk of transmission (see appendix C for further CWD information); this risk is determined as follows: (1) when the disease is not known to occur within a 60-mile radius of the national lakeshore, and (2) when the disease is known to occur within the national lakeshore or within a 60-mile radius of the national lakeshore. As of spring 2006, the nearest known case of CWD in free-ranging deer was approximately 80 miles from the national lakeshore. Given the proximity of CWD to the national lakeshore, both levels of action pertaining to CWD monitoring that could be taken during the life of the plan are described below.

CWD Occurs More Than 60 Miles from the National Lakeshore

Testing

The national lakeshore would initiate opportunistic surveillance on every available deer carcass until a statistically valid[3] sample size has been reached to ensure reasonable certainty that CWD is not present within the national lakeshore's deer population. Opportunistic sampling means taking biological samples from available dead animals (e.g., road kill, predation, culling management actions). In other words, animals would not be killed for the purpose of CWD surveillance. The assumption is that the results of opportunistic sampling would represent a random sample; however, it is acknowledged that opportunistic sampling is likely to be a more sensitive measure of disease recognition. The time necessary to reach a statistically valid sample size would depend on the opportunities available annually. It would be expected to take a number of years. If no CWD cases are found initially, opportunistic sampling will be repeated on a regular basis consistent with state CWD surveillance.

To cooperate with other government agencies in determining the presence of this disease, the national lakeshore may also take a small number of animals (fewer than 10 annually) showing no sign of the disease to test for CWD prevalence.

Coordination

The national lakeshore would coordinate with state and federal wildlife and agriculture agencies regarding surveillance methods and results.

Disposal/Consumption

Animals collected for opportunistic surveillance typically would not be fit for consumption (e.g., found dead, died of unknown causes). The national lakeshore would follow NPS Public Health Service guidance (NPS 2006c) pertaining to the disposal or donation of meat. Meat donation would require informed consent from recipients. Any animal confirmed to be infected with CWD would be disposed of in accordance with local and NPS Public Health Service disposal guidelines.

[3] In the case of opportunistic deer sampling, a statistically valid sample size may mean sampling to achieve 99 percent confidence that if CWD is present at a 1-percent or greater prevalence, it will be detected. For example, with a population of 1,000 deer, approximately 370 animals would need to be tested. After a valid sample size is reached, the national lakeshore may discontinue sampling until conditions warrant additional testing.

CWD Occurs Less Than 60 Miles from the National Lakeshore

Testing

In addition to opportunistic surveillance, as described above, the national lakeshore may also perform targeted surveillance as a component of this alternative if CWD is found less than 60 miles from the national lakeshore. Targeted surveillance involves lethal removal and testing of any deer exhibiting clinical signs consistent with CWD.

To cooperate with other government agencies in determining the presence of this disease, the national lakeshore may also take a small number of animals (fewer than 10 annually) showing no sign of the disease to test for CWD prevalence.

Coordination

The national lakeshore would coordinate with state and federal wildlife and agriculture agencies regarding surveillance methods and results.

Disposal/Consumption

The national lakeshore would follow NPS Public Health Service guidance (NPS 2006c) pertaining to the donation of meat from a documented CWD area. Meat donation would require informed consent from recipients. Any animal confirmed to be infected with CWD would be disposed of in accordance with local and NPS Public Health Service disposal guidelines.

Monitoring, Data Management, and Research

Current monitoring of both vegetation impacts and deer population levels would continue and would be expanded as necessary to better understand any correlations between the two.

Monitoring and data collection activities common to all alternatives could include any or all of the following:

- Monitor deer numbers by national lakeshore–wide observations. The national lakeshore would continue to use the distance-sampling method to estimate the deer population density annually, using an established protocol (see appendix D).
- Use spotlight surveys (conducted as part of distance sampling) to monitor population composition (e.g., age, sex ratio).
- Monitor indicator species using an existing vegetation-monitoring protocol to determine the status of herbaceous vegetation (see appendix D). The three existing 65-square-foot (20-square-meter) paired plots and 15 small (5-square-foot, or 1.5-square-meter) plots would continue to be used for monitoring trillium. An additional 50 paired small-area plots would be added over the next five years (about 10 per year).
- Conduct surveillance for evidence of deer overbrowsing where deer are found in high densities. This could include the construction of additional deer-proof exclosures as experimental controls.
- Monitor deer health for clinical signs of disease or if a disease has been discovered within the region. Opportunistic and targeted surveillance (see appendix C) would be implemented for CWD.

All actions that would involve direct management of individual deer would attempt to minimize stress, pain, and suffering to the extent possible. NPS staff would use recommendations from the "Guidelines for the Capture, Handling, and Care of Mammals," as approved by the American Society of Mammalogists (ASM) for the humane treatment of animals (e.g., minimal human contact, use of tranquilizers if needed). Every effort would be made to minimize the degree of human contact during procedures that require handling of deer (ASM 1998). Specific deer population and vegetation-monitoring methods that would be used under alternative A (as well as the other alternatives) are included in appendix D.

Education

Communication with and input from other organizations and the public would be a key component of alternative A and of the other alternatives. Communication activities would include presenting continuing education and interpretive programs, displaying exhibits at visitor centers, producing brochures and publications, and conducting teacher workshops and education about deer management (e.g., the negative effects of feeding deer). The national lakeshore website would also be used to discuss what the national lakeshore is doing about deer management, and relevant articles would be published in local newspapers.

Implementation Costs

The costs associated with alternative A primarily would be for monitoring, plus limited fencing and repellent application, as shown in Table 4. The cost associated with CWD testing is expected to be in the range of $50 to $75 per deer to cover laboratory and collection costs. A specific number of deer to be tested in a given year cannot be predicted. However, approximately $25 of that cost would be for the laboratory test, which would be conducted by the NPS Biological Resource Management Division; that cost borne by the Division and not the national lakeshore. Similarly, the collection cost (the physical collection of a sample from the carcass) is expected to be less than the $25 to $50 estimate, assuming that staff would be trained in proper sample collection and handling and taking into consideration the overlap with labor costs to dispose of carcasses. Therefore, the cost of CWD testing is assumed to be covered in existing labor costs.

The costs (in 2005 dollars) involved in implementing alternative A are defined in Table 4.

TABLE 4: COST ESTIMATE—ALTERNATIVE A: NO ACTION (EXISTING MANAGEMENT CONTINUED)

Action	Assumptions	Annual Cost	Cost for the 15-Year Planning Period
Distance sampling/spotlight surveys	Conduct five nights of survey, including data analysis.	$3,850	$57,750
Fence Installation: -Install small-area protection fences for plant protection -Install paired plots	Install up to five new small-area fences per year for a total of 75 over the 15-year planning period ($133 each). Install 50 new paired plots (10 per year for 5 years) ($133 each).	$665 $443*	$9,975 $6,650
Vegetation monitoring: -Existing plots (15 small; 3 large plots) -New plots (50 small plots added)	Perform data collection and analysis.	$6,050 $10,000	$90,750 $150,000
Maintenance: -Existing paired plots -New paired plots -Small protection fences and exclosure	Make four visits/year for paired plots and protection fences and one exclosure (labor).	$850 $130 $150	$12,750 $1,950 $2,250
Repellent use	Limit use to restoration planting areas.	$50 for materials and labor	$750
Total		$22,188	$332,825

* Averaged over 15 years.

ALTERNATIVE B: COMBINED NONLETHAL ACTIONS—FENCING, REPELLENTS, AND REPRODUCTIVE CONTROL

Under alternative B, a combination of nonlethal actions would be implemented, in addition to the actions described under alternative A, to protect plant species and biodiversity and to manage deer numbers in the national lakeshore. The additional actions would include construction of additional small-area protection fences and large-area exclosures, more extensive use of repellents in areas where fencing or exclosures would not be appropriate or feasible, control of doe reproduction, and additional education regarding deer management.

During the development of alternatives, it was determined that implementation of any of the nonlethal actions alone would be insufficient to address the herbaceous vegetation regeneration problem and would not meet plan objectives. For example, the use of fencing or repellents alone would not reduce deer density. The use of reproductive control alone would take longer than the life of the plan to have an effect and would not provide immediate protection for sensitive areas. The use of reproductive control of does would be phased in when there is a federally approved fertility control agent for application to free-ranging populations that provides multiyear efficacy for does (i.e., three to five years). Therefore, alternative B is composed of a combination of nonlethal actions.

Additional Actions Proposed under Alternative B

Additional Fencing and Exclosures

In addition to the small-area protection fencing and the large-area exclosure that would be implemented under alternative A, alternative B would include additional fencing and exclosures for protection of herbaceous vegetation important to the national lakeshore. The objective is not to eradicate deer but to limit or mitigate deer-browsing impacts within the national lakeshore; therefore, fencing the entire national lakeshore would not be prudent. The national lakeshore includes 123 state-listed plant species, 1 of which is also federally listed. The locations and habitats of these rare plants are scattered throughout the national lakeshore. Given the large number of listed species and the widely scattered pattern of these plants, it is also not feasible to place a fence around or apply repellents on all listed species within the national lakeshore.

Under alternative B, a combination of nonlethal actions would be implemented, including fencing, repellents, and reproductive control.

Type and Number of Fencing and Exclosures

Two types of plant protection would be installed under this alternative. The first type would be small-area protection fencing intended to preserve an individual plant or colony. A small protection fence, as described in alternative A, would typically be less than 43 square feet (4 square meters) and would consist of a 3- to 4-foot-high woven-wire fence with netting or other covering over the top. These small protection fences would be used for plant protection only (no indicator species monitoring). Up to 15 small protection fences would be installed per year under this alternative, in addition to small protection fencing provided in alternative A.

Large-area exclosures (greater than 215 square feet, or 20 square meters) would consist of woven-wire fence. These exclosures would be a minimum of 8 to 10 feet tall, with 4-inch wire mesh, metal fence posts, and wooden 4-inch-x--4-inch posts set in concrete on the exclosure corners and on every 100 feet of the exclosure. The large exclosures would cover areas containing several rare species or protect an entire population of a species or a specific habitat or management zone. Electric fences would not be used within the national lakeshore based on concerns for visitor safety and long-term maintenance requirements. The minimum number of large exclosures needed under this alternative is estimated at 303 (see Table 7). The number and locations of large exclosures are further described in the following section.

Exclosure Locations

To determine where large exclosures would be placed, a decision matrix was developed to assign priority scores to areas containing listed and highly palatable plants (Table 5). The matrix was designed using the plants' state-listed or federally listed status as threatened or endangered, combined with national lakeshore plant rankings (termed "locally important" for this discussion) developed through on-site surveys conducted in 1990 (Wilhelm 1990). It also considers the palatability of the plant and size of the population, or abundance, within the national lakeshore. The definitions for rare, common, and abundant are taken from the NPS biodiversity database (NPS 2006d) and are listed in appendix E.

The matrix provides the highest protection priority to federally listed plant species, followed by state-listed species, then species with a national lakeshore ranking. The population size or abundance within the national lakeshore also contributes to the weight of the priority score.

To further refine the ranking, plant palatability (as defined in the literature) was also factored into the matrix, based on whether the plant has been cited to be susceptible to preferential deer browsing or has a similar life history and habitat to such a species. Table 30 in chapter 3 provides documented palatability for the listed species within the national lakeshore. The most palatable species, and those that have a similar life history and habitat as palatable plants, would receive a higher protection priority score than less palatable species.

Each category in the matrix was assigned a number, and total priority scores were achieved by adding the numbers in each category. For example, a federally listed plant (3 points) that is also rare (3 points) but not palatable (0 points) would have a total score of 6, as shown in Table 5.

TABLE 5: MATRIX OF PRIORITY FOR SELECTING EXCLOSURE CONSTRUCTION LOCATIONS

Properties of the Plant Species	Rare (3+)		Common (2+)		Abundant (1+)	
	Palatable* (2)	Non-Palatable* (0)	Palatable* (2)	Non-Palatable* (0)	Palatable* (2)	Non-Palatable* (0)
Federally Listed (3)	8	6	7	5	6	4
State Listed (2)	7	5	6	4	5	3
Locally Important (1)	6	4	5	3	4	2
Other (0)	5	3	4	2	3	1

* Palatability is defined as a noted preference by deer for certain plants. Palatability is a subjective analysis based on observed deer preference, herd density, food availability, and plant availability in a given area. A list of palatable and nonpalatable plants is provided in chapter 3, Table 30.

Action would then be taken based on the total priority score from Table 5. Areas with the highest score (7 or 8) would be considered critical priority and would be protected first, as would areas with a score of 5 or 6, which would be considered high priority. After areas receiving the highest scores were protected, action would be taken to protect the next lower priority category, as noted in Table 6.

TABLE 6: ACTIONS TO BE TAKEN BY PRIORITY RANKING

Priority Ranking	Score	Action
Critical	7-8	Immediate fencing
High	5-6	Immediate fencing
Moderate	3-4	Application of repellents; limited fencing
Low	1-2	Continued monitoring for browse impacts

National lakeshore staff has identified 303 critical and high-priority areas (Table 7) listed by deer management zone. When implementing this alternative, national lakeshore staff would consider the treatment area in relation to visitor use areas, accessibility, and maintenance requirements. Repellents would be substituted for exclosures in areas where visual impacts from large-area exclosures would detract from visitor experience (described in the following section). However, if repellents are not effective in protecting critical and high-priority species in such locations, exclosures would be installed in these areas and interpretive signs would provide an educational opportunity for visitors as mitigation for potential visual impacts. It is estimated that it would take three years (at a rate of 100 exclosures per year) to construct exclosures in all critical and high-priority areas listed in Table 7.

TABLE 7: ESTIMATED CRITICAL AND HIGH-PRIORITY AREAS REQUIRING LARGE-AREA EXCLOSURES BY DEER MANAGEMENT ZONE

Deer Management Zone	Zone Size (Acres)	Acres of Sensitive Species	Number and Size of Areas to Protect	Number of Exclo-sures	Linear Feet of Fence
East - Dune Ridge	2,817	547.5	2(209Ac.) 1 (30Ac.) 1 (25Ac.) 2 (15Ac.) 2 (12Ac.) 2 (5.5Ac.) 1 (4.3Ac.) 3 (3.6Ac.) 3 (2.7Ac.) 2 (1.4Ac.) 2 (1 Ac.) 3 (0.84Ac.) 3 (0.5Ac.) 1 (0.34Ac.) 3 (0.28Ac.) 39 (<0.25Ac.)	70	80,913
East - Dune Wood	1,827	123.2	1 (50Ac.) 1 (30Ac.) 1 (12Ac.) 1(8Ac.) 3 (3.6Ac.) 2(2.3Ac.) 3 (1.5Ac.) 2(1Ac.) 2 (0.36Ac.) 26 (<0.25 Ac.)	42	37,885
East - Cowles Dunes	2,122	34.9	4 (6 Ac.) 2 (2Ac.) 3 (0.9Ac.) 1 (0.68Ac.) 5 (0.36Ac.) 42 (<0.25Ac.)	57	36,963
East - Little Calumet	1,246	0.7	1 (0.48Ac.) 1 (0.17Ac.)	2	578
West - West Beach	1,408	54.2	1 (8.3Ac.) 1 (7Ac.) 3 (3.5Ac.) 1 (3Ac.) 2 (2.6Ac.) 3 (2.0Ac.) 5 (1Ac.) 3 (0.65Ac.) 6 (0.4Ac.) 21 (<0.25 Ac.)	46	35,445
West - Inland Marsh	1,090	27.3	1 (8Ac.) 1 (4Ac.) 3 (2.25Ac.) 3 (1.4Ac.) 2 (1Ac.) 4 (0.32Ac.) 12 (<0.25Ac.)	26	19,352
West - Miller Woods	1,042	19.8	1 (9.5Ac.) 2 (3 Ac.) 2 (1Ac.) 2 (0.6Ac.) 13 (<0.25Ac.)	20	13,889
Heron Rookery	655	73.6	1 (50Ac.) 1 (17Ac.) 4 (1Ac.) 2 (0.35Ac.) 8 (<0.25Ac.)	16	17,028
Pinhook Bog	404	47.2	2 (24Ac.) 1 (1 Ac.) 1 (0.64 Ac.) 14 (<0.25Ac.)	18	15,522
Hobart Prairie	332	6.0	1 (5Ac.) 2 (0.5Ac.)	3	3,047
Calumet Prairie	308	1.9	1 (1Ac.) 2 (0.4Ac.)	3	1,892
Total	13,251	936.3		303	262,514

Deer would be driven out of the exclosures during construction by national lakeshore staff before completion. In most cases, visitors would not be able to use the exclosed areas during and after construction. During the construction of exclosures, tree removal or trimming around the exclosures may be required to minimize possible damage from falling trunks or limbs. National lakeshore staff would maintain all exclosures. Maintenance would consist of visual inspection for exclosure integrity at least four times per year and after any major storm. If any deer were found within an exclosure, they would be removed, as would any other animals that appeared to be trapped within the exclosure.

Additional Use of Repellents

Repellents may be used in areas where the installation of a fence is undesirable, such as around historical resources where a fence would disrupt the historical integrity of the site or in areas with scenic viewsheds. Repellents would be applied during the growing season. Large-scale application of repellents is not practical due to high application costs, label restrictions on use, and variable effectiveness. Repeated applications of spray repellents would be necessary because of weather and emergence of new growth. For example, if a repellent is required to be applied six times per year to remain effective, with application rates per application of 22 gallons per acre, the annual cost to treat only 1 acre of the national lakeshore would be $1,320 (six applications using 22 gallons each multiplied by $10 per gallon of concentrate). Treating only 5 percent (660 acres) of the national lakeshore would cost $871,200 for the repellant, not including labor costs for the application.

Because the effectiveness of repellents is variable, they would be used on an experimental basis until the level of effectiveness was established. NPS staff or approved contractors would apply repellents with backpack sprayers or with an all-terrain vehicle (ATV)–mounted sprayer. The area's sensitivity and accessibility would determine which method is used, with backpack spray techniques being applied in only the more sensitive and remote access areas. Under this alternative, it is estimated that repellent use would double from what was described in alternative A and would primarily be used in restoration planting areas.

Reproductive Control

Technology

Reproductive control of does would be phased in under alternative B when there is a federally approved fertility control agent available for application to free-ranging populations that provides multiyear efficacy for does (i.e., three to five years). A science team would evaluate the new product to determine if its use is feasible at the national lakeshore. If the science team recommends the use of the new agent, a small research project would be implemented to evaluate it in the field. If the new control agent is successful, reproductive control could be expanded and phased in to the deer management program.

Several reproductive control agents are currently being developed and tested for use in deer population control (Fagerstone et al. 2010). These include porcine zona pellucida (PZP) (Naugle et al. 2002; Turner et al. 1996; Rutberg and Naugle 2008); uniquely formulated PZP, such as SpayVac® (Fraker et al. 2002, Locke et al. 2007), GonaCon™, a GnRH vaccine (Gionfriddo et al. 2009; Miller et al. 2000, 2001; Curtis et al. 2002); prostaglandin $F_{2\alpha}$ (DeNicola et al. 1997), and leuprolide (Baker et al. 2002, 2004; Conner et al. 2007). Each of these agents is described briefly in Table 8 and in more detail in appendix F, which provides an overview of reproductive control technologies for deer management.

GonaCon is approved as a restricted-use pesticide by the U.S. Environmental Protection Agency (EPA) to control female white-tailed deer fertility. Its use requires pesticide approval on a state-by-state basis. It is labeled for use by hand injection only, and treated animals must be marked. According to the label, the product will last one year or longer. All fertility control agents to be used in free-ranging wildlife are regulated by the EPA.

Because some of the treated animals are likely to move out of the national lakeshore, staff there would work closely with the IDNR to develop a treatment protocol that meets the objectives of both the state and national lakeshore.

TABLE 8: REPRODUCTIVE CONTROL AGENTS

Agent	Federally Approved	Multiyear Efficacy (3 to 5)	Capable of Remote Administration	Meat Safe for Humans	Success in Free-ranging Populations
Immunocontraceptives					
"Native" PZP	No	Noa	Yes	Likely, but EPA approval is needed	Yes, but only in closed populations with relatively high population turnover
SpayVac®	No	Possiblyb	Unknown		
GnRH	Yes	Possiblyc	Possiblyd	Yes	Untested
GnRH Agonists					
Leuprolide Acetate	No	No	Yes	Likely, but EPA approval is needed	Untested
Histrelin Acetate	No	No	No	Likely, but EPA approval is needed	Untested
Other					
GnRH Toxins	No	Unknown	Unknown	Likely, but unknown	Untested
Steroid Hormones	No	No	Unknown	Unlikely, but regulatory guidance is needed	Untested
Contragestives	No	No	Yes	Yes	Not likely, but untested

[a]Initial research on one-shot, multiyear PZP vaccine has demonstrated 88.3% efficacy in the first year and 75% efficacy in the second year post-treatment (Turner et al. 2008). Research is currently ongoing to evaluate effectiveness in year 3 and beyond. Dr. Allen Rutberg has indicated that "based on the design of the vaccine and our experience with horses, it's unlikely that the vaccine would have much effect past the third year" (Rutberg 2009). However, research on this vaccine is still developing and is expected to continue into the future.

[b]SpayVac® has demonstrated 80% to 100% efficacy for up to five to seven years in horses and deer (Fraker 2009; Miller et al. 2009; Killian et al. 2008). The term "possibly" is used because long-term studies (longer than 5 years) have been conducted only in captive deer and with a small sample size in each treatment group (N = 5) (Miller et al. 2009).

[c]Recently published research on one-shot, multiyear GnRH vaccine in penned/captive deer indicates that GonaConTM is 88% to 100% effective in year 1, 47% to 100% effective in year 2, and 25% to 80% effective up to five years post-treatment (Miller et al. 2008). The term "possibly" is used because the multiyear formulation has been used only in captive deer, has been used only with small sample sizes, and lacks confidence intervals on the data.

[d]Recent work published on elk used dart delivery to administer the GnRH vaccine (Killian et al. 2009).

Administration of the Reproductive Control Agent

Timing of Application

At the national lakeshore, the administration of GonaCon (or a similar agent) to deer would occur primarily in September and October, when visitation begins to taper off.

Number of Does Treated

To effectively reduce population size, treatment with a reproductive control agent must decrease the reproductive rate to less than the mortality rate in a closed population. Based on research of reproductive controls in a free-ranging deer population, it would be necessary to treat at least 90 percent of does annually to halt population growth (Hobbs et al. 2000; Rudolph et al. 2000). After several years of application at this rate of treatment, a small (e.g., 5 percent) reduction in the population could be expected (Hobbs et al. 2000).

The Indiana Dunes National Lakeshore's current deer population is estimated at 1,162 deer, based on 70 deer/mi^2 in East Unit zones (12.5 square miles) and 35 deer/mi^2 in West Unit and outlying zones (covering 8.2 square miles). Assuming that approximately 50 percent of the deer in the national lakeshore are reproductively mature females (does), there are 581 does in the national lakeshore, of which a minimum of 523 (90 percent) would need to be successfully treated each year. However, for the reasons discussed below, treating 523 does in a free-ranging population in the national lakeshore would be very difficult.

Application Procedures

Depending on the reproductive control agent used, treated does would need to be marked for nonconsumption or to facilitate identification of does that have been treated to make initial treatment and subsequent treatments more efficient. This marking can be accomplished using ear tags. Each doe must be captured and handled at least once initially and may require additional handling during annual treatment. Tracking and capturing previously treated deer would require time to locate the doe or to lure it to a trap site so that it could be temporarily restrained and treated. After does have been handled one or more times, capturing them for subsequent treatments can become very difficult (Rudolph et al. 2000; B. Underwood, USGS, pers. comm., 2005). Given that 523 does would need to be treated, any technique requiring capture would be difficult to implement in the national lakeshore's free-ranging deer population.

The telemetry dart and clover traps would be the primary capture methods. The telemetry dart incorporates a tranquilizer in a dart fitted with a radio transmitter, which allows the animal to be located after the tranquilizer has taken effect. The dart is then recovered, the doe marked, the control agent administered, and the doe released. Some handling-related mortality could occur under this method because of tranquilizer use and stress on the doe (DeNicola and Swihart 1997; Kilpatrick et al. 1997); no more than 5 percent mortality would be accepted by the national lakeshore. The application of annual treatments by remote delivery can be time-consuming and expensive, and human and animal safety precautions must be addressed. An alternative capture method would include the use of drop/rocket nets.

Given the large number of does that would need to be treated, bait piles would be used to concentrate deer in certain locations so that the darting could be done as efficiently as possible. As many does as possible would be treated daily, with the goal of treating 90 percent of the does. Visitor access would be restricted in certain areas of the national lakeshore during the treatment period. The areas targeted for treatment would be chosen based on maximizing deer presence and accessibility, while minimizing visitor inconvenience. The treatment of does would take place during off-peak visitor hours (early morning and evening) and on weekdays to the extent possible. Regardless of the technique implemented, qualified federal employees or contractors trained in the administration of reproductive controls and holding a pesticide applicator's license would perform these activities. Training would include safety measures, particularly related to use of the dart gun, to protect both visitors and NPS employees. If more than one shooting location was used to remotely administer controls with dart guns, these areas would be adequately separated for safety reasons. Federal employees or contractors would also be qualified to handle live does to prevent disease transmission and minimize negative impacts on the animal or the employee.

Monitoring

Fencing, Exclosures, and Repellents

Once small-area protection fences and exclosures are constructed, they would remain in place until monitoring indicates browse impacts outside the protected area no longer exceed the action threshold. Plots outside the protected areas would be maintained and monitored to determine if the deer-browse impact level ever indicates that the fencing or exclosures could be removed. A small protection fence or large exclosure may be removed after successful reestablishment of a plant colony or habitat outside the protected area, depending on how well the protected vegetation has recovered. However, under this alternative, the deer population and the browse level are expected to remain high outside protected areas, because no method for rapid reduction of the deer population would be implemented. This situation would require long-term maintenance of fencing and exclosures.

As deer are excluded from feeding within protected areas or in repellent-treated areas, open (nontreated) areas would be monitored for changes in plant population sizes and palatability because of the probability of increased browsing pressure. The deer population is expected to remain higher than the initial deer-density goal under this alternative during this plan's duration (given the long timeframe required for reduction with reproductive controls to take effect); thus, the construction of additional small-area protection fences and large exclosures and additional repellent applications might be required to meet the national lakeshore's objectives. Browse impacts would be monitored as described in the national lakeshore's monitoring protocol (appendix D). If monitoring indicates that species outside the protected or treated areas were decreasing in abundance or increasing in palatability to deer, their priority score would be elevated, eventually resulting in the construction of additional exclosures (see the "Adaptive Management" section on page 70).

Reproductive Control

To monitor treated animals, a spotlight survey would be conducted in the summer or fall to evaluate the effectiveness of the reproductive control measures by counting deer and calculating fawn/doe ratios, in addition to monitoring overall population size. The additional monitoring would be similar to the distance-sampling protocol, with five additional days of survey during the summer to document the number of fawns. Additional observations would be made during the fall's annual distance-sampling surveys.

CWD Testing

Testing for CWD would occur as described under alternative A (page 44).

Education

In addition to the existing communication and educational activities described under alternative A, alternative B would include educational opportunities related to deer management activities. Such information would include reasons for implementing actions as part of the alternative and how the actions would be performed. This information would be available to visitors through documentation at the visitor center or incorporated into existing plans and public programs.

Implementation Costs

Alternative B would include the same costs described under alternative A (continued monitoring programs, limited fencing, and repellent use) plus the costs of constructing and maintaining additional small-area protection fencing and large exclosures, some additional repellent use, and reproductive control and monitoring. The overall cost of implementing alternative B would depend on the number of fences and exclosures installed, number of deer treated, methods used, number of personnel required, and monitoring costs. These costs are not yet explicitly defined, but estimates based on certain assumptions are provided in Table 9.

Fencing and Exclosures

The national lakeshore would install 15 small-area protection fences per year to protect specific plants, for a total of 225 during the life of this plan. The cost to build a small-area protection fence would be approximately $133 each. Maintenance of these fences would be $450 per year, assuming a cost of about $2 per small-area protection fence.

Large exclosures would be used to cover areas containing several rare species or to protect an entire population of a species or a specific habitat or deer management zone. Material and installation costs are estimated at $9 per linear foot of fence for large exclosures (R. Knutson, Indiana Dunes National Lakeshore, pers. comm., May 25, 2005). Based on Table 7, 303 large exclosures (262,514 linear feet of fence) would be planned under this alternative to protect critical and high-priority areas within the national lakeshore. It is estimated that 100 exclosures could be constructed each year for the first three years, completing all 303 critical and high-priority areas within that timeframe. It is estimated that 49.7 miles of exclosure material would be required.

To calculate maintenance costs, it was assumed that all 303 exclosures would be built in the first year. Labor to inspect and maintain exclosures is estimated annually at one person half-time for a full year.

Repellents

Repellents are estimated to cost approximately $616 to $756 per acre. The labor cost to apply repellents would be approximately $16 to $32 per acre based on national lakeshore estimates, depending on location, vegetation density, and area remoteness. Therefore, the total cost (materials and labor) for applying repellents is estimated at $624 to $772 per acre. With an estimated 30,000 plugs planted each year (covering roughly 3,000 square feet, or 0.06 acres), the estimated cost of repellent application would be about $50 per year ($772 x 0.06 acres).

Reproductive Control

A study in New York (one of the few conducted on a suburban free-ranging deer population) estimated that the minimal annual time commitment per deer for reproductive control (using PZP) was approximately 20 hours, costing in the range of $450 to $1,000 per deer (Rudolph et al. 2000). At Cleveland Metro Parks in Ohio, labor was about $450 per deer, and vaccines and equipment cost about $450 per deer (A. DeNicola, White Buffalo, Inc., pers. comm., April 16, 2004). Vaccine trials in Connecticut cost $1,128 per deer for 30 deer over two years, with 64 percent of the cost going to labor (Walter et al. 2002). These suburban examples may underestimate the effort needed in a more natural setting, where the labor costs to locate deer for treatment can be substantially higher than in urban settings (Watry et al. 2004).

TABLE 9: COST ESTIMATE—ALTERNATIVE B: COMBINED NONLETHAL ACTIONS

Action	Assumptions	Annual Cost	Cost for the 15-Year Planning Period
Same actions as alternative A (common to all alternatives)	Actions include distance sampling, small fence installation, monitoring of existing and 50 new plots, maintenance of plots and fences, repellent use and deer health checks.	$23,388	$350,825
Construction of additional large exclosures	The number of exclosures to be built will be 303, requiring an estimated 262,514 linear feet of fence at $9/linear foot for materials and labor	$787,542 (each year for first three years only)	$2,362,626
Construction of additional small-area protection fences	Cost will be $133 per small-area protection fence; 15 added per year	$1,995	$29,925
Additional exclosure maintenance[a]	Labor: one person devoted to maintenance half-time for a full year	$16,380	$245,700
	Materials: about 49.7 miles of fence to be inspected and repaired at $525/mile	$26,093	$391,395
Additional repellents	Assume twice the area as alternative A	$50	$750
Reproductive control	Assume 90% of does (523) treated each year, beginning at year 1, at $1,000 per deer annually.	$523,000	$7,845,000
Additional deer population monitoring	Assume five days of survey plus data analysis each summer	$3,850	$57,750
Total			$11,283,971[b]

[a]To calculate maintenance costs, it was assumed that all 303 exclosures were built in year 1.

[b] Total cost could be reduced considerably if reproductive control costs could be decreased based on improved technology.

Costs per deer would include costs for the reproductive-control agent, labor and equipment, and bait piles. Additional handling and processing costs associated with delivering the treatment would also apply. Given these factors and the disjunct geography of the lands of the national lakeshore, the expected costs for implementing reproductive controls would likely be at the high end of the range; for this analysis, $1,000 per deer is used. However, these costs could decrease based on improved technology or increase if capturing deer is substantially more difficult than assumed.

ALTERNATIVE C: LETHAL ACTION—SHARPSHOOTING

Under alternative C, sharpshooting would be used to reduce and control deer herd numbers.

Alternative C would continue the actions described under the no-action alternative, with sharpshooting used to reduce and control deer herd numbers. Individual deer would be captured and euthanized in certain circumstances where sharpshooting would not be appropriate. NPS would manage the direct reduction, which would be carried out by qualified federal employees and authorized agents. Authorized agents can include, but are not limited to, other agency and tribal personnel or contractors. Skilled volunteers would not be used as sharpshooters.

Personnel engaged in direct reduction of deer for this plan would have the appropriate skills and proficiencies in the use of firearms and protection of public safety. In addition, these personnel would have experience in the use of firearms for the removal of wildlife. In addition to other federal-contracting requirements, for this plan's purposes, a contractor would be a fully insured business entity, nonprofit group, or other entity engaged in wildlife management activities that include lethal removal by sharpshooting with firearms. The contractor would possess all necessary permits. NPS will use only professional sharpshooter contractor personnel or park service staff for the actual shooting in cull operations. NPS would not use skilled volunteers as sharpshooters. Volunteers may be used in secondary roles to assist in reduction activities that do not involve using firearms. Skilled volunteers (e.g., volunteers to assist with CWD sampling) would need to demonstrate appropriate proficiency, depending on their proposed involvement. Those skilled volunteers who qualify for participation would become part of a pool of available personnel to supplement deer management teams. In addition, all skilled volunteers would need to be directly supervised in the field by NPS personnel during deer management actions.

Additional Actions Proposed under Alternative C

Sharpshooting

Sharpshooting would consist of using sharpshooters to shoot deer in designated areas of the national lakeshore. Methods, removal numbers, and gender preferences are described below.

Methods

As described above, qualified federal employees and authorized agents would implement alternative C. These personnel would be experienced with sharpshooting methods and would have the necessary qualifications to implement sharpshooting actions with or under the supervision of appropriate national lakeshore personnel. Such actions include setting up bait stations, locating deer, sharpshooting, and disposing of deer (donation of meat or disposal of waste or carcasses) (Z. Bolitho, Gettysburg National Military Park and Eisenhower National Historic Site, pers. comm., 2006; K. Sullivan, USDA, pers. comm., 2005; J. Loven, USDA, pers. comm., 2005).

High-power, small-caliber rifles would be used from close range. Every effort would be made to make the shootings as humane as possible. Deer injured during the operation would be put down as quickly as possible to minimize suffering. Noise suppression devices and night vision equipment would be used to reduce disturbance to the public. Activities would comply with all federal laws administered by the Bureau of Alcohol, Tobacco, and Firearms.

Sharpshooting would occur primarily at night (between dusk and dawn) during the late fall and winter months when deer are more visible and few visitors are in the national lakeshore. In some restricted areas, sharpshooting could be conducted during the day, if needed, which could maximize effectiveness and minimize the overall time of visitor restrictions. If this is done, the areas would be closed to visitors. The public would be notified of any national lakeshore closures in advance. Deer management exhibits would be displayed at visitor centers, and information would be posted on the national lakeshore's website to inform the public about deer management actions. Visitor access would be limited as necessary while reductions were taking place, and NPS rangers would patrol public areas to ensure compliance with national lakeshore closures and public safety measures.

As a safety measure, sharpshooting would not occur within 100 feet of an occupied building. Qualified federal employees or contractors trained in all aspects of sharpshooting would perform these activities. Training would include the use of safety measures to protect both visitors and NPS employees. If more than one shooting location is used, these areas would be adequately separated to ensure safety.

Bait stations could be used to attract deer to safe removal locations and would consist of small grains, apples, hay, or other food placed on the ground. The stations would be placed in national lakeshore–approved locations, away from public use areas, to maximize the efficiency and safety of the reduction program. The amount of bait placed in any one location could be in the range of 20 to 100 pounds, depending on the bait used and the number of deer in the immediate area (A. DeNicola, White Buffalo, Inc., pers. comm., April 13, 2004).

Disposal

CWD has not been detected in the wild populations of deer in Indiana to date. Therefore, no standardized methods or guidelines for disposal of CWD-infected animals have been produced by the Indiana State Board of Animal Health or the IDNR. However, because of the potential of CWD in deer, randomly selected animals could be sent to confirm a CWD diagnosis with laboratory tests. Incineration of the carcass would follow any positive test. Discarding large numbers of carcasses could be achieved via landfill disposal. If CWD is found within the state, the Indiana State Board of Animal Health and/or the IDNR would meet and create a contingency plan concerning the future and long-term methods and guidelines for disposal of CWD-infected deer carcasses (S. Chaviz, Indiana State of Animal Health, pers. comm., 2008; J. Mitchell, IDNR, pers. comm., May 13, 2008). Animals that are confirmed to be infected should be disposed of in one of the following ways:

- alkaline digestion
- incineration
- landfill

Donation

According to the NPS Manager's Reference Notebook to Understanding CWD (2007):

> There is currently no scientific evidence linking the consumption of meat from deer in areas with historic CWD to human disease. The National Park Service Public Health Program (PHP) finds no compelling reason based on the current scientific literature to prohibit the practice of donating meat from these animals. A link between CWD and human disease has neither been proved nor disproved. In this situation, and given the current state of our knowledge about this issue, it is appropriate for NPS to use an abundance of caution when approaching this issue. While the policy of testing each carcass for CWD before donation makes good common sense, it is important to note that the CWD tests are not sensitive enough to be thought of as a "food safety test", i.e. a negative result does not guarantee that the animal does not have CWD. Animals in the earlier stages of infection may not test positive. Due to the uncertainty about CWD's potential to impact human health, we recommend that should any park within 60 miles of a known CWD case decide to cull and donate meat or use public hunts, NPS actively ensures a process of gaining "informed consent." Wherever possible, NPS should maintain direct control over the education and consent process. The PHP does not recommend leaving the informed consent process to a third party such as a food pantry or soup kitchen. It may be possible to work with such entities to ensure that people choosing to consume this meat are properly informed. Prior to human consumption of meat from collected animals, the NPS Public Health Program should be consulted. Additionally, donation of deer or elk meat to organizations who intend to use the meat for animal feed should be consistent with the Food and Drug Administration's recommendations for use of material from deer and elk in animal feed. Material from CWD-positive animals may not be used for human consumption or in any animal feed or feed ingredients.

The NPS *Manager's Reference Notebook to Understanding CWD* provides guidance for meat donation. Currently, CWD has been detected 65 miles from the Indiana Dunes National Lakeshore and Guidance Section 3 is applicable. However Guidance Sections 1 and 2 would be applicable, if in the future, the disease was detected either within 60 miles (Guidance Section 2) or within the boundary (Guidance Section 1) of the national lakeshore. The applicable guidance sections are provided below.

Guidance Section 1: Donation of Deer Meat Gathered from Areas where CWD is Known to Occur

The PHP would like to be notified of the park's intentions to cull herds and donate meat before it takes place.

Donation

1. No obviously sick, emaciated or otherwise unhealthy appearing animals should be donated for human consumption.
2. Only animals that appear completely healthy should be considered for donation.
3. All harvested animals should be tested CWD negative before the meat is considered for donation.
4. Meat will not be donated to food pantries, soup kitchens or any entity that intends to redistribute the product.
5. Meat will only be donated to individuals from whom informed consent can be clearly obtained.
6. All donated meat should be processed and packaged in a state or USDA-approved and licensed meat processing plant that processes all cuts according to state or USDA/FSIS recommendations to reduce risk of exposure to the CWD agent.

Handling in the Field

1. Guidelines published by the appropriate state wildlife management departments for field dressing procedures and carcass handling to minimize exposure to CWD infectious material should be followed at all times.
2. Sanitary conditions should be maintained throughout the process from the time of kill through field dressing and transport.
3. Positive carcass identification linked to the CWD sample associated with that carcass must be established at the time of kill, and maintained throughout transport, storage, processing and donation.
4. All carcasses and carcass parts, whether donated or not, should be transported according to all state and federal laws and regulations regarding transport of elk or deer carcasses and parts from areas with known CWD.
5. Any carcasses to be disposed of in a landfill should be disposed of in accordance with all local, state, and federal laws and regulations regarding disposal of such carcasses or carcass parts from areas with known CWD.

The PHP is available for consultation on how to help maintain sanitary conditions during field dressing and carcass transport.

Processing and Distribution

1. Parks should work closely with appropriate state or local officials to ensure compliance with all state laws and regulations regarding donation of wild game meat.
2. Ideally, carcasses should not be processed into edible meat cuts until final CWD testing results are obtained. If this is not practical, each batch of carcasses processed should retain

clear batch identification until CWD test results are available. Batch records should include all individual carcass identifications that comprise the complete batch. A batch is defined as all carcasses that are processed into edible cuts between complete processing equipment cleaning and sanitizing.

3. All donated meat should be held under the park's or meat processor's direct control until final CWD test results are obtained and the meat is cleared for consumption.
4. A positive CWD test for any animal in a batch should result in the entire batch of processed meat or carcasses being appropriately disposed of according to state and federal laws regarding disposal of such meat or carcasses.
5. Meat should only be donated to individuals after informed consent has been obtained.

Guidance Section 2: Donation of Deer Meat Gathered from Areas within 60 Miles of a Known CWD Case

Section 2 guidance is intended for park units falling within category 2 of the Definition of an Area Affected by CWD. The PHP would like to be notified of the park's intentions to cull herds and donate meat before it takes place.

Donation

1. No obviously sick, emaciated or otherwise unhealthy appearing animals should be donated for human consumption.
2. Only animals that appear completely healthy should be considered for donation.
3. A baseline estimate of the likelihood of CWD presence within the herd should be established (i.e. 99% confident that CWD is not present at more than 1% prevalence within the herd.)
4. All animals that are tested for CWD as part of any surveillance program should have negative test results before the carcasses or meat of that animal are considered for donation. Additionally, it is strongly recommended that no meat or carcasses from a given culling batch be donated for human consumption until negative test results are obtained from those animals that are sampled for testing.
5. Meat should only be donated to individuals from whom informed consent can be clearly obtained.
6. After consultation with the PHP and BRMD programs, donation to food pantries, soup kitchens or other third party entities that intend to redistribute the product can be considered, providing a clear and confirmable mechanism for gaining informed consent from the final consumer is in place, and initial CWD testing suggests with a high degree of confidence that CWD is not present within the population (99% confidence that CWD prevalence is <1%).
7. All meat that is donated in processed and packaged form should be processed and packaged in a state or USDA approved and licensed meat processing plant that processes all cuts according to state or USDA/FSIS recommendations to reduce risk of exposure to the CWD agent.

Handling in the Field

1. Guidelines published by the appropriate state wildlife management departments for field dressing procedures and carcass handling to minimize exposure to CWD infectious material should be followed at all times.

2. Sanitary conditions should be maintained throughout the process from the time of kill through field dressing and transport.
3. Positive carcass identification linked to the CWD sample associated with that carcass must be established and maintained from the time of kill, transport, storage, and processing.
4. All carcasses and carcass parts, whether donated or not, should be transported according to all state and federal laws and regulations regarding transport of elk or deer carcasses and parts from areas with known CWD.
5. Any carcasses to be disposed of in a landfill should be disposed of in accordance with all local, state, and federal laws and regulations regarding disposal of such carcasses or carcass parts from areas with known CWD.

The PHP is available for consultation on how to help maintain sanitary conditions during field dressing and carcass transport.

Processing and Distribution

1. Parks should work closely with appropriate state or local officials to ensure compliance with all state laws and regulations regarding donation of wild game meat.
2. Ideally, carcasses should not be processed into edible meat cuts until final CWD testing results are obtained. If this is not practical, each batch of carcasses processed should retain clear batch identification until CWD test results are available. Batch records should include all individual carcass identifications that comprise the complete batch. A batch is defined as all carcasses that are processed into edible cuts between complete processing equipment cleaning and sanitizing.
3. All donated meat should be held under the park's or meat processor's direct control until results of CWD testing are obtained and the meat is cleared for consumption.
4. Meat should only be donated to individuals after informed consent has been obtained.
5. A positive CWD test for any animal in a batch should result in the entire batch of processed meat or carcasses being appropriately disposed of according to State and Federal laws and regulations regarding disposal of such carcasses/meat. Additionally, any positive CWD test moves the park into Guidance Section 1.

Guidance Section 3: Donation of Deer Meat Gathered from Areas Outside 60 Miles of a Known CWD Case

Section 3 guidance is intended for park units falling within category 3 of the Definition of an Area Affected by CWD. The PHP would like to be notified of the park's intentions to cull herds and donate meat before it takes place.

Donation

1. No obviously sick, emaciated or otherwise unhealthy appearing animals should be donated for human consumption.
2. Only animals that appear completely healthy should be considered for donation.
3. If limited or no CWD surveillance has been performed in the herd:
4. All cervids that are tested for CWD as part of any surveillance program should have negative test results before the carcass or meat of that animal is considered for donation.

5. It is recommended that no meat or carcasses from a given culling batch be donated for human consumption until negative test results are obtained from those animals that are sampled for testing.
6. If CWD surveillance data are available from the herd:
7. Depending on the quantity and quality of available surveillance data and the level of confidence that CWD does not exist in the herd, donation of meat prior to receiving results of CWD testing may be considered by the park after consultation with the PHP and BRMD programs.
8. If a carcass or meat is donated for human consumption prior to return of CWD test results, informed consent (including a recommendation not to consume meat from the carcass until a negative test result has been reported) should be obtained.
9. Donation to individuals from whom informed consent can be obtained is the preferred approach.
10. After consultation with the PHP and BRMD programs, donation to food pantries, soup kitchens or other third party entities that intend to redistribute the product can be considered.
11. All meat that is donated in processed and packaged form should be processed and packaged in a state or USDA approved and licensed meat processing plant.

Handling in the Field

1. Guidelines published by the appropriate state wildlife management departments for field dressing procedures and carcass handling to minimize exposure to CWD infectious material should be followed at all times.
2. Sanitary conditions should be maintained throughout the process from the time of kill through field dressing and transport.
3. Positive carcass identification linked to the CWD sample associated with that carcass must be established and maintained from the time of kill, transport, storage, processing, and donation.
4. All carcasses and carcass parts, whether donated or not, should be transported according to all existing state and federal laws and regulations regarding transport of elk or deer carcasses and parts from areas with negative or unknown CWD status.
5. Any carcasses to be disposed of in a landfill should be disposed of in accordance with all existing local, state, and federal laws and regulations regarding disposal of such carcasses or carcass parts from areas with negative or unknown CWD status.

The PHP is available for consultation on how to help maintain sanitary conditions during field dressing and carcass transport.

Processing and Distribution

1. Parks should work closely with appropriate state or local officials to ensure compliance with all state laws and regulations regarding donation of wild game meat.
2. Ideally, carcasses should not be processed into edible meat cuts until final CWD testing results are obtained. If this is not practical, each batch of carcasses processed should retain clear batch identification until CWD test results are available. Batch records should include all individual carcass identifications that comprise the complete batch. A batch is defined as

all carcasses that are processed into edible cuts between complete processing equipment cleaning and sanitizing.

3. All CWD tested meat intended for donation should be held under the park's or meat processor's direct control until CWD test results are obtained and the meat is cleared for consumption.
4. A positive CWD test for any animal in a batch should result in the entire batch of processed meat or carcasses being appropriately disposed of according to state and federal laws regarding disposal of such carcasses/meat. Additionally, any positive CWD test moves the park into Guidance Section 1.

The first priority for excess animals is to make suitable meat available for donation. Several food banks in Indiana accept donations of deer and game animals. Donations are given to a licensed processor to cut and package the meat, which is then taken to regional food banks. The donor is ask to cover the processing costs, usually about $50; however, some processors also give discounts when preparing game that will be donated, and sometimes, the receiving charities help cover the bill. Several groups in Indiana offer information and assistance for providing food for the hungry, including the Indiana chapter of Safari Club International, Sportsmen Against Hunger, Farmers and Hunters Feeding the Hungry, the Indiana Deer Hunters Association, and Food Finders Food Bank (NRA 2008). The IDNR also lists several meat processors that participate in the donation of game meat to food banks (2008). A qualified federal employee or contractor would coordinate with local meat processors to have usable carcasses processed for donation. The suitability of meat for donation would depend on the condition of the animal (no signs of disease), location and accessibility of the deer shot, number of deer shot in each location, acceptance by food banks, and informed consent from consumers.

If more deer are shot than can be collected in one night or delivered to a processor at one time, the remains of these deer would be disposed of in a local landfill or buried onsite. In cases where one to a few deer have been shot at a given site or shot in remote areas with difficult access, the carcass or internal organs would be scattered and left above ground to be naturally scavenged or to decompose. Should CWD be found in the deer herd, the national lakeshore shall follow NPS guidelines for disposal of deer infected with the disease (NPS 2002, 2005, 2006, 2007).

Disposal Pits

In cases where the meat from deer is unsuitable for donation to charity or for surface or landfill disposal, the carcasses and internal organs would be buried onsite. Disposal pits would be located at previously disturbed sites (e.g., razed building sites) throughout the national lakeshore. All the potential disposal locations are in previously disturbed areas and none contains archeological resources. Disposal pits would be approximately 8 feet wide, 8 feet long, and 4 feet deep. They would be dug before sharpshooting activities and covered and fenced to prevent entry. Soil removed from the pits would remain onsite and covered to prevent erosion. To avoid adverse impacts from potential groundwater contamination, qualified national lakeshore staff would select disposal pit locations that do not have highly permeable soils, over-fractured or cavernous bedrock within 2 feet of the bottom of the pit, or a seasonal high-water table of less than 2 feet from the bottom of the pit. In addition, the pit locations must accommodate a depth suitable for animal disposal (including 3 feet of ground cover). Multiple pits would be separated by a minimum of 3 feet of undisturbed or compacted soil.

Carcasses would be transported to a pit within 12 hours of sharpshooting. After each addition of carcasses, the pit would be covered with approximately 1 foot of soil. When the pit has reached capacity, it would be covered with approximately 3 feet of soil. The soil would be covered with straw or wood-chip mulch to prevent erosion, and when the weather and season are appropriate, the soil would be seeded with an NPS-approved seed mix and mulched. Any soil not used to refill the pits would be used in other disturbed locations within the national lakeshore.

Numbers of Deer Removed

The national lakeshore's deer population is currently (as of fall 2005) estimated at 1,162 deer, based on 70 deer/mi^2 in East Unit zones (covering 12.5 square miles) and 35 deer/mi^2 in West Unit and outlying zones (covering 8.2 square miles). National lakeshore staff would determine the number of deer to be removed from the national lakeshore based on an initial population density goal of 15 deer/mi^2 (or 311 deer). At least three years would be required to reach this goal, given the limited accessibility to some national lakeshore areas and the expected changes in population movements as the population size decreases.

- Year 1 — The USDA Wildlife Services has estimated that, with concentrated efforts, about half of the deer (581) could be removed the first year, assuming periodic removal efforts over a five-month period (November to March).
- Year 2 — Assuming 20 percent growth (a general rate commonly used by deer managers, considering reproduction, mortality, and recruitment), the deer population would be an estimated 697 by the second year. If half of the population (348) was removed, 349 deer would remain in the national lakeshore.
- Year 3 — Assuming the same 20-percent growth rate, the deer population would be 419 by the third year. Removing one-quarter of these deer (105) would leave 314 in the national lakeshore, which would be near the initial density goal of 15 deer/mi^2.
- Subsequent years — Assuming the same 20-percent-growth rate, a minimum of 63 deer would need to be removed annually in subsequent years to maintain the desired population size. However, it is expected that as the density decreases and herbaceous vegetation regeneration increases, deer reproductive rates and immigration may also increase. Therefore, it is more likely that the removal number to maintain the population at 15 deer/mi^2 would be in the range of 70 to 100 deer per year.

Several factors could influence the number of years to reach the initial deer-density goal. As the deer population decreases through successful reduction efforts, deer might become adapted to the sharpshooting operations and become more evasive, increasing the effort necessary to reach the removal numbers in any year. Existing reproduction and mortality rates might differ from the estimate used in this projection. If reproduction rates were higher and mortality was lower than estimated, the population growth would be greater than 20 percent, and more deer would need to be removed, potentially increasing the time to reach the initial density goal. The converse would be true if reproduction rates were lower and mortality rates were higher than estimated, resulting in fewer deer having to be removed, and efforts could take less time. Immigration of deer into the national lakeshore could also have a substantial effect on the number of deer to be removed, especially if the goal was toward a low population density (Porter et al. 2004).

The number of females in the population would also influence reproduction rates. If the population composition shifted closer to a 50/50 sex ratio—because does would be preferentially removed during the first few years—reproduction rates should decrease because fewer females would be reproducing.

Gender Preference

Removing does would be preferred because this would reduce the population level more efficiently over the long term. However, during the first three years of treatment, both does and bucks would be removed, based on opportunity. Buck-only removal would not control population growth, as deer populations are largely dependent on the number of does with the potential for reproduction. Harvest of does is necessary to stabilize or reduce populations, and for a rapid decrease in deer population, at least 15 does should be taken for every 10 bucks during the first three years of treatment (West Virginia University 1985).

Records would be kept on the age and gender of all deer removed from the national lakeshore to aid in defining the local population composition. This information would be compared with composition data collected in national lakeshore spotlight surveys.

Capture and Euthanasia

Capture and euthanasia would be used only in circumstances where sharpshooting would not be appropriate because of safety or security concerns. This method is expected to account for 3 percent or less of the total number of deer being removed. The method involves qualified federal employees or authorized agents trapping deer, approaching them on foot, and euthanizing them. Activities would occur at dawn or dusk when few visitors are in the national lakeshore.

Deer would be captured with nets or traps and euthanized as humanely as possible. Euthanasia methods could include a combination of penetrating captive bolt gun and potassium chloride, firearm, exsanguination, or other humane techniques. Several methods of wildlife trapping could be used, including drop nets and box traps. Most trapping methods involve using bait to attract deer to a specific area or trap. Box traps safely hold a deer in a confined space so that staff can approach it. Drop-net traps also often use bait to attract deer to the drop zone, where suspended nets are triggered to drop over the deer and restrain it to allow staff to approach (Lopez et al. 1998). The method of capture would be selected based on the specific circumstances (location, number of deer, accessibility, and reasons why sharpshooting is not advised) for each deer or group to be removed.

Deer could also be immobilized by darting with a tranquilizer gun (Schwartz et al. 1997) or hand-injection with traquilizing agents. This method could be used in cases where deer had not been successfully attracted to a trap area or if an animal needs to be chemically restrained once in a trap. Similarly, anesthetic agents could be used prior to the penetrating captive bolt gun or firearm technique to immobilize the animal prior to euthanasia. Injection of a lethal dose of euthanasia solution (under supervision of a veterinarian or NPS park practitioner) could also be used. However, when drugs are used for either immobilization or for euthanasia, the meat from that animal cannot be donated as food, and the carcass may be unsuitable for surface disposal. If this is the case, the carcass would be buried as described under the "Sharpshooting" section.

Qualified federal employees or authorized agents trained in the use of penetrating captive bolt guns, firearms, or tranquilizer guns would perform these actions. Training would include safety measures to protect both visitors and NPS employees. Federal employees or authorized agents would also be qualified to handle live deer to prevent disease transmission and prevent any harm to an animal or an employee. Appropriate safety measures would be followed when setting drop nets or box traps.

Because capture and euthanasia would typically result in increased stress levels in captured deer compared to sharpshooting, this method of population control would be used only in selected situations and would supplement the sharpshooting method described earlier.

The number of deer removed by capture and euthanasia would be recorded, including the age and sex, location of removal, circumstance requiring capture and removal, and the lethal method used.

Monitoring

Sharpshooting

Throughout the removal efforts, vegetation monitoring would document any changes in deer-browsing impacts that may result from reduced deer numbers. However, vegetation response to lower deer numbers will take several years and will directly depend on how quickly the deer population is reduced. Likewise, the number of deer to be removed in subsequent years would be adjusted based on the success of previous removal efforts, projected growth of the population, and vegetation and deer-monitoring results.

Vegetation monitoring would be conducted annually to document vegetation recovery. If national lakeshore objectives are being met and herbaceous vegetation regeneration is successful at the target deer-density goal, removal efforts would be maintained at the level necessary to keep the deer population at the target density. Management adjustment of the removal goal in either direction from the initial density goal could be made, based on how close the conditions (indicated by vegetation monitoring) are to the national lakeshore's objectives (see the “Adaptive Management” section on page 70).

Capture and Euthanasia

The same monitoring conducted for sharpshooting would be used for capture and euthanasia.

CWD Testing

Testing for CWD would occur as described under alternative A (page 44). However, under alternative C, a statistically valid sample may be reached sooner than under alternative A, given increased opportunities for testing.

Education

Education and communication under alternative C would be the same as described under alternative B.

Implementation Costs

Costs of implementing alternative C would include the same costs as described under alternative A (continued monitoring programs, limited fencing and repellent use), plus the cost of sharpshooting and capture/euthanasia. Estimated costs for alternative C are discussed below and summarized in Table 10.

Sharpshooting

Factors affecting the final cost of implementing this alternative include deer density, number of deer to be removed, ease of access to deer, number and location of bait stations, equipment availability, amount of data to be collected from deer, and processing requirements. The greatest costs would generally be incurred when deer and bait stations are difficult to access, deer are wary of humans, the removal area is large, and deer densities are lower (requiring more time to find each deer). Conversely, lower costs could be expected when the removal area is smaller, deer density is high (less time required to find each deer), and deer are accustomed to human activities (A. DeNicola, White Buffalo, Inc., pers. comm., April 16, 2004). For this alternative, it is assumed that a qualified federal employee or contractor would conduct the lethal removal activities and process the deer, collect biological data, prepare meat for transfer to a local food bank (as appropriate), and arrange for disposal of deer carcasses (as needed).

Costs and efficiencies of sharpshooting programs have been assessed in the literature. One study documented that costs ranged from $72 to $260 per deer harvested (Warren 1997). A study in Minnesota compared methods to reduce deer abundance, and sharpshooting averaged $121 per deer harvested (Doerr et al. 2001). Gettysburg National Military Park reported that costs averaged $128 per deer, with 355 deer removed (Frost et al. 1997). In a suburban area near Minneapolis, the cost for a contractor to remove 36 deer in 2004 was $400 per deer, based on several bait station locations, difficult access to removal locations, and a lower deer density (D. Jacobson, City of Burnsville, pers. comm., 2004).

TABLE 10: COST ESTIMATE—ALTERNATIVE C: LETHAL ACTION (SHARPSHOOTING)

Action	Assumptions	Annual Cost	Cost for the 15-Year Planning Period
Same actions as described for alternative A (common to all alternatives)	Includes distance sampling, small fence installation, monitoring of existing and 50 new plots, maintenance of plots and fences, repellent use and deer health checks.	$23,388	$350,825
Direct removal (sharpshooting)	Year 1: 581 deer removed ($200/deer) Year 2: 349 deer removed ($200/deer) Year 3: 105 deer removed ($200/deer) Years 4–15: 85 deer removed ($400/deer) per year[a]	Year 1: $116,200 Year 2: $69,800 Year 3: $21,000 Years 4–15: $34,000/yr	$615,000[b]
Capture and euthanasia	15 deer maximum/year (range of $100–$1,000/deer)	$1,500–$15,000	$22,500–$225,000[c]
Total			$988,325–$1,190,825

[a]Cost increase after year 3 is due to additional time needed to locate deer at a lower deer–density level.
[b]This cost could increase if the deer-density goal is not reached by the third year.
[c]Costs for this method would vary but would likely be in the lower end to middle of this range.

This alternative is estimated to initially cost $200 per deer for the first three years, increasing to $400 per deer as the population decreased. However, with a smaller population, even though the cost per deer might increase because of more time needed to locate deer, the overall removal costs could decrease because fewer deer would have to be removed.

Capture and Euthanasia

The costs for capturing deer would likely vary. Factors would include the location of the removal site, accessibility, type of trap or immobilization drug used, means of deer disposal, and type of euthanasia used. Based on the experience of national lakeshore personnel and the range of costs identified for capturing deer under the reproductive control action, costs could range from $100 to $1,000 per deer. An experienced contractor estimates that the minimum cost for capture and euthanasia would be $400 per animal (White Buffalo, Inc. 2005); therefore, actual costs for this method would likely be closer to the lower end or middle of the range.

ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL ACTIONS

Alternative D would include a combination of lethal and nonlethal actions to reduce deer herd numbers.

Alternative D would include all actions described under alternative A, plus a combination of certain additional lethal and nonlethal actions from alternatives B and C to reduce deer herd numbers. The lethal actions would include sharpshooting, done initially to quickly reduce deer herd numbers, and capture/euthanasia. Reproductive control of does would be implemented as a maintenance tool to keep deer numbers at an acceptable level when there is a federally approved fertility control agent for free-ranging populations that provides multiyear efficacy for does (i.e., three to five years). All safety measures described under alternatives B and C would be implemented under those actions that also apply to alternative D.

Direct reduction would be managed by the NPS and carried out by qualified federal employees and authorized agents. Authorized agents can include other agency and tribal personnel or contractors. Skilled volunteers would not be used.

Personnel engaged in direct reduction of deer for this plan would have the appropriate skills and proficiencies in using firearms and protecting public safety. In addition, these personnel would be experienced in using firearms for the removal of wildlife. For this plan's purposes, a contractor would be a fully insured business entity, nonprofit group, or other entity engaged in wildlife management activities that include using firearms for direct animal reduction. The contractor would possess all necessary permits. NPS will use only professional sharpshooter contractor personnel or park service staff for the actual shooting in cull operations. Although NPS would not use skilled volunteers as sharpshooters, volunteers may be used in secondary roles to assist in reduction activities that do not involve using firearms. Skilled volunteers (e.g., volunteers to assist with CWD sampling or carcass removal) would need to demonstrate appropriate proficiency, depending on their proposed involvement. Those skilled volunteers who qualify for participation would become part of a pool of available personnel to supplement deer management teams. In addition, all skilled volunteers would need to be directly supervised in the field by NPS personnel during deer management actions.

Additional Actions Proposed under Alternative D

Fencing, Exclosures, and Repellents

Small-area protection fencing and repellents would be used to protect small populations of sensitive plant species, small plant restoration projects, or areas that cannot otherwise be managed due to their proximity to buildings or visitors. Small-area protection fencing is a method of completely protecting a small area from damage if the plants are highly susceptible to deer browse. This fencing would not reduce deer numbers and would cause deer to concentrate browsing elsewhere, potentially resulting in more damage to those areas. Size and locations for small-area protection fencing or repellent use would be determined as described under alternative B.

Small-area protection fencing and large-area exclosures would be constructed as described in alternative B. However, the number of protected areas would differ from alternative B, with only five small fenced areas for plant protection and monitoring installed annually throughout the life of the plan. This alternative could also include construction of up to one large-area exclosure (1 to 5 acres) every other year for plant protection until the deer-density goal is reached.

Sharpshooting

Direct reduction by sharpshooting would be used to initially reduce the deer population in deer management zones where the action threshold is triggered. Methods described in alternative C would be implemented. This action would continue for a minimum of three years, at which time it is estimated that the population would be reduced to the initial density goal of 15 deer/mi^2. The disposal methods described under alternative C would apply to alternative D, as well.

Sharpshooting could also be used to maintain the deer population size at the initial target density through annual removals. Once a density of approximately 15 deer/mi^2 is achieved, the annual removal number is estimated to be 70 to 100 deer.

Capture and Euthanasia

Capture and euthanasia would be implemented in areas where sharpshooting was not possible. This action would include trapping or immobilizing deer using the technique that would create the least amount of stress. The disposal methods described under alternative C would apply to alternative D, as well.

Reproductive Control

Reproductive control could be implemented as described under alternative B (when a federally approved fertility control agent becomes available for application to free-ranging populations that provides multiyear efficacy) to maintain the lowered deer population level after sharpshooting reduces the population size. The success of implementing reproductive controls on a population that has undergone sharpshooting for several years would depend on advances in reproductive control technology, sensitivity of the deer herd to humans, methods used by the sharpshooters, changes in immigration with reduced deer density, and general deer movement behavior (Porter et al. 2004; Naugle et al. 2002). It should be expected that getting close enough to administer remote injections would become increasingly difficult after sharpshooting efforts occur because of deer behavior changes in response to previous human interaction (B. Underwood, USGS, pers. comm., 2005).

A deer density of 15 deer/mi^2 would translate to 311 deer (covering 20.7 square miles) in the national lakeshore). Assuming that the sex ratio of the reduced deer population would be nearly one to one, there would be approximately 158 does in the population. The majority (at least 90 percent, or 142) of the does would need to be treated and marked so that they could be identified for retreatment in successive years. The population would continue to be monitored for growth.

It is possible that deer treated with reproductive controls could either be shot later under the sharpshooting component of this alternative or could wander onto neighboring lands and be shot during a hunt outside the national lakeshore boundaries. Under implementation of this alternative's sharpshooting component, efforts would be made by national lakeshore staff or their agents to shoot only those deer that have not been marked (tagged) as being treated with reproductive controls. National lakeshore staff would cooperate with local land agencies to inform them of any reproductive control measures taken within the national lakeshore and how to identify treated deer.

If the deer population increased by more than 20 percent during application of reproductive control under this alternative, periodic sharpshooting would be initiated to maintain the population density at the identified goal.

Monitoring

Monitoring would include the same techniques described for sharpshooting and capture/euthanasia under alternative C, reproductive controls, and fencing and exclosures under alternative B.

Monitoring activities include spotlight surveys to assess the effectiveness of reproductive controls and vegetation monitoring to document changes in growth of indicator species.

Under alternative D, national lakeshore personnel would also monitor the status of ongoing reproductive control research. If advances in technology could increase efficiency and efficacy and reduce costs, the application of different reproductive control agents or measures would be considered (see the "Adaptive Management" section on page 70).

CWD Testing

Testing for CWD would occur as described under alternative A. Under alternative D, a statistically valid sample may be reached sooner than under alternative A, given increased opportunities for testing.

Education

Education and communication under alternative D would be the same as described under alternative B.

Implementation Costs

Costs of implementing alternative D would include the same costs described under alternative A, plus additional costs for small-area protection fencing, large-area exclosures, repellents, sharpshooting, capture/euthanasia, and reproductive control. Estimated costs for alternative D are discussed below and summarized in Table 11.

Fencing and Repellents

As described in alternative B, small-area protection fences were estimated to cost $133 each (at $7 per linear foot), and large-area fences were estimated to cost $9 per linear foot for materials and labor to install. Alternative D includes installation of five small-area protection fences per year, for a total of 75 small fenced areas, and one large-area exclosure every two years, in the range of 2 to 5 acres (1,180 to 1,867 linear feet) each.

The increased use of repellents under this alternative is estimated at approximately double the amount used under the no-action alternative (same as in alternative B).

Sharpshooting

The cost for using sharpshooting to reduce the overall population size would be the same as in alternative C for years 1 through 3, plus a potential need for periodic removals (estimated to be needed in 2 of the remaining 12 years). Costs for using this method would depend on the number of deer removed annually.

Capture and Euthanasia

The cost for using capture and euthanasia to supplement the sharpshooting effort would be the same as for alternative C.

Reproductive Control

For purposes of this analysis, it was assumed that reproductive control would begin in year 4 using GonaCon (or a similar agent) and that 90 percent of the does would be treated in this year and subsequent years. Costs could be reduced considerably depending on the results of the sharpshooting efforts, the cost per deer based on technology used, and the timing used for this method.

TABLE 11: COST ESTIMATE—ALTERNATIVE D: COMBINED LETHAL AND NONLETHAL ACTIONS

Action	Assumptions	Annual Cost	Cost for the 15-Year Planning Period
Same actions as described for alternative A-	Includes distance sampling, small-fence installation, monitoring of existing and 50 new plots, maintenance of plots and fences, repellent use and deer health checks.	$23,388	$350,825
Construction of additional small-area protection fences	Five small-area protection fences constructed per year for 15 years ($133 each for materials and labor)	$665	$9,975
Construction of additional large-area exclosures	One large exclosure constructed every 2 years for a total of seven in 15 years. Size estimated to be 1,180 to 1,867 linear feet per exclosure (range based on 2-acre and 5-acre area), installed at $9/linear foot.	$10,620–$16,803	$74,340– $117,621
Additional exclosure maintenance	Labor and materials: $525/mile and an estimated 0.22 to 0.35 miles per year	$116–$184	$1,740–$2,760 $86,055–$130,356
Additional repellents	Double application amount covered in alternative A, adding another $50 per year in labor and materials	$50	$ 750
Sharpshooting	Same level of effort as alternative C in years 1 to 3, plus two subsequent years	Year 1: $116,200 Year 2: $69,800 Year 3: $21,000 Two subsequent years: $34,000/year	$275,000[a]
Capture and euthanasia	Similar to alternative C	$1,500–$15,000	$22,500–$225,000[b]
Reproductive control	Assume treatment of 158 deer annually starting after year 3 (for 12 years)	$1,000/deer or $158,000	$1,896,000[c]
Total		$473,339–493,090	$2,631,130– $2,877,931[d]

[a]This cost could increase if the deer-density goal was not reached by the third year.

[b]Costs for this method would vary but would likely be in the lower end to middle of this range.

[c]Reproductive control costs could be reduced considerably with improved technology.

[d]The cost to maintain the deer population at lower density could vary considerably depending on which management action or combination of actions is implemented.

ADAPTIVE MANAGEMENT

All the action alternatives (B, C, D) described in this chapter incorporate adaptive management approaches to meeting the plan's objectives. Each alternative includes a management action followed by a period of monitoring to evaluate the action's results. By using an adaptive management approach, managers would be able to change the timing or intensity of management treatments to better meet the plan's goals as new information is obtained. The adaptive management approach and its integration into the action alternatives are more fully described below.

All the action alternatives incorporate adaptive management approaches to meeting the plan's objectives.

Successful management of natural systems is a challenging and complicated undertaking. The Department of the Interior requires that its agencies "use adaptive management to fully comply" with the Council on Environmental Quality's guidance that requires "a monitoring and enforcement program to be adopted… where applicable, for any mitigation" (516 DM 1.3 D (7); 40 CFR 1505.2). Adaptive management is based on the assumption that current resources and scientific knowledge are limited. Nevertheless, an adaptive management approach attempts to apply available resources and knowledge and adjusts management techniques as new information is revealed. Holling (1978) first described the principle of adaptive management as requiring management decisions and policies to be viewed as hypotheses subject to change.

Using the Adaptive Management Process

Adaptive management requires an examination of a hypothesis to be tested. For this plan, adaptive management starts with the hypothesis that deer density is the primary factor limiting herbaceous vegetation regeneration. Monitoring would test for a substantial difference in plant heights between open plots and enclosed plots. If this difference exists, then deer management actions would be taken, as described previously under the heading "Deer-Density Goal and Thresholds for Taking Action under Alternatives B–D." If no difference exists, data would be examined to identify the most important variable(s) affecting herbaceous reproduction and distribution. These could include light penetration, soil moisture, and nutrient availability, in addition to deer density.

The adaptive management approach can be divided into the following basic steps: assessment, design, implementation, monitoring, evaluation, and adjustment or continuation (Nyberg 1998). Ideally, the resulting ecosystem management would improve as more information is gathered, analyzed, and incorporated into the process. Adaptive management requires setting quantitative objectives, exploring alternative management strategies, monitoring progress, and evaluating performance in terms of risks and benefits (Goodman and Sojda 2004). The applicability and success of decisions depends on the frequency and precision of monitoring (Williams 1997).

Adaptive management incorporates scientific experimental methods in the management process while remaining flexible to adjust to changes in the natural world, as well as the policies that govern it. The goal is to give policymakers a better framework for applying scientific principles to complex environmental decisions (Wall 2004). Figure 4 illustrates an adaptive management approach.

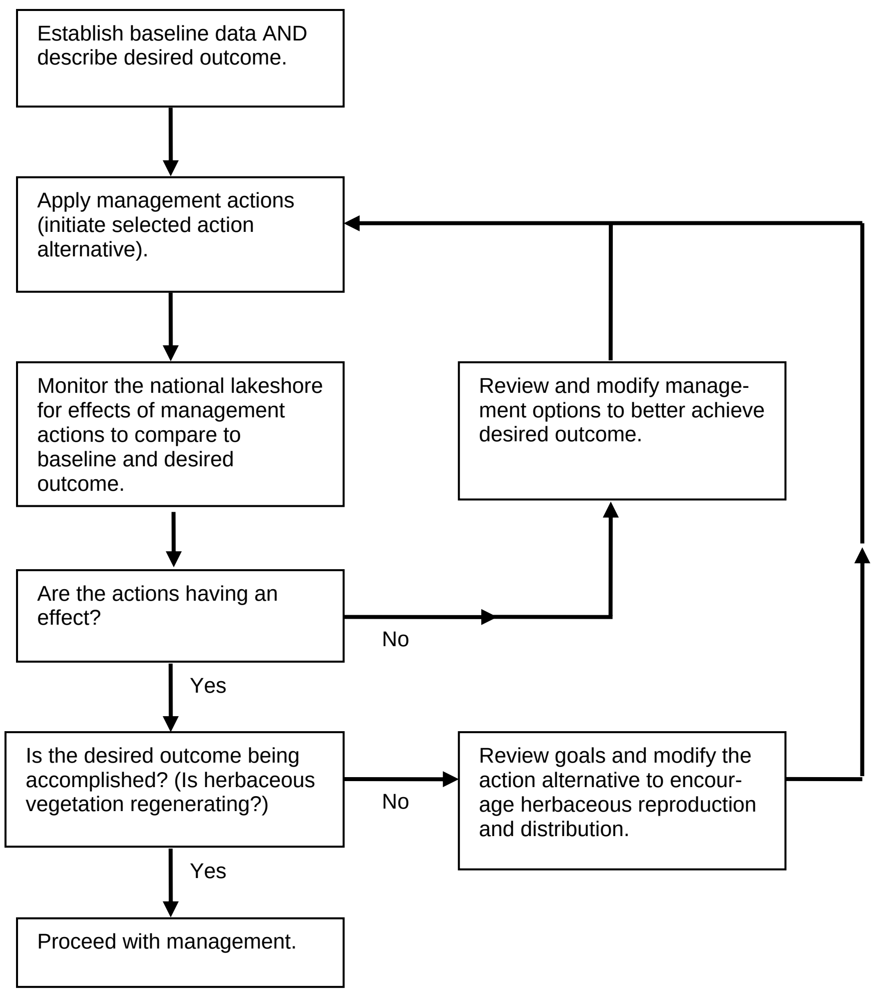
Under this plan, the following six steps would constitute the adaptive management approach. For illustrative purposes, alternative D is used as an example for each of these steps.

1. Review the baseline data — Existing conditions would be recorded and monitored to establish a set of baseline conditions for future comparison.
2. Apply the management action — Deer would be managed using an action alternative described in this document; for example, alternative D could apply a combination of plant protection, repellents, sharpshooting, and reproductive control.
3. Monitor the effectiveness of each management action — Monitoring would determine whether the management actions were achieving the desired outcome. For example, it would determine if the exclosures were protecting enough rare species or if sharpshooting reduced the population of deer to a low enough density to allow rare species to reproduce.
4. Monitor for effects of the management action on other resources — Resources in the national lakeshore would be monitored during and after management to determine whether there were any unacceptable effects on native vegetation, wildlife, sensitive species, or cultural resources (e.g., increase in invasives observed; visual impacts on cultural landscapes from fences).
5. If monitoring indicates that rare/indicator species are not growing at an acceptable level, reconsider the management actions — When unexpected results are found during

monitoring, national lakeshore management staff would try to find the reason behind the unexpected results (e.g., influence of weather or other wildlife) and whether modifications to the actions are needed. For example, under the combination alternative, staff would consider building additional fencing or lowering the deer/mi^2 goal. Similarly, if an action is found to have unintended effects on deer or other environmental components, modification would be considered. For example, this may involve changing the location or type of fence or the location or timing of sharpshooting.

6. If the management action is effective and the rare plant species are recovering, management might consider modifications to the action's intensity. For example, if deer density was maintained under sharpshooting, the number of deer treated might be able to be reduced and still have the same plant recovery effect.

FIGURE 4: AN ILLUSTRATION OF THE ADAPTIVE MANAGEMENT APPROACH FOR THE ACTION ALTERNATIVES



Potential Adaptive Management Approaches

The adaptive management approach would be used to a limited extent in the following areas (see the discussion for each alternative for additional details).

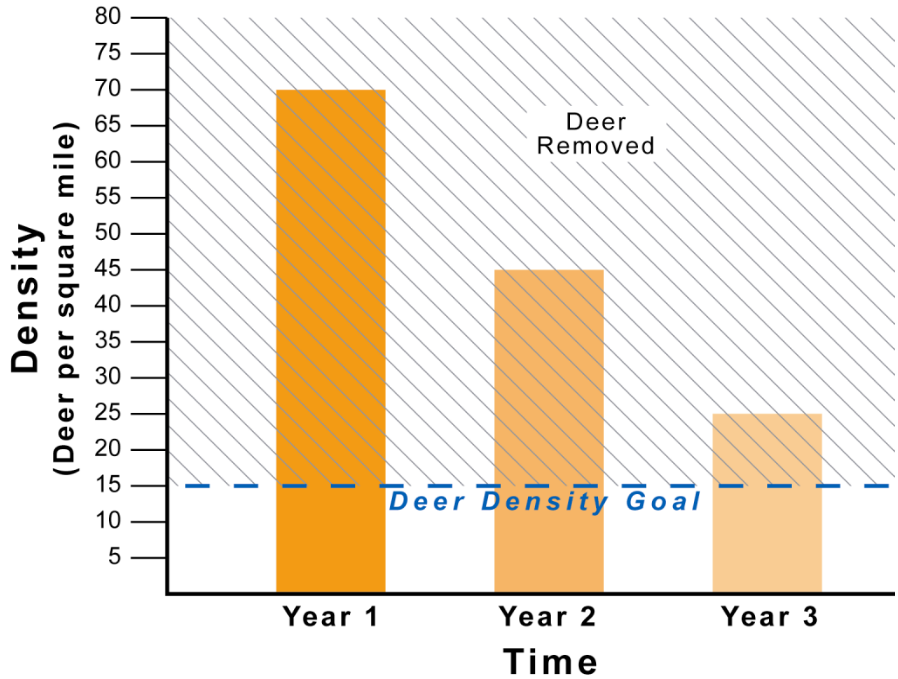
Action Threshold

The action threshold could be modified, based on the results of vegetation monitoring data and deer-density changes. The action threshold is based on the best available data for plant-height indicators in a similar plant community. As data are collected, the results would be compared to expectations that rare species reproduction would increase as deer density decreases. It is expected that up to five years may be required from the time that deer density was lowered until the time that measurable rare species regeneration results would be seen in the monitored plots. If results after five years did not meet expectations, the action threshold would be evaluated, along with the monitoring data and other potential factors (e.g., weather, other wildlife), to determine what adjustments might be necessary.

Deer Removal Goal

For alternatives that would directly reduce the deer population through removal (sharpshooting or hunting), the number of deer to be removed annually would be adjusted based on the results of the previous year's removal effort, monitoring of the herbaceous vegetation, deer population density surveys, and growth projections. When a management action was first triggered, the approximate number of deer to be removed would be defined by the difference between the deer population density estimated during annual deer surveys and the initial density goal selected (i.e., 15 deer/mi^2). Using this example, if the population density was estimated at 70 deer/mi^2 in the Dune Ridge deer management zone, the treatment goal would be to reduce the population by 55 deer/mi^2. The initial management goal would be set to achieve the density of 15 deer/mi^2. For example, starting in 2006, with an estimated 308 deer (4.4 square miles multiplied by 70 deer/mi^2) in the Dune Ridge zone, 242 deer (4.4 square miles multiplied by 55 deer/mi^2) would be the removal goal for that year in that zone. However, because this density goal may not be achieved in one year, annual removal goals would be revised based on the number of deer remaining after each year's removal actions and factoring in an annual growth rate. This process of determining the number of deer to be removed each year would be repeated until the population density goal was reached. An example is shown in Figure 5.

FIGURE 5: ACHIEVING THE DEER-DENSITY GOAL



The results of deer removal would be documented annually so that removals could be adjusted based on the response of the vegetation to lower deer density. If the vegetation was observed to rebound before the deer-density goal was reached, management actions could then be modified or adjusted. Similarly, management actions would be adjusted if no change in the vegetation was observed after implementation. The following are examples of how this adaptive management approach could be implemented based on different outcomes:

- If vegetation responds (increased growth) before meeting the initial deer-density goal, the deer-density goal would be adjusted upward (e.g., 20 deer/mi^2 rather than 15).
- If no response in herbaceous vegetation occurred within five years after the initial deer-density goal was reached, the density goal could be lowered by intervals of 5 deer/mi^2 with three-year monitoring periods in between changes in density goals.
- If the initial deer-density goal of 15 deer/mi^2 was not reached within five years, additional efforts would be made to reach the desired density through the use of other methods of removal, such as increasing the use of capture and euthanasia in areas where sharpshooting was not effective.
- If no response in herbaceous vegetation occurred after a goal of 10 deer/mi^2 was reached, methods and protocols would be reviewed to identify the variables that were limiting the expected results, and the methods used would be adjusted as necessary to correct for such factors.

Fencing, Exclosures, and Repellents

More extensive fencing, exclosures, and repellent use are proposed under alternatives B and D. As some areas are treated, deer-browsing pressure on other areas could increase, making additional treatments necessary in these areas. Thus, over the course of management actions, the investment in materials and maintenance could increase. Areas inside and outside the proposed large exclosures would be monitored according to the monitoring protocol described in appendix D. If vegetation further deteriorates in the untreated areas, increased repellent use or additional exclosures would be considered or, under alternative D, sharpshooting would be used to decrease browsing pressure in areas outside of the protected areas.

As described under alternative B in Table 7, the national lakeshore has identified a number of areas as critical and high priority for exclosures based on such factors as plant status, abundance, and palatability. As deer adapt to increased exclosures, other areas currently identified as medium or low priority may be elevated to higher-priority levels if changes in palatability affect other species or if changes in browsing result in decreased abundance of a species.

Reproductive Control

Reproductive control is one of the proposed measures under alternative B. However, there is limited information regarding the safety, efficacy, and feasibility of applying reproductive control agents in large, free-ranging populations. As science catches up to the need for management, additional agents could be developed and tested for reproductive control on free-ranging deer. The science could be reviewed at that time to determine if other agents were appropriate for the national lakeshore. The size, scale, and location of the application would depend on the specifications and efficacy of the drug.

Group of deer at the Indiana Dunes National Lakeshore

Alternative Implementation

For illustrative purposes, alternative D (combined lethal and nonlethal actions), for example, would be adjusted as described for each individual action to maximize the response of herbaceous vegetation, especially rare species. These actions could also be adjusted to stay current with new technologies or research. The initial plan would be to focus on sharpshooting to decrease deer population density as quickly as possible, to minimize the number of deer to be removed over time, and to test action thresholds within a reasonable timeframe. After deer density was reduced to the initial goal, as indicated by vegetation monitoring, the population density would be maintained through a combination of fencing, reproductive control, and sharpshooting, depending on the management zone and the adaptive management parameters described above.

HOW ALTERNATIVES MEET OBJECTIVES

As stated in Chapter 1: Purpose of and Need for Action, all action alternatives selected for analysis must meet all objectives to a large degree. The action alternatives must also address the stated purpose of taking action and resolve the need for action; therefore, the alternatives were individually assessed in light of how well they would meet the objectives for this plan and EIS, as stated in chapter 1, “Objectives in Taking Action.” Alternatives that did not meet the objectives were not analyzed further (see the “Alternatives Considered but Eliminated from Detailed Evaluation” section in this chapter).

Table 12 on page 77 summarizes the elements of the alternatives being considered, while Table 13 on page 78 compares how each of the alternatives described in this chapter would meet the objectives. Chapter 4: Environmental Consequences describes the effects of each alternative on each impact topic, including the impact on recreational values and visitor experience. These impacts are summarized in Table 14 on page 79.

TABLE 12: COMPARISON OF ALTERNATIVES

	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Preferred Alternative- Combined Lethal and Nonlethal Actions
Management Actions	Continue limited use of fencing and repellents, plus inventorying and monitoring efforts throughout the national lakeshore where needed. No new deer management actions would be taken.	All actions under alternative A, plus: Preserve vegetation through installation of additional fences or increased application of repellents. Protect priority areas of sensitive resources from deer browse, taking into account the plants' palatability, listed status, and population size. Use repellents in moderate and low-priority areas and where installation of a fence is undesirable. Implement reproductive control of does.	All actions under alternative A, plus: Sharpshooting to reduce the deer population in the national lakeshore area that has been documented to have substantial browse impacts. Donate meat, if possible.	All actions under alternative A, plus a combination of techniques from alternatives B and C: Use fencing and repellents to protect small populations of sensitive plant species, small plant restoration projects, or areas that cannot be managed by other means. Use direct reduction to prevent unacceptable resource damage (initially and periodically as needed). Apply reproductive controls to limit population growth.
Reduction in Deer Population	None, other than natural sources of mortality.	Potential reduction in deer population if reproductive controls could be applied throughout the national lakeshore but only after the first several years of treatment or until natural mortality exceeded reproduction and reduced the population. Population reduction would be gradual.	Initially remove an estimated 581 deer, with fewer deer in subsequent years. To maintain the population at target levels (15 deer/mi^2), remove an estimated 70 to 100 deer annually.	Initially similar to alternative C. Potential for future reductions through reproductive control used as a population maintenance tool.
Time Required to Achieve Desired Objectives	Controls immediately prohibit deer from browsing but in small areas only; controls not fully effective at meeting national lakeshore objectives.	Fencing would immediately prohibit deer from browsing in certain areas, but several years would be required for vegetation regrowth. Reproductive control is not likely to contribute to achieving a healthy and sustainable ecosystem.	Immediate reduction. May take a minimum of three years to reach density goal and could be longer, depending on such factors as deer becoming more evasive, changes in reproduction and mortality rates, and immigration from outside of the national lakeshore boundaries.	Varies by methods used. See alternatives B and C.
Handling of Deer	None.	No physical handling of deer is required to drive them out of fenced areas. With telemetry dart application, physical handling of deer is required to administer reproductive control (leuprolide). The dart is then recovered, the doe marked, the control agent administered, and the doe released.	No capture required for sharpshooting activities.	Same as alternative B for reproductive control.
Monitoring	Continued monitoring of vegetation impacts and deer population levels, expanded as necessary to correlate vegetation impact levels with deer population levels.	Continued monitoring as described under alternative A, plus monitoring of plants for signs of recovery within exclosures. For reproductive control, monitoring of treated deer using additional spotlight surveys to determine reproductive control effectiveness.	Continued monitoring as described under the no-action alternative. In addition, vegetation monitoring would document any changes in deer-browsing impacts that may result from reduced deer numbers. Five years of monitoring would be completed and evaluated to determine if the removal-density goals need to be continued or modified.	Same as alternatives B and C.
Regulatory Considerations	No specific regulatory requirements. Application rate restrictions would apply to different repellents that could be used.	Application rate restrictions may apply to different repellents that could be used. Veterinarian prescription required pursuant to the Animal Drug Use and Clarification Act for off-label use of reproductive controls in does. Additional requirements could be prescribed by a veterinarian (e.g., meat-withdrawal period, marking). Follow Public Health guidelines for CWD.	No prohibition on spotlights or suppression devices that could be used, along with night vision equipment, to reduce disturbance to the public. Any necessary ATF permits would be obtained. Coordination with state/local/nonprofit/private entities might be needed to donate meat.	Same as alternatives B and C.
CWD Testing	Testing coordinated with the state and conducted opportunistically when CWD is greater than 60 miles from the national lakeshore. Targeted removal and testing of animals with clinical signs of CWD when CWD is less than 60 miles from the national lakeshore.	Same as alternative A.	Same as alternative A. Under this alternative, a statistically valid sample may be reached sooner than under alternative A, given increased opportunities for testing.	Same as alternative A. Under this alternative, a statistically valid sample may be reached sooner than under alternative A, given increased opportunities for testing.
Education	Continue existing educational programs.	Additional education and public programs about deer management activities implemented.	Additional education and public programs about deer management activities implemented.	Additional education and public programs about deer management activities implemented.
National Lakeshore Closure/ Restricted Access	None.	Restricted access within exclosures or in areas of active reproductive control activities.	Areas closed or access restricted during reduction activities, closures or restrictions minimized by conducting activities during periods around dawn and dusk and in winter.	Same as alternatives B and C.
Adaptive Management	No specific adaptive management included under this alternative.	Relocation of vegetation paired plots, changes in action thresholds (including indicator species) or deer-density goals, possible changes in repellent use and number and locations of exclosures, possible change in reproductive control agent and its application procedures.	Relocation of vegetation paired plots, changes in action thresholds or deer-density goals, or possible changes to implementation procedures for direct reduction.	Same as alternatives B and C.
Estimated Cost (15-Year Plan)	$350,825	$11,283,971	$988,325 to 1,190,825	$2,631,130 to $2,877,931

TABLE 13: ANALYSIS OF HOW THE ALTERNATIVES MEET OBJECTIVES

	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Preferred Alternative-Combined Lethal and Nonlethal Actions
Management Methodology				
Determine a science-based, well-informed, and defensible vegetation impact level that would serve as a threshold for taking management action within the national lakeshore.	**Does not meet objective.** No management action would be taken; therefore, no thresholds for taking action would apply.	**Fully meets objective.** Thresholds for taking action have been identified by the science team and incorporated into this plan. All action alternatives address the need for science-based impact levels and an adaptive management approach to management of deer populations.	**Fully meets objective** for reasons described under alternative B.	**Fully meets objective** for reasons described under alternative B.
Develop and implement an adaptive management approach (Porter and Underwood 1999) for maintaining a viable deer population within the Indiana Dunes National Lakeshore.	**Does not meet objective.** Would not maintain a viable deer population.	**Partially meets objective.** The viable deer population would be maintained through the adaptive management process identified in this plan, although a reproductive control method that would work at the national lakeshore does not yet exist and is unlikely to be available soon. Without such a method, the national lakeshore may not be able to maintain a viable (healthy) deer population.	**Partially meets objective.** Provides fewer management options. Sharpshooting would be adaptively managed throughout the life of this plan to maintain a viable deer population.	**Fully meets objective.** Provides more adaptive management elements and more management options than other action alternatives. The viable deer population would be adaptively managed throughout the life of this plan by first reducing the deer herd using sharpshooting and then applying reproductive control for longer-term maintenance if and when it becomes feasible.
Wildlife and Wildlife Habitat				
Maintain a healthy white-tailed deer population within the national lakeshore while protecting other national lakeshore resources.	**Does not meet objective.** The deer population would not be in balance with the ecosystem, potentially resulting in compromised herd health. No reduction in deer population size and no control on vegetation damage within the national lakeshore would occur other than in small areas.	**Partially meets objective.** Would not fully protect other national lakeshore resources, except for those protected within exclosures, as deer would be concentrated in unfenced areas. Since deer are part of the natural ecosystem of the national lakeshore, exclosures would not be natural landscapes.	**Partially meets objective.** Would quickly reduce deer numbers, resulting in a viable deer population in a short timeframe. Other national lakeshore resources would be protected as a result of reducing herd size.	**Fully meets objective.** Would quickly reduce deer numbers, resulting in a viable deer population in a short timeframe. Other national lakeshore resources would be protected as a result of reducing herd size. Exclosures would protect rare wildlife species until deer are reduced to a viable population.
Protect lower-canopy and ground-nesting bird habitat from adverse impacts from deer browsing.	**Does not meet objective.** Continued browse pressure could limit natural regeneration of the lower canopy, reducing the amount of bird habitat.	**Partially meets objective.** Lower canopy and bird habitat would only be protected in enclosures.	**Fully meets objective.** Protection of lower-canopy and ground-nesting bird habitat would occur with a smaller deer herd.	**Fully meets objective** for reasons described under alternative C.
Protect habitat of sensitive and rare species from adverse impacts related to deer browsing.	**Does not meet objective.** Protection of habitat of sensitive and rare species would not occur with increased browse pressure, resulting in unacceptable adverse impacts on these species.	**Partially meets objective.** Habitat of sensitive and rare species would be protected only in exclosures.	**Fully meets objective.** Protection of habitat of sensitive and rare species would occur quickly with a smaller deer herd.	**Fully meets objective.** Would provide exclosures for rare wildlife species until viable deer population is achieved. Protection of habitat of sensitive and rare species would occur quickly with a smaller deer herd.
Vegetation				
Protect vegetation, sensitive plant populations, and rare plant species within the national lakeshore from deer browsing.	**Does not meet objective.** Deer browsing would result in a decline in rare plants. (Small existing and planned fenced areas would help protect some sensitive or rare species, but fenced areas are inadequate to protect these species on an ecosystem level.)	**Partially meets objective.** Because the entire national lakeshore cannot be fenced, only very rare plants would be protected. A minimum of 10 years of reproductive control is required before it becomes effective with current methods. Additional fencing/repellent used may not be effective for conservation of native and rare plant species.	**Partially meets objective.** Protection of vegetation, sensitive plant populations, and rare plant species would occur with a smaller deer herd. Immediate reduction of deer would provide almost immediate benefit to stressed vegetation.	**Fully meets objective.** Protection of vegetation, sensitive plant populations, and rare plant species would occur with a smaller deer herd. Fenced areas would protect more rare species until deer are reduced to a viable population.
Do not allow deer-browsing impacts to lead to the extirpation of rare plant species.	**Does not meet objective.** Deer browsing would result in extirpation of some species (small existing and planned fenced areas would help protect some sensitive or rare species but are inadequate to protect these species on an ecosystem level).	**Partially meets objective.** Not all plant species could be fenced; plants within fenced area could experience other adverse effects, such as invasion of nonnative plants, which could lead to extirpation regardless of browse impacts.	**Partially meets objective.** A smaller deer herd would reduce the amount of browsing that could lead to extirpation of rare plant species. Some rare plant species may continue to decline without additional fencing, increasing the potential for extirpation.	**Fully meets objective.** Protection of vegetation, sensitive plant populations, and rare plant species would occur with a smaller deer herd. Fenced areas would protect more rare species until deer are reduced to a viable population.
Visitor and Employee Health and Safety				
Reduce the potential for health and safety impacts related to deer.	**Does not meet objective.** Taking no actions to reduce deer population would not address health and safety issues.	**Does not meet objective.** Extended time period to resolve issues associated with the deer population would not address health and safety issues.	**Fully meets objective.** A smaller deer herd would reduce health and safety issues in a relatively short time period.	**Fully meets objective** for reasons described under alternative C. Long-term management methods would lessen dangers associated with firearm use.
Visitor Experience				
Provide opportunities for the public to experience a balanced, functioning Indiana Dunes National Lakeshore ecosystem where deer are not the driving force and to understand the natural role of deer in the ecosystem.	**Does not meet objective.** Habitat would be degraded with existing management.	**Partially meets objective.** Fencing could be a negative experience for some visitors. Additional education and public information about deer management actions would be provided.	**Fully meets objective.** A balanced ecosystem would provide a more natural visitor experience. Additional education and public information about deer management actions would be provided.	**Fully meets objective** for reasons described under alternative C.
Cultural Resources				
Recreate and manage historically accurate cultural landscapes. This includes maintaining the deer impact and visibility to an acceptable level to achieve the desired historical landscape.	**Does not meet objective.** Would not support a historically accurate cultural landscape. (Although the fields at Chellberg Farm are bordered by a 4.5-foot fence, it does not keep deer out.)	**Does not meet objective.** Fencing may concentrate deer on cultural landscapes. Difficult to fence without creating visual impacts.	**Fully meets objective.** A smaller deer herd would maintain deer impacts at acceptable levels.	**Fully meets objective** for reasons described under alternative C.

TABLE 14: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Preferred Alternative-Combined Lethal and Nonlethal Actions
Vegetation	The deer population would remain in excess of the recommended density for sustaining the natural reproduction of native national lakeshore vegetation and would likely remain high or increase over time, adversely affecting native plant abundance and diversity. As long as the deer population remained high or increased, overall effects would include decreased ability of plants to reproduce naturally, which in turn would lead to decreased native plant diversity, increased opportunity for exotic plants, and decreased abundance of native plants. Some benefits would be gained from such management actions as maintaining small fenced areas and applying repellents in selected areas; however, the benefits would not protect or affect the majority of the national lakeshore. Some benefits could also be gained after periodic declines in deer population from disease or lack of available food; however, such population declines would not last long enough for native plant communities to recover fully. The impact of large numbers of deer browsing on a very large percentage of the national lakeshore's native vegetation, thus limiting natural plant reproduction, would be adverse, long term, and major. Past, present, and future actions, when combined with the continued pressure on plant reproduction expected under this alternative, would result in both adverse and beneficial impacts, with adverse, long-term, major cumulative effects. Because alternative A would not reverse the expected long-term density or growth in the deer population, damage to vegetation would likely continue.	Under alternative B, overall, approximately 7 percent of the national lakeshore's native vegetation would benefit from constructing exclosures over the life of this plan, and doubling the use of repellents would help protect small areas. Remaining vegetation within the national lakeshore would continue to be adversely affected by deer browsing over the long term until reproductive controls became effective and the deer population decreased. However, because the benefits of reproductive control would not be fully realized within the life of this plan, overall impact on vegetation would be adverse, long term, and major as native vegetation decreased in abundance and diversity in the majority of the national lakeshore. Past, present, and future activities, when combined with the continued pressure on native vegetation expected under this alternative, would result in both adverse and beneficial effects. Over the long term, cumulative impact would be adverse and moderate to major. Alternative B would provide continued protection of certain areas of the national lakeshore over the long term, would protect 7 percent of the national lakeshore overall, and would introduce reproductive controls that could reduce deer numbers gradually over an extended period of time.	Enhancing native plant reproduction by quickly reducing deer-browsing pressure under alternative C and by maintaining a smaller deer population through sharpshooting would result in beneficial, long-term effects because native vegetation throughout the national lakeshore could recover. In the short term, implementation of alternative C would result in moderate impacts on vegetation, as a quick reduction in deer numbers would support an increase in plant reproduction. Although a smaller deer herd would reduce the amount of browsing that could lead to extirpation of rare plant species, some rare plant species may continue to decline without additional fencing and repellents, increasing the potential for extirpation of some species. As deer numbers are further reduced over the long term, native plant diversity and abundance would increase, resulting in a reduction of adverse impact to minor levels. Under alternative C, less than 1 percent of the national lakeshore's vegetation would be affected by trampling at bait stations, shooting sites, or disposal sites; placement of these sites would be in previously disturbed areas free of sensitive vegetation. Therefore, adverse impacts of these actions would be short term and negligible. Past, present, and future activities, when combined with the reduced browsing stress on native vegetation and subsequent increase in plant diversity and abundance, would result in beneficial, long-term cumulative impacts.	Enhancing native vegetation reproduction by quickly reducing deer-browsing pressure under alternative D and by maintaining a smaller deer population through the use of reproductive control and sharpshooting would result in beneficial, long-term impacts because native vegetation could recover throughout the national lakeshore. In the short term, implementation of alternative D would result in moderate impact on vegetation, as a quick reduction in deer numbers would support an increase in plant reproduction. As deer numbers are further reduced over the long term, native plant diversity and abundance would increase, resulting in a reduction of adverse impact to minor levels. Under alternative D, less than 1 percent of the national lakeshore's vegetation would be affected by trampling at shooting, treatment, or disposal sites. Therefore, the adverse effects of these actions would be short term and negligible. Past, present, and future activities, when combined with the reduced browsing stress on native vegetation and subsequent increase in plant diversity and abundance, would result in beneficial, long-term cumulative impacts.
Soils and Water Quality	Adverse, long-term, negligible impacts on soils and water quality could result from soil erosion and sedimentation resulting from loss of vegetation from increased deer browsing, assuming continued growth of the deer population under alternative A. The potential for adverse, long-term, negligible impacts on water quality could result from increased fecal loading from the deer population. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Past, present, and future activities both inside and outside the national lakeshore, when combined with the continued pressure from deer browsing expected under this alternative, would result in adverse, short- and long-term, minor to moderate impacts on soils and water quality.	Adverse, long-term, and minor impacts on soils and water quality could occur if deer displaced by the small-area protection fencing and large-area exclosures concentrated in other areas of the national lakeshore and neighboring areas, resulting in increased loss of vegetation in those areas and a potential increase in soil erosion. These impacts would gradually shift to beneficial in the long term as revegetation occurred in the large exclosures, potentially reducing soil erosion. Beneficial long-term impacts would also result from decreased loss of vegetation, as reproductive control of the deer population would gradually reduce deer numbers over time. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Beneficial, long-term effects occurring inside the national lakeshore would offset cumulative impact only slightly.	Beneficial, long-term impact on soils and water quality would result from rapidly reducing the number of deer in the national lakeshore and maintaining a sustainable population of 15 deer/mi^2 after the third year of implementation. Vegetative ground cover would be able to reestablish, helping reduce soil erosion and sediment loading in the national lakeshore's creeks. Fecal loading in surface waters from the deer population would be reduced. Adverse, long-term, moderate impact on groundwater quality could result from animal disposal pits placed in areas of unknown soil type, bedrock type, and water table level. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Any beneficial impact occurring inside the national lakeshore would not offset adverse cumulative impacts.	Impacts on soil and water quality would be beneficial and long term as a result of rapidly reducing the number of deer in the national lakeshore and maintaining a population of 15 deer/mi^2 after the third year of implementation. Vegetative ground cover would be able to reestablish, helping reduce soil erosion and sediment loading in the national lakeshore's creeks. Fecal loading in surface waters from the deer population would be reduced. Adverse, long-term, moderate impact on groundwater quality could result from animal disposal pits. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Any beneficial effects occurring inside the national lakeshore would not offset adverse cumulative impact.
White-Tailed Deer and Deer Habitat	Alternative A would provide no control on the growth of the deer population, resulting in adverse, long-term, major impact on deer and their habitat. These effects would continue because of excessive deer browsing and the continued high density of the population. Past, present, and future activities, when combined with the continued pressure on vegetation resources and deer habitat expected under this alternative, would result in adverse, long-term, major cumulative impact. Because alternative A would not reverse the expected adverse habitat impacts, they would likely continue or worsen in Indiana Dunes National Lakeshore and would occur over the long term.	Impact on deer under alternative B would be adverse, long-term, and major. Such actions as the use of fencing and exclosures and increased use of repellents would help maintain plant diversity in only very limited areas; because the effect of reproductive control on the deer population would not be seen for many years, the overall long-term effect of alternative B would be expected to remain at major adverse levels for the life of this plan. Past, present, and future activities, when combined with continued pressure on vegetation resources and deer habitat expected under this alternative, would result in adverse, long-term, moderate to major impact. Impacts may diminish after the life of the project because alternative B would provide for reproductive control of the deer herd and a potential for gradual reduction in deer herd numbers over an extended period.	The relatively rapid reduction of the deer herd and the resulting regeneration of forage under alternative C would result in beneficial effects on deer habitat and would reduce adverse impact to negligible or minor levels over the long term as the deer population decreased. Adverse impact would still range from minor to moderate while habitat recovered. Past, present, and future activities, when combined with the reduced browsing pressure expected under this alternative, would result in long-term, beneficial cumulative impact on deer.	Implementing long-term deer population reduction and management through the use of sharpshooting and reproductive control under alternative D would have long-term and beneficial effects, and adverse impacts on deer habitat would be reduced to negligible or minor levels over the long term as the deer population decreased. Reproductive controls, with the current technology, would help maintain adverse impacts at lower population levels. Past, present, and future activities, when combined with the reduced pressure on deer habitat expected under this alternative, would result in beneficial, long-term cumulative impacts on deer.

Impact Topic	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Preferred Alternative-Combined Lethal and Nonlethal Actions
Other Wildlife and Wildlife Habitat	Habitat for wildlife species other than white-tailed deer would continue to be adversely affected by a large deer population and related browsing, resulting in a loss of ground/shrub habitat, decreased habitat diversity, and increased abundance of nonnative plants. A few predator species would benefit from a large deer population and a more open understory and ground cover, enabling them to see and catch prey more easily. However, the impact of large numbers of deer browsing on vegetation would adversely affect a large percentage of habitats for other wildlife (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles), resulting in adverse, long-term, and potentially major impact, depending on the species. Past, present, and future activities, combined with the continued pressure on ground/shrub habitat expected under this alternative, would result in both adverse and beneficial impacts, with adverse, long-term, major cumulative effects. Alternative A would not reverse the expected long-term continued growth of the deer population, and wildlife habitat would likely continue to be degraded.	Approximately 7 percent of the national lakeshore vegetation would benefit from constructing fencing and exclosures and increased use of repellents over the life of the plan. The remaining habitat, however, would continue to be subject to a high degree of deer browsing, adversely affecting both ground- and shrub-layer habitat for many other species of wildlife until reproductive controls took effect and reduced the deer population (more than 15 years). Overall, impact on other wildlife would be adverse and long term and would range from negligible (e.g., snapping turtles, spotted salamanders) to potentially major (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles), depending on the species. Past, present, and future activities, combined with the continued pressure on wildlife habitat expected under this alternative, would result in both adverse and beneficial effects, with adverse, long-term, moderate to major cumulative effects on other wildlife. Impacts may diminish after the life od the project because alternative B would provide continued protection of certain areas of the national lakeshore over the long term and would introduce reproductive controls that could reduce deer numbers over an extended period of time.	Impact on other wildlife species and habitat would be beneficial and long term as a result of rapid reductions in deer numbers in the national lakeshore, thereby reducing deer-browsing pressure on vegetation and allowing increased abundance and diversity of other wildlife that depend on ground/shrub habitat, such as ovenbirds, wood frogs, eastern hognose snakes, and box turtles. Adverse, long-term effects would be reduced to negligible or minor levels over time. Human disturbances from trampling at bait stations, shooting from designated sites, or disposing of deer carcasses would be temporary and isolated within the national lakeshore. Therefore, the adverse impact of these actions on other wildlife species would be short term and negligible. Past, present, and future activities, combined with the reduced browsing pressure on ground/shrub habitat expected under this alternative, would result in long-term, beneficial cumulative impact on other wildlife.	Impact on other wildlife would be long term and beneficial because of rapidly reduced deer numbers in the national lakeshore, resulting in decreased browsing pressure on habitat and allowing increased abundance and diversity of other wildlife that depend on ground/shrub habitat, such as ovenbirds, wood frogs, eastern hognose snakes, and box turtles. Long-term management of the deer population would be implemented through the use of sharpshooting or reproductive control, resulting in continued, long-term, beneficial effects by maintaining the population at desired levels. Over time, the present adverse effects would be reduced to negligible or minor levels. Other wildlife would be temporarily affected by trampling at bait stations, shooting from designated sites, applying reproductive control techniques, or disposing of deer carcasses. The adverse impact of these isolated actions on other wildlife would be short term and negligible. Past, present, and future activities, combined with the reduced pressure on habitat expected under this alternative, would result in beneficial, long-term cumulative effects on other wildlife.
Sensitive and Rare Species	Impacts on federal- and state-listed wildlife and plant species under alternative A would be both beneficial and adverse. Beneficial effects would result from maintaining fencing around known individual plants and rare plant communities and from establishing fencing around newly discovered rare plants in the national lakeshore. Overall, adverse, long-term, moderate to major impact on listed plant and wildlife species from excessive deer browsing and the resulting suppression of new, viable populations of sensitive and rare species in the national lakeshore would be expected. Past, present, and future activities, combined with the continued pressure on federal- and state-listed plant and wildlife species expected under this alternative, would result in both adverse and beneficial impact. Adverse cumulative impact would be long term and moderate to major. Because alternative A would not reverse the expected long-term high density or continued growth in the deer population, damage to vegetation and habitat would likely continue.	Impacts on federal- and state-listed plant and wildlife species under alternative B would be adverse, long term, and moderate to major until reproductive controls on the national lakeshore deer herd were effective. Placing and maintaining exclosures would protect sensitive vegetation in about 7 percent of the national lakeshore over the life of the plan. These areas would include sensitive and rare plants, resulting in beneficial, long-term effects. However, adverse, long-term, minor to moderate impact from deer browsing would continue outside the exclosures. Past, present, and future activities, combined with the continued pressure on listed plant and wildlife species expected under this alternative, would result in both beneficial and adverse effects. Adverse cumulative impact would be long term and minor to moderate.	Impact on listed species under alternative C would be both beneficial and adverse. Beneficial effects would be expected as a result of a relatively rapid reduction in deer density and browsing pressure on native plant communities and federal- and state-listed species. Some deer browsing would continue even were the herd density to be maintained at targeted levels. Potential impact on palatable sensitive plant species growing outside fenced areas would be adverse, long term, and minor. Past, present, and future activities, combined with the continued pressure on federal- and state-listed species expected under this alternative, would result in both beneficial and adverse impact. Adverse cumulative effects would be long term and minor.	Impact on federal- and state-listed species under alternative D would be both beneficial and adverse. Beneficial impact would be expected as a result of reducing deer density and browsing pressure on listed plant species in the national lakeshore. Some deer browsing would continue, even with herd density maintained at targeted levels, but vegetation recovery would occur more rapidly than it would under alternative B. Potential impact on palatable sensitive plant species growing outside fenced areas would be adverse, long term, and minor. Past, present, and future activities, combined with the continued pressure on federal- and state-listed plant species and wildlife habitat, would result in both beneficial and adverse effects. Adverse cumulative impact would be long term and minor.
Archeological Resources	Installing small-area protection fencing and maintaining the large-area exclosure to protect individual plant groupings would result in adverse, long-term, negligible impacts on national lakeshore archeological resources; however, the limited extent and location of potential disturbance associated with the fences and exclosures would minimize this likelihood. Furthermore, fences would be located so as to avoid direct impacts on archeological resources. Cumulative impact would be negligible to minor, resulting from ground disturbance.	Installing small-area protection fencing and large-area exclosures with multiple support posts could result in some ground disturbance that could affect unknown archeological resources. Locating fences and exclosures away from known resources and monitoring in potentially sensitive areas would result in adverse, long-term, negligible to minor impact. As in alternative A, installing small-area protection fences around individual plant groupings could result in adverse, long-term, negligible impact to national lakeshore archeological resources. Cumulative impact would be adverse, long term, and negligible.	Sharpshooting activities would have no direct impact on archeological resources. Bait stations and burial pit locations would not be placed on known archeological resources. As in alternative A, installing small fences could result in adverse, long-term, negligible impact on national lakeshore archeological resources. Cumulative impact would be adverse, long term, and negligible to minor to national lakeshore archeological resources, resulting from ground disturbance.	Reducing the deer population via sharpshooting and the use of reproductive controls would have no direct impact on archeological resources. Bait stations would not be set on known archeological resources. Installing small-area fences or up to one large exclosure every other year could result in adverse effects, which would be offset by monitoring. Cumulative impact would be adverse, long term, and negligible, resulting from ongoing ground disturbance.
Cultural Landscapes	Continued growth of the deer population and the associated ongoing decline in the abundance and diversity of native plant communities and decimation of crops would result in an adverse, long-term, minor impact to the cultural landscape. The use of small-area protection fencing and repellents to protect naturally occurring trees and other vegetation within or near the cultural landscape could result in beneficial, long-term, minor effects on these parts of the cultural landscape's vegetation. Adverse, long-term, minor cumulative effects would result from the ongoing decline of native plant communities as a result of deer browsing and crop decimation, despite benefits from the use of this alternative's protective measures and exotic species control.	The use of additional fencing and exclosures would allow regeneration of native woody plant populations outside of the cultural landscape but would not inhibit crop damage from deer within the cultural landscape, resulting in adverse, long-term, minor effects. Deer repellents would be used to protect specific landscaped areas and crops, resulting in beneficial, long-term, minor effects. The use of reproductive controls, if implemented, could result in further beneficial, long-term, minor effects by reducing the deer population and subsequent browsing and crop decimation. Beneficial, long-term, minor cumulative impact would result from some regeneration of native plant populations, the control of nonnative species, and crop protection.	Reduced browsing pressure and crop damage from sharpshooting would allow native plant populations to regenerate throughout the national lakeshore, and small fenced areas and repellents would help protect other character-defining vegetation within the cultural landscape. These actions would result in beneficial, long-term, moderate impact on Chellberg Farm and component cultural landscapes. Cumulative effects would be beneficial, long term, and moderate, resulting from crop protection and regeneration of native plant populations, which would benefit the forested landscape component.	Reducing the deer populations via sharpshooting and the use of reproductive controls would have no impact on the cultural landscape. Bait stations would not be set within the boundaries of the cultural landscape. Installing small-area fences or up to one large exclosure every other year could result in adverse effects, which would be offset by monitoring. Cumulative impact would be primarily beneficial, long term, and moderate.

Impact Topic	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Preferred Alternative-Combined Lethal and Nonlethal Actions
Visitor Use and Experience	Overall impact on visitor use and experience under this alternative would be negligible for beach users, who are the majority of national lakeshore visitors. Visitors who appreciate seeing deer would experience negligible beneficial effects; amateur botanists, birdwatchers, butterfly watchers, and people seeking other wildlife in their natural habitat would experience negligible to moderate adverse impact, depending on the extent of increased browse pressure and the type of species affected. Implementing the no-action alternative may result in continuation of high levels of visitor satisfaction; however, visitors would not be able to experience a balanced, functioning ecosystem unless deer numbers were reduced. Cumulative impact would be both beneficial and adverse and would range from negligible to minor, depending on the visitor's goals.	Wildlife viewers, amateur botanists, and other visitors would experience beneficial, minor to moderate impact related to increased sightings of species protected by fencing, exclosures, and repellents and negligible to minor adverse impact reactions to visual intrusions and disruptions. Cumulative impact would also be both beneficial and adverse and range from negligible to minor, depending on the visitor's goals.	Adverse impact on visitors would be short term and result from required national lakeshore closures or negative responses to sharpshooting activities and would range from negligible to moderate. Beneficial results from a decrease in browse impacts include the ability to experience a wider range of natural resources in the long term. Cumulative impact would be both adverse and beneficial, ranging from negligible to moderate, as well, depending on visitors' beliefs and reasons for coming to the national lakeshore.	Adverse impact on visitors would be short term and result from required national lakeshore closures or negative responses to sharpshooting activities and would range from negligible to moderate. Beneficial effects would result from a decrease in browse impact on natural resources. Cumulative impact would be adverse and beneficial, ranging from minor to moderate.
Visitor Health and Safety	Impact related to increasing deer–vehicle collisions would be adverse, long term, and negligible. Indirect effects related to possible Lyme disease transmission would be adverse, long term, and negligible. Cumulative impact related to improved road safety and hunting on adjacent lands would be primarily adverse, long term, and negligible to minor.	Deer–vehicle collisions and the possibility of disease transmission could increase in the short term, until reproductive controls take effect. Hunters on neighboring lands could experience the indirect effects of treating deer with reproductive controls. Overall impact on visitor health and safety would be adverse, long term, and negligible. Cumulative impact would be primarily adverse, long term, and minor.	Impact on visitor health and safety as a result of using firearms within the national lakeshore would be adverse, primarily for local residents. However, safety measures would be taken to offset potential risks, and sharpshooting would occur when visitation is low and residents are likely to be indoors, resulting in adverse, short-term, minor impacts. Impact intensity would diminish in the long term as the need to continue sharpshooting diminishes. Cumulative impact would be adverse, minor to moderate, and short term, diminishing in intensity in the long term.	Impact on visitor health and safety as a result of using firearms would be adverse, primarily for local residents. However, safety measures would be taken to offset potential risks, resulting in adverse, short-term, minor impacts. Impact intensity would diminish in the long term as the herd size decreases. Cumulative impacts would be adverse, moderate, and short term, diminishing in intensity in the long term.
Employee Health and Safety	Impact would be adverse, long term, and negligible to minor under this alternative. Cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore; these impacts would be adverse, long term, and minor to moderate, as the national lakeshore is not meeting its current safety goal.	Impact would be adverse, long term, and negligible to minor under this alternative. Cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore; these impacts would be adverse, long term, and moderate, as the national lakeshore is not meeting its current safety goal.	Impact would be adverse, long term, and negligible to minor, as adequate training and safety precautions would be applied to all sharpshooting activities. Cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore, as well as increased use of firearms in the region; these effects would be adverse, long term, and moderate.	Impact would be adverse, long term, and negligible to minor, as adequate training and safety precautions would be applied to all sharpshooting activities, as well as administration of reproductive controls. Cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore, as well as increased use of firearms in the area; these impacts would be adverse, long term, and moderate.
Soundscapes	No or negligible adverse impact on soundscapes would occur under alternative A. Cumulative impact would be minor to moderate and adverse in the short and long term because of the variety and abundance of noise sources that already exist around and within the national lakeshore, including the use of firearms for removing deer on neighboring lands.	Impact on soundscapes would be short term, negligible to minor, and adverse under alternative B because of intermittent construction and spraying activities. The degree of the impact would vary by location. However, even though individual construction and spraying events would be short term, they would continue indefinitely into the future, resulting in a long-term, negligible to minor adverse impact. Cumulative impact resulting primarily from the variety and abundance of existing noise sources and the continuation of hunting on neighboring lands would be minor to moderate and adverse in the short and long term.	Impact on soundscapes from sharpshooting would be short term and long term and adverse, primarily affecting local residents because sharpshooting would occur primarily at night and during off-peak visitation seasons. Perception of the intensity of the impact would vary depending on several factors, including attenuation levels, distance from the source, and attitude toward the action, resulting in minor to moderate impact on individuals experiencing the sound. Cumulative impact would be adverse, short term and long term, and moderate. However, these effects would be expected to decrease in the long term as deer populations in all affected areas decrease and the need for direct reduction decreases, as well.	Overall impact on soundscapes under this alternative would be short term, adverse, and minor to moderate, particularly resulting from the use of firearms. Perception of impact intensity would vary depending on several factors, particularly the reaction to firearms. However, long-term impact would be expected to decrease as the overall herd population decreases, reducing the need for direct reduction. Given the planned continuance of hunting on neighboring lands and the urban, industrialized nature of the national lakeshore's surroundings, cumulative impact would be adverse, short term and long term, and moderate.
Socioeconomics	Continuing to exceed the carrying capacity for deer population would result in additional damage to landscaping, vegetation, and crops (corn and soybeans) on agricultural and other private and state lands adjacent to the national lakeshore as a result of increased deer browsing. This additional damage would result in adverse, long-term, minor to moderate impact on residents and farmers. The extent of agricultural damage and the degree of impact depend on the farmers' crops, location relative to the national lakeshore, and whether deer would use private lands within their existing home range and/or expand or shift their home range as browse became scarcer within the national lakeshore. Large fluctuations in annual deer populations could result in varying impacts. Landowners would also incur additional costs for fencing, repellents, managed hunts, and other forms of deer control to protect their crops and landscaping. Cumulative impact would be adverse, short term and long term, and moderate because of crop and landscaping damage and would include the costs of local deer removal efforts and the economic impact of combined hunting expenditures on the local economy.	Under alternative B, reproductive controls (if successful) would allow for only a gradual reduction in the number of deer, and there could be some displacement of deer from the national lakeshore because of exclosures, which could result in slightly greater per-acre damage to landscaping, vegetation, and field crops (e.g., corn and soybeans) on adjacent private lands than under alternative A. Adverse, long-term effects on farmers would be moderate. The extent of damage and degree of impact would depend on such factors as the location of the crop relative to the national lakeshore, deer feeding habits, and whether deer would use private lands within their existing home range and/or expand or shift their home range as browse became scarcer within the national lakeshore. Over the long term, reproductive controls could lessen adverse browsing impacts. Potential large annual fluctuations in the deer population and the presence of exclosures could render short-term impacts more severe than under alternative A, resulting in adverse, short-term, moderate impacts on farmers and other landowners. Landowners would also incur additional costs for fencing, repellents, hunting, and other forms of deer control to protect their crops, vegetation, and landscaping. Cumulative impact would be adverse and moderate over the short and long term.	The reduction of the existing deer population in both the short and long term could result in fewer deer leaving the national lakeshore and browsing on crops, vegetation, and landscaping on adjacent lands, assuming that these lands are within the home range of the national lakeshore's deer population. The degree of reduction in crop damage is unknown; however, the reduction would most likely be measurable, reducing adverse effects on farmers and other landowners to minor over the short and long term by increasing harvested yield, preserving landscaping, and preserving vegetation in the state park. A corresponding decline in costs for fencing, repellents, hunting, and other forms of deer control to protect crops and other vegetation could also occur. Cumulative impact would be beneficial compared to alternative A; adverse impact would be reduced to minor over the short and long term.	Sharpshooting would affect crop and landscaping damage to the same degree as alternative C. Therefore, crop and landscaping damage would be reduced, resulting in beneficial effects compared to alternative A. Deer-browsing impact would continue at some level, but adverse impact on farmers and other landowners from improved harvest yields and preserved landscaping and vegetation would be reduced to negligible or minor levels over the short and long terms. Costs to farmers and other landowners for fencing, repellents, and other forms of deer control could also decline. Cumulative impact would be beneficial compared to alternative A, and adverse impact would be reduced to minor.

Impact Topic	Alternative A: No Action (Existing Management Continued)	Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control	Alternative C: Lethal Action—Sharpshooting	Alternative D: Preferred Alternative- Combined Lethal and Nonlethal Actions
National Lakeshore Management and Operations	Alternative A would result in negligible long-term impacts on national lakeshore management and operations, as national lakeshore staff continues creating and monitoring small-area protection fencing and applying repellents in limited situations. Cumulative impact on national lakeshore management and operations would be long term and negligible to minor.	Alternative B would result in minor to possibly major long-term adverse impact on national lakeshore management and operations because of increased deer management activities, particularly erecting a large number of exclosures, monitoring and maintaining them, and administering reproductive control of does. Cumulative impact would be adverse, long term, and major.	Under this alternative, the national lakeshore would experience short-term, adverse, and minor to moderate effects. Long-term effects would also be adverse and moderate, as associated costs accrue each year. However, the need to establish small fences and apply repellents to protect plant species may diminish as the deer population decreases, offsetting a small portion of costs associated with deer management. Cumulative impacts would be adverse, short or long term (depending on the number of years required to implement deer management actions), and moderate.	Impact would be similar to alternative B but on a smaller scale as fewer fences and exclosures would be constructed and reproductive control would be used only as a maintenance tool. Impact would also be most similar to alternative C, because sharpshooting would be implemented in the same manner, resulting in adverse, long-term, and moderate effects. Cumulative impact would be adverse, short or long term, and moderate.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

The following alternatives were considered but eliminated from detailed study, as explained below.

Managed Hunt

A managed public hunt was considered as a preliminary alternative to reduce the white-tailed deer population. A public hunting alternative was not carried forward for further analysis because it would be inconsistent with existing laws, policies, regulations, and case law regarding public hunts in units of the national park system, and it would be inconsistent with long-standing, basic policy objectives for national park system units. The likelihood that the NPS would change its long-standing, servicewide policies and regulations regarding hunting in parks is remote and speculative.

Throughout the years, the NPS has taken differing approaches to wildlife management, but for the most part, it has maintained a strict policy of not allowing hunting in park units of the national park system. In 1970, Congress passed the General Authorities Act and, in 1978, the Redwood Amendment, which clarified and reiterated that the single purpose of the NPS Organic Act is conservation. Although the Organic Act authorizes the secretary of the interior to destroy plants or animals for the purposes of preventing detriment to park resources, it does not give the secretary the authority to permit the destruction of animals for recreational purposes. In 1984, after careful consideration of congressional intent with respect to hunting in national parks, the NPS promulgated a rule that allows public hunting in national park areas only where "specifically mandated by Federal statutory law" (36 CFR 2.2). The NPS reaffirmed this approach in its *Management Policies 2006*.

Congress has not authorized hunting legislation for the Indiana Dunes National Lakeshore. Therefore, to legally allow hunting at the national lakeshore, the current NPS hunting regulation would have to be changed, or Congress would need to specifically authorize hunting. In addition to other considerations, security issues concerning NPS and allowing firearm use by the public in the national lakeshore would likely limit any congressional action to allow hunting. The NPS has a legislative mandate to protect the natural and cultural resources within national parks to allow for their enjoyment by future generations. The NPS does not have a mandate to allow public hunting in national parks. At this time, the agency intends to exhaust all other possible alternatives before it attempts to change its governing laws, regulations, or policies because of concerns that such actions may have negative impacts on the visitors and resources of other parks in the national park system.

In addition to legal and policy-related concerns, a managed public hunt was also evaluated based on cost, efficiency, safety, and the likelihood of achieving long-term management goals. A managed hunt has not been shown to be more cost-effective or efficient than other direct reduction methods, such as sharpshooting by agency personnel, which is currently allowed under NPS laws and policies. In fact, when compared to sharpshooting, a managed hunt lacks similar efficiency, safety, and the likelihood of successful long-term management.

Based on the literature, costs for managed hunts generally range between $83 and $237 for each deer removed (Warren 1997). A white-tailed deer study in Minnesota that compared four lethal removal methods found that the cost of a managed hunt averaged $117 per deer removed, based on the average net cost per deer after including revenues generated by selling permits to participating hunters (Doerr et al. 2001). Even after considering permit revenue, however, the cost of a managed hunt is not necessarily lower than other removal methods, such as sharpshooting. Warren (1997) documents that costs for sharpshooting programs have ranged from $72 to $260 per deer harvested. In the Minnesota study mentioned above, the cost for sharpshooting averaged $121 per deer harvested (compared to $117 per deer harvested in the managed hunt after revenue from license sales

CHAPTER 2: ALTERNATIVES

was considered; Doerr et al. 2001). Gettysburg National Military Park reported sharpshooting costs averaged $128 per deer (Frost et al. 1997). The range of costs for sharpshooting ($72 to $260 per animal harvested) substantially overlaps the range of costs reported for managed hunts ($83 to $237 per animal harvested), suggesting that minimal to no cost savings are realized by using citizen hunters.

Managed hunts are also less efficient in meeting ungulate-reduction project goals when compared to sharpshooting. Doerr et al. noted that the highest harvest rate (0.55 deer per hour) was achieved when sharpshooters shot over bait. This was compared to hunting, which resulted in a rate of 0.03 deer per hour, or 31 hunter hours per deer killed. In addition to harvest rates, sharpshooting is also more selective than hunting. As the reduction in does was the primary goal, 59 percent of the hunting harvest was females, whereas 63 percent of the sharpshooting harvest was females (Doerr et al. 2001).

In addition to cost and efficiency, safety is also an issue to consider when using lethal control methods. Sharpshooting has been suggested to offer safety features that a typical managed hunt does not. For example, sharpshooting over predetermined bait sites can establish shooting lanes and backstops. Also, sharpshooting can take place when park visitation is low or absent, reducing or eliminating public safety concerns. The implication here is not that hunts are unsafe; in areas where they are used, safety is a major concern that is addressed. However, the extensive planning and oversight that would be required to ensure a level of safety comparable to wildlife professionals engaged in sharpshooting activities would likely make a managed hunt less feasible.

The NPS considered and rejected a managed public hunt as a reasonable alternative for this plan for the following reasons: (1) implementing a public hunt in the national lakeshore would require changes to basic NPS regulations and policy or an act of Congress; (2) case law supports dismissing an alternative that would require a major change in long-standing, basic policy; (3) other direct removal alternatives, such as using agency personnel as sharpshooters, could be implemented without changing current laws and policies and would better meet the plan's purpose, needs, and objectives; and (4) other direct removal alternatives raise fewer safety concerns and would have substantially the same environmental effects as a managed hunt.

Reproductive Control of Bucks

Another form of reproductive control includes sterilization of bucks. In a study of sterilization of feral horses, sterilizing only dominant harem stallions resulted in relatively modest reductions in population growth. Substantial reproduction may occur even when 100 percent of the dominant harem stallions are sterilized if other males perform as little as 10 percent of the breeding. Adequate suppression of population growth may be attained only if a large proportion of all males in the population are sterilized (Garrott and Siniff 1992).

Another study on the use of vasectomy on wolves suggested that population reduction depends largely on the degree of annual immigration. With high immigration (which could be expected from the state park that shares the Indiana Dunes National Lakeshore boundary and private lands surrounding the national lakeshore), periodic sterilization produced only moderate reductions in population size relative to an untreated population. Similar reductions in population size were obtained by periodically removing large numbers of wolves (Haight and Mech 1997).

Under this alternative, long-term population stability would become an issue, along with genetic variability (a few nondominant bucks could breed the entire herd). If females did not become pregnant, their estrous cycle could be extended, resulting in later pregnancies and lower survival for fawns born later in the year (as a result of a higher winter-kill potential). The population dynamic and makeup of the herd could suffer under this alternative.

Because of concerns relating to effectiveness, population stability, and genetic variability, reproductive control of bucks was eliminated as an alternative for detailed analysis.

Predator Reintroduction

Relationships between predators and prey are complex, and the impact of predators on herbivore populations is variable (McCullough 1979). Coyotes are potential deer predators that reside throughout much of North America, including the Indiana Dunes National Lakeshore area. However, these species appear to be opportunists that capitalize on specific periods of deer vulnerability, and none of these predators has demonstrated a consistent ability to control deer populations. Although coyote populations have increased and their range has expanded in the past 20 years, in many areas, both deer and coyote populations have increased simultaneously. Biologists in some areas believe coyotes are partly responsible for declining deer numbers, but changes in deer populations in other areas appear unrelated to coyote density. In addition, coyotes are often serious agricultural pests (Ellingwood and Caturano 1988).

Wolves and mountain lions are efficient deer predators but have been eliminated from much of the United States. Reintroducing these predators into the Indiana Dunes National Lakeshore would not be feasible due to a lack of suitable habitat. A wolf has a home range averaging 30 square miles when deer are the primary prey, which is much larger than the national lakeshore's 20.7 square miles (Mech 1991). In addition, most of the national lakeshore area is surrounded by an urban/suburban environment, which would likely result in human safety issues, making it inappropriate for such predators to be reintroduced (MD DNR 1998).

For the reasons described above relating to effectiveness, habitat limitations, and human safety concerns, reintroduction of predators was eliminated as a reasonable alternative.

Use of Poison

Under this alternative, poison would be mixed with food sources, such as grains, to kill deer. Death from poisoning would not be immediate, and health concerns resulting from people potentially hunting and eating poisoned deer that have wandered out of the national lakeshore could be an issue. In addition, nontarget native wildlife or roaming pets could potentially eat a tainted carcass or the poison itself.For these reason, this action was eliminated as a reasonable alternative.

Capture and Relocation

Capturing deer within the Indiana Dunes National Lakeshore and relocating them would be in violation of NPS policy regarding translocation (NPS 2002a). Even if the policy were not in effect, relocating deer to areas a sufficient distance from the national lakeshore to ensure that they would not return would require permits, and because of concerns related to CWD testing, possible quarantine processes would be required. Given the abundance of deer in Indiana and in most of the United States, recipients for such a program would be very limited. Also, live capture and relocation methods can result in high mortality rates among captured and relocated deer. Implementation of this alternative could result in the death of more than 50 percent of the deer during the first year after release (Jones and Witham 1990). In one study, only 15 percent of the relocated deer had survived one year after relocation (O'Bryan and McCullough 1985). Because of these concerns relating to policy, costs, feasibility, and high mortality, capture and release was eliminated as a reasonable alternative.

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Supplemental Feeding

Providing supplemental food sources for deer could potentially decrease browsing pressure on vegetation for a very limited period of time. However, increasing food sources would increase deer health and reproduction, leading to a growing deer population. In the long term, this would compound problems associated with high deer numbers (MDNR 1998). For these reasons, this alternative was eliminated.

Surgical Sterilization of Does

This alternative would have the advantage of permanently sterilizing individual does. Does would be captured, tagged, and surgically sterilized, usually requiring a licensed veterinarian, and then released back into the national lakeshore. In addition to the stress of the capture, individual animals would also be stressed by tranquilizers/anesthesia, surgical procedures, and recovery, which could increase the mortality rates of sterilized individuals. Additionally, the long-term effects of this alternative on population genetics or behavior have not been well documented. Some researchers suggest that, depending on the type of sterilization used, changes in animal behavior would be expected (Warren and Warnell 2000). Removal of the ovaries, thus changing hormone production in the treated animal, would result in altered behavior. With a ligation procedure, normal hormone production would remain; however, this has been shown to result in repeated estrous cycles during the breeding season (Knox et al. 1988), extending the rut by modifying the male response behavior.

Another issue to be considered is the high numbers of deer needing treatment (a minimum of 523 does each year) in the national lakeshore and the actual amount of work required to manage does by surgical sterilization. Due to these concerns about feasibility, stress to the animals, and long-term effects on population genetics and behavior, this alternative was eliminated.

Fencing the Entire National Lakeshore

As outlined in NPS *Management Policies 2006* (2006b), the NPS will adopt "park resource preservation, development, and use management strategies that are intended to maintain the natural population fluctuations and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks." However, the entire national lakeshore could be fenced to prevent deer from entering or leaving national lakeshore boundaries. Fencing would prevent deer from being pushed into the national lakeshore from the Indiana Dunes State Park during the special hunt, and it would also prevent deer from the national lakeshore entering agricultural areas, alleviating impacts on local farmers. A fence approximately 8 feet high would be needed to prevent deer from jumping over the barrier. However, vegetation within the Indiana Dunes National Lakeshore would continue to suffer the effects of deer browsing, the deer population within the fenced area would continue to increase, and the health of the contained herd would suffer. Therefore, all deer within the fence would need to be removed or the deer population within the fence would need to be managed with other methods to meet the goals of the national lakeshore management plan. For these reasons, this alternative was eliminated.

CONSISTENCY WITH THE PURPOSES OF THE NATIONAL ENVIRONMENTAL POLICY ACT

NEPA requires an analysis of how each alternative meets or achieves the purposes of the act, as stated in sections 101(b) and 102(1). The alternatives analyzed in a NEPA document must be assessed as to how they meet the following purposes:

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
2. Ensure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
3. Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
4. Preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
5. Achieve a balance between population and resource use that would permit high standards of living and a wide sharing of life's amenities.
6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.
7. The Council on Environmental Quality has promulgated regulations for federal agencies' implementation of NEPA (40 CFR Parts 1500–1508). Section 1500.2 states, "[f]ederal agencies shall, to the fullest extent possible, interpret and administer the policies, regulations, and public laws of the U.S. in accordance with the policies set forth in NEPA (sections 101(b) and 102(1); CEQ 1978)"; therefore, other acts and NPS policies are referenced as applicable in the following discussion.

Alternative A: No Action (Existing Management Continued)

Alternative A would meet the purpose of NEPA to some degree because limited protection fencing, limited use of repellents, and inventorying and monitoring efforts would continue. Alternative A would not fulfill the responsibilities of each generation as the trustee of the environment for succeeding generations or preserve important aspects of our national heritage (purposes 1 and 4), because damage to vegetation, other wildlife, and sensitive and rare species would occur as a result of excessive browsing by high numbers of deer and an expected increase in the size of the deer herd. Alternative A would do little to enhance the quality of renewable national lakeshore resources (purpose 6), and the expected long-term, major, adverse impacts on vegetation, white-tailed deer, other wildlife and habitat, and sensitive and rare species would not ensure healthful, productive, or aesthetically pleasing surroundings (purpose 2).

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

This alternative would meet many of the purposes in NEPA to some degree, and perhaps even to a moderate degree when considering long-term results. However, it would provide only limited direct protection of vegetation, and it would rely heavily on an unproven technology (reproductive control) that might not be successfully implemented for a large, free-ranging deer population. Therefore, none of the NEPA purposes would be met to a large degree. In particular, the additional small-area protection fences and large-area exclosures would detract from aesthetically pleasing surroundings (purpose 2). Further, reproductive control methods would present an element of risk to health or safety or other unintended consequences (purpose 3), although safety precautions would be implemented to reduce risk. The lack of protection for a large percentage of the national lakeshore and the time it would take for any reproductive control to be effective would mean that succeeding generations might not see desired results for some time (purpose 1) and probably not within the 15-year life of this plan. The adaptive management component of alternative B would help achieve some balance between population and resource use (purpose 5), but the limited history of reproductive control success and the limits on how much vegetation can be included in exclosures means that it would not be possible to completely approach the maximum attainable recycling of resources (purpose 6).

Alternative C: Lethal Action—Sharpshooting

The evaluation of alternative C by the interdisciplinary team showed that it would fulfill the responsibilities of each generation as a trustee of the environment for succeeding generations (purpose 1) to a large degree because alternative C would immediately reduce deer numbers and sustain that reduction through maintenance actions. A reduction in deer numbers would result in productive and aesthetically and culturally pleasing surroundings (purpose 2) in the form of a healthy and sustainable ecosystem. Safety risks (purpose 3) associated with the use of firearms under this alternative would be mitigated through precautionary measures defined under each alternative. Overall, alternative C would preserve important historic, cultural, and natural aspects of our national heritage in the long term (purpose 4). Alternative C includes adaptive management, which would help achieve a balance between population and resource use (purpose 5), and would have a high likelihood of fully approaching the maximum attainable regeneration of depletable resources (e.g., national lakeshore vegetation) due to its high certainty of success (purpose 6).

Alternative D: Combined Lethal and Nonlethal Actions

Alternative D would meet purposes 1 through 6 for the same reasons listed above for alternative C. However, alternative D also involves some concern about unintended consequences (purpose 3), because it would rely on technology that has not been proven in free-ranging deer as a maintenance tool. Risks to health and safety (purpose 3) associated with reproductive control methods would be an additional concern under alternative D, although safety precautions would be implemented to reduce risk.

ENVIRONMENTALLY PREFERRED ALTERNATIVE

The NPS is required to identify the environmentally preferred alternative in its NEPA documents for public review and comment. Guidance from the Council on Environmental Quality states that the environmentally preferred alternative is "the alternative that causes the least damage to the biological and physical environment" and is the alternative that "best protects, preserves, and enhances historic, cultural, and native processes" (CEQ 1981).

Alternative D is selected as the environmentally preferred alternative because it is the alternative that would best protect the biological and physical environment by ensuring an immediate reduction in deer herd numbers that could be sustained with proven methods over the life of the plan. Alternative D would also best protect, preserve, and enhance the natural processes within the national lakeshore to maintain a viable deer population since there would be little, if any, uncertainty involved with implementing the selected methods to maintain low deer numbers. Alternatives A and B were not considered environmentally preferred because of their lack of effect on deer herd numbers, which would result in potentially adverse effects on the national lakeshore's biological and physical resources over the life of the plan. Alternative C was not selected because it resulted in fewer management options and less-adaptive elements to achieve the defined objectives.

NATIONAL PARK SERVICE-PREFERRED ALTERNATIVE

To identify the preferred alternative, the interdisciplinary planning team evaluated each alternative based on the ability to meet the plan objectives (see Table 13) and on the potential environmental impacts (see Table 14 and Chapter 4: Environmental Consequences). Alternative D was identified as the NPS-preferred alternative. Alternative D is the only alternative that fully meets all the plan objectives and provides the broadest range of management options that can be adapted to environmental circumstances. Alternative C meets some of the objectives but has fewer management options than alternative D and does not adequately address impacts to small rare-plant populations. Alternative B only partially meets each of the objectives because of the lack of immediate reduction in deer numbers and the uncertainty that the deer-density goal would be achieved even over an extended period of time. Alternative A (no action) fails to meet the objectives because no action would be taken to address the two principal components of the purpose and need: to reach and maintain a healthy white-tailed deer population within the national lakeshore while protecting sensitive plants and other national lakeshore resources.

Chapter 2: Alternatives

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Chapter 3
AFFECTED ENVIRONMENT

CHAPTER 3: AFFECTED ENVIRONMENT

This chapter on the affected environment describes existing conditions for those elements of the natural and cultural environments that would be affected by the implementation of the actions considered in this EIS. The natural environment components addressed include vegetation, soils and water quality, white-tailed deer and deer habitat, other wildlife and wildlife habitat, and sensitive and rare species. The cultural environment components include archeological resources and cultural landscapes. Visitor use and experience, visitor and employee health and safety, soundscapes, socioeconomic resources, and national lakeshore management and operations are also addressed. Impacts for each of these topics are then analyzed in Chapter 4: Environmental Consequences.

VEGETATION

The national lakeshore comprises more than 15,000 acres of wetlands, pannes, dunes, forests, prairies, savannas, and open water and supports more than 1,100 species of flowering plants and ferns. Plant communities at the national lakeshore include those typical of the Eastern Deciduous Forest, Northern Boreal Forest, Atlantic Coastal Plain, and tallgrass prairies (NPS 1993a).

The Eastern Deciduous Forest generally occupies the eastern half of the United States and southeastern Canada. The northern boundary of the Eastern Deciduous Forest blends gradually into the Northern Boreal Forest in New England and southern Canada. The Eastern Deciduous Forest is defined by the dominance of deciduous trees in the ecosystem. Deciduous trees that drop their leaves, such as oaks (*Quercus* spp.), maples (*Acer* spp.), beech (*Fagus* spp.), hickories (*Carya* spp.), and birches (*Betula* spp.), are almost all angiosperms. The Eastern Deciduous Forest develops under a particular set of climatic conditions of cold winters, longer summers, and higher temperatures (when compared to locations farther north). Precipitation, in the form of both rain and snow, is possibly the most important climatic feature that influences the composition of plant species in the Eastern Deciduous Forest. Annual precipitation levels are high and are relatively constant month by month (Bailey 1995).

The Northern Boreal Forest stretches unbroken from eastern Canada westward throughout the majority of Canada to the central region of Alaska. The Northern Boreal Forest is dominated by a few species of conifers, in contrast to the richness of the forests of the Eastern Deciduous Forest. The dominant tree species of the Northern Boreal Forest are black spruce (*Picea mariana*), white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), paper birch (*Betual papyrifera*), and quaking aspen (*Populus tremuloides*). The Northern Boreal Forest covers a wide variety of climatic differences, but common conditions tend to include cold, long winters; short, cool summers; and low precipitation (Bailey 1995).

The Atlantic Coastal Plain is along the eastern seaboard of the United States, extending from New England south to Florida and the Mexican border. The western boundary is generally associated with the Appalachian and Great Smoky mountains; however, west of Florida, the Atlantic Coastal Plain extends as far north as southern Indiana (west of Florida, to the Yucatan Peninsula of Mexico, it is typically referred to as the Gulf Coastal Plain) (Bailey 1995; NPS 2000f). In areas away from the coast, subclimax pine (*Pinus* spp.) communities interspersed with grass and sedge (*Carex* spp.) savannas are dominant. The Atlantic Coastal Plain covers a wide variety of climates with small to moderate annual temperature ranges, and rainfall is abundant and well distributed throughout the year (Bailey 1995).

Tallgrass prairie in the United States typically occurs in the midwestern states, from the Canadian border south to Oklahoma and as far west as the foothills of the Rocky Mountains. Tall bunchgrasses, such as big bluestem (*Andropogon gerardii*), dominate the prairie vegetation, while grasses, including little bluestem (*Schyzachrium scoparium*), switchgrass (*Panicum virgatum*), and Indiangrass (*Sorghastrum* spp.), are also supported. These tallgrass areas grade into shortgrass prairies, as well as oak savannas and woodlands in many areas, depending on soil conditions and moisture regime. Summer is usually hot and winters are cold, especially in the northern portion of the prairie. Average annual precipitation is moderate and falls mainly during the growing season (Bailey 1995).

Plant Community Types

The vegetation at Indiana Dunes National Lakeshore varies substantially from one unit to another in both quantity and quality.

Table 15 lists the general and specific plant community types supported in the national lakeshore and notes the general community types that occur in the deer management zones. Figures 6 and 7 depict the distribution of the general community types in the units of Indiana Dunes National Lakeshore.

TABLE 15: GENERAL AND SPECIFIC PLANT COMMUNITY TYPES

General Community Type	Occurrence in Deer Management Zones[a]	Specific Community Type
Aquatic/Herbaceous Wetlands	Little Calumet Cowles Dunes Dune Wood (very small amount) Miller Woods West Beach Inland Marsh	Aquatic Bog Fen[b] Marsh Sedge Meadow/Wet Prairie
Wooded Wetlands	Same zones as Aquatic/Herbaceous Wetlands, plus: Heron Rookery and very small amount in Miller Woods	Fen Bottomland Swamp Complex Hydromesophytic Forest Conifer Swamp Pin Oak (Quercus palustris) Flat
Panne	West Unit only; very small amount in: Miller Woods Wear Beach	Not Applicable
Dune Complex	Same zones as Aquatic/Herbaceous Wetlands	Stabilized Dune Forest Leeside Dune Forest Mesophytic Pocket Beach Foredune Blowout
Pine Forest/Woodland	Same zones as Aquatic/Herbaceous Wetlands but very small amount in all zones	Jack pine (Pinus banksiana) foredune White Pine (Pinus strobus)/Black Oak (Quercus velutina) Pine Plantation
Mesophytic Forest	Little Calumet Cowles Dunes Heron Rookery Dune Wood (very small amount) Inland Marsh (very small amount)	Not Applicable
Prairie/Savanna Complex	Same zones as Aquatic/Herbaceous Wetlands	Mesophytic Prairie Savanna
Agricultural	Little Calumet Heron Rookery Inland Marsh Pinhook Bog	Orchard Cropland Pasture
Revegetation	Heron Rookery, plus all zones in East and West Units: Little Calumet Cowles Dune Dune Wood Dune Ridge Miller Woods West Beach Inland Marsh	Not Applicable

[a] No vegetation data are available for Pinhook Bog or Calumet Prairie.
[b] "Fen" applies to a wide range of plant communities, including herbaceous and woody types, and is included in both types of wetlands.

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FIGURE 6: PLANT COMMUNITY TYPES, EAST UNIT

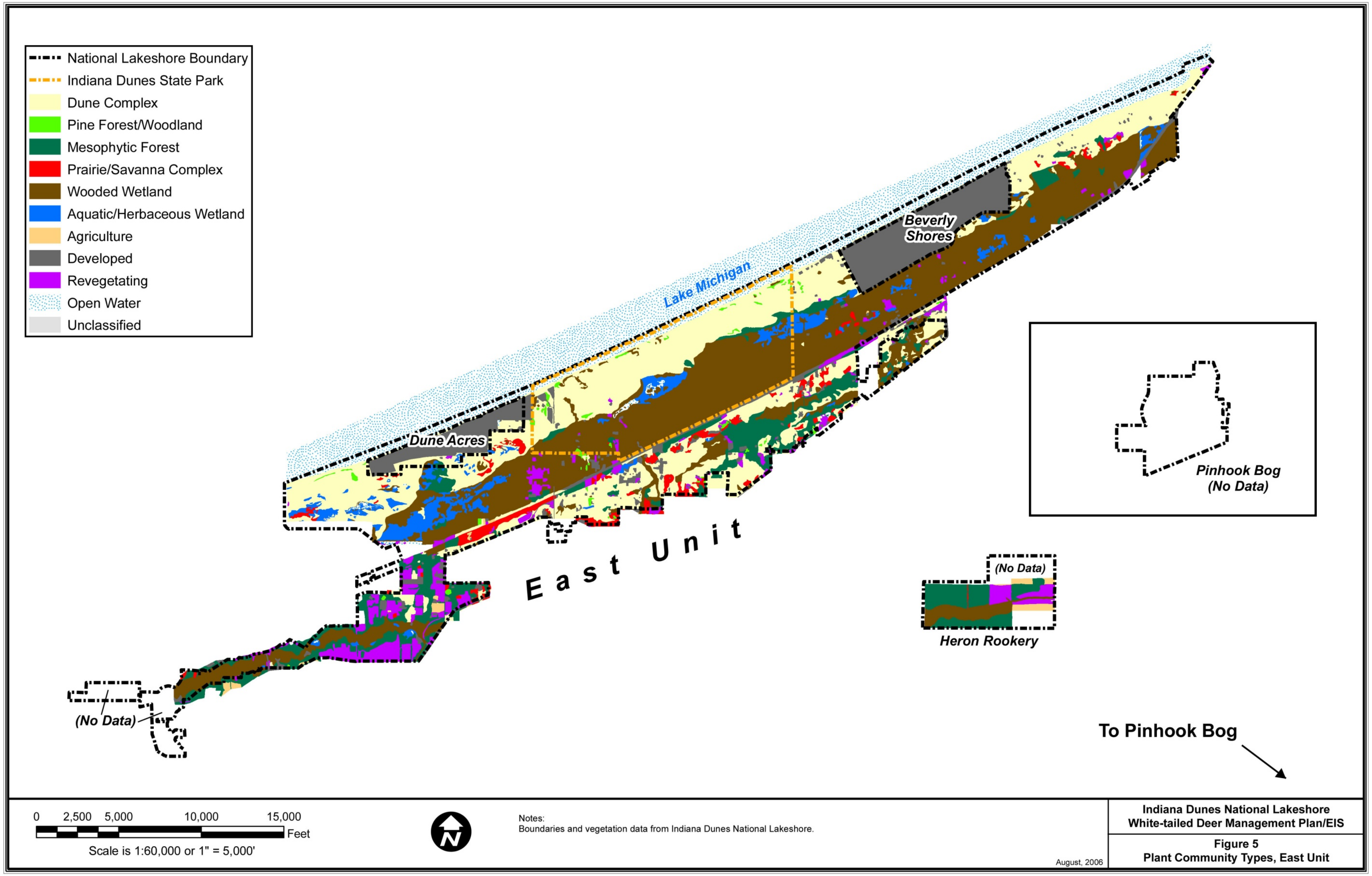

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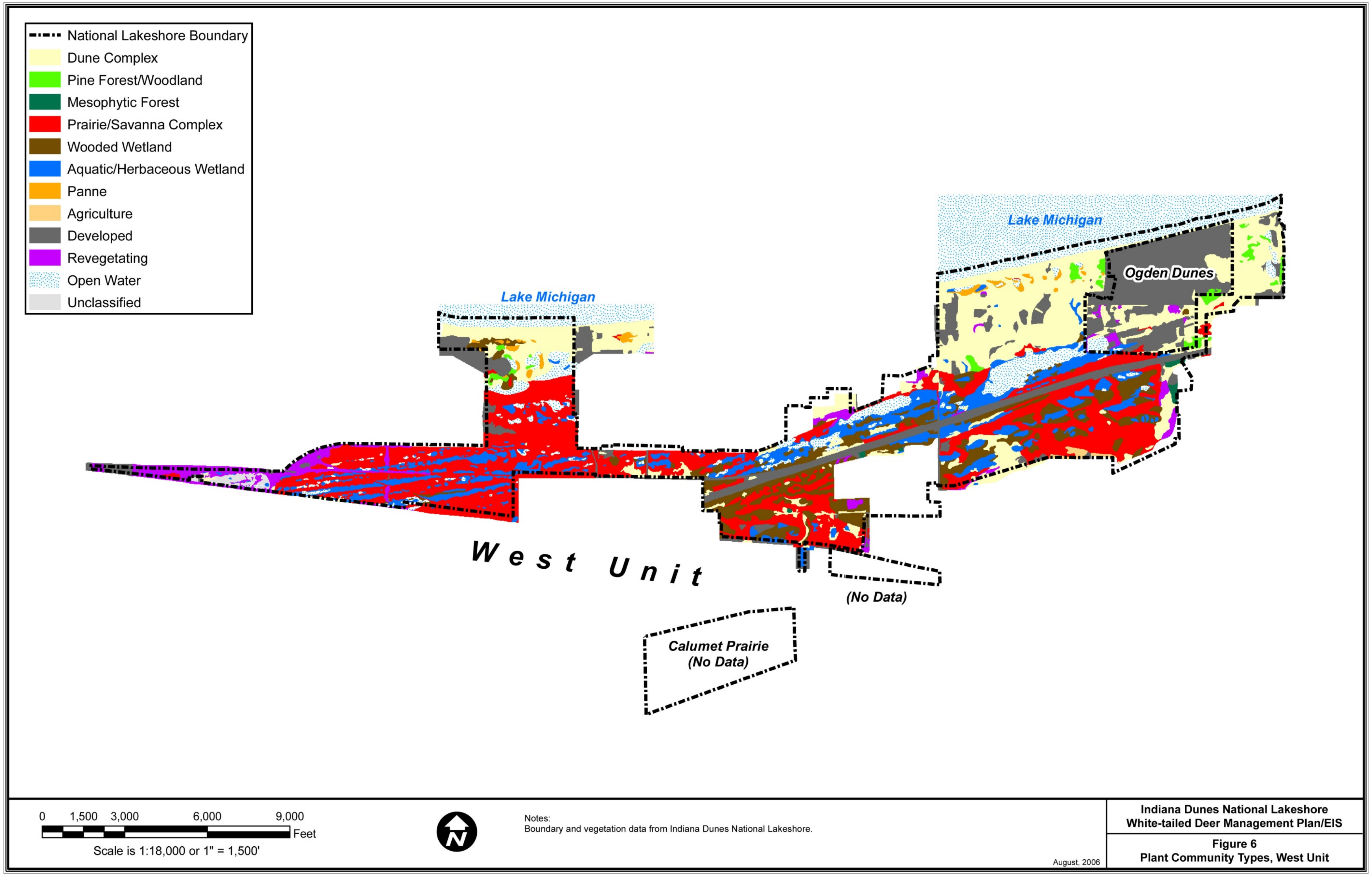
FIGURE 7: PLANT COMMUNITY TYPES, WEST UNIT



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The following sections describe the general community types at the national lakeshore and, as appropriate, specific plant communities that make up these general types. Dominant species that characterize or typify each community type are also discussed.

Wetlands

Aquatic wetlands, bogs, bottomlands, marshes, fens, sedge meadows/wet prairies, conifer swamps, hydromesophytic forests, and flatwoods all occur at Indiana Dunes National Lakeshore (Wilhelm 1990). Approximately 30 percent of the vegetative cover at the national lakeshore is supported in wetlands, with swamps alone amounting to more than 20 percent of the cover (Reshkin et al. 1981). These wetlands have been divided into aquatic/herbaceous and wooded wetlands for this plan's purposes.

Aquatic/Herbaceous Wetlands

Aquatic

The aquatic community is dominated by plant species with life cycles that occur on the surface or underwater. It grades into the marsh communities as emergent fuel species become dense enough to support occasional fire from wind-swept adjacent uplands (Wilhelm 1990).

Watershield (*Brasenia shreberi*), common hornwort (*Ceratophyllum demersum*), yellow pond lily (*Nuphar advena*), American white waterlily (*Nymphaea tuberosa*), longroot smartweed (*Polygonum coccineum*), pickerel weed (*Pontederia cordata*), pondweed (*Potamogeton* spp.), and broadleaf arrowhead (*Sagittaria latifolia*) are plant species that dominate the aquatic plant community in the national lakeshore (Wilhelm 1990).

Bog

Bogs contain hydric/edaphic vegetation supported by an acidic, usually organic, underlying layer. Bogs generally develop locally on a floating mat of peat and are dominated by herbaceous or shrubby vegetation. Scattered conifers, principally tamarack (*Larix laricina*) and American arborvitae (*Thuja occidentalis*), are also supported. Plants that dominate the bog plant community at the national lakeshore include bog rosemary (*Andromeda glaucophylla*), sedges, leatherleaf (*Chamaedaphne calyculata angustifolia*), buckbean (*Menyanthes trifoliata minor*), mountain holly (*Nemopanthus mucronatus*), rose pogonia (*Pogonia ophioglossoides*), white beakrush (*Rhynchospora alba*), and small cranberry (*Vaccinium oxycoccos*) (Wilhelm 1990).

Fen

"Fen" is a term that applies to a wide range of plant communities, including herbaceous and woody types, which typically occur on a basic substrate that is saturated by flowing water throughout the growing season. The substrate can range from exposed marl to deep peat. Fen conditions in the national lakeshore are rare; conditions are present in portions of the floating mat area known as Cowles Bog. Here, the open, herbaceous portion of the fen, which occupies a small area north of the large cattail marsh, is dominated by tickseed sunflower (*Bidens coronata tenuiloba*), marsh bellflower (*Campanula aparinoides*), eastern marsh fern (*Dryopteris thelypteris prubescens*), bluntleaf bedstraw (*Galium obtusum*), spiked muhly (*Muhlenbergia glomerata*), swamp lousewort (*Pedicularis lanceolata*), marsh cinquefoil (*Potentilla palustris*), alderleaf buckthorn (*Rhamnus alnifolia*), blue-leaf willow (*Salix glaucophylloides glaucophylla*), and hard-stemmed bulrush (*Scirpus acutus*) (Wilhelm 1990).

The wooded portion is on the southeast edge of the hydromesophytic forest in Cowles Bog and north of the open area of the fen. Dominant plants of the wooded fen include marsh marigold (*Caltha palustris*), white turtlehead (*Chelone glabra*), spotted water-hemlock (*Cicuta maculate*), black

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ash (*Fraxinus nigra*), tamarack, swamp lousewort, poison sumac (*Rhus vernix*), roughleaf goldenrod (*Solidago patula*), skunk cabbage (*Symplacarpus foetidus*), and arborvitae (*Thuja occidentalis*) (Wilhelm 1990).

Marsh

The marsh community is a nonforested community supported by a substrate that is saturated by water for all or most of the growing season. These conditions provide habitat for a wide range of intergrading plant communities; their composition depends on the nature of the soil, alkalinity, stability of water levels, frequency of fire, disturbance history, and other factors (Wilhelm 1990).

Great Marsh

Plants that serve as fuel for the regular fires in the marsh community generally include members of the plant family Cyperaceae, such as water sedge (*Carex aquatilis altior*), longhair sedge (*Carex comosa*), Hayden's sedge (*Carex haydenii*), hairy sedge (*Carex lacustris*), wooly sedge (*Carex lanuginose*), American woolyfruit sedge (*Carex lasiocarpa americana*), Sartwell's sedge (*Carex sartwellii*), upright sedge (*Carex stricta*), hard-stemmed bulrush, and softstem bulrush (*Scripus validus creber*). Other plants that dominate healthy marsh communities are numerous and include purplestem aster (*Aster puniceus firmus*), broom sedge (*Carex tribuloides*), swamp loosestrife (*Decodon verticillatus*), tufted loosestrife (*Lysimachia thyrsiflora*), swamp smartweed (*Polygonum hydropiperoides*), marsh cinquefoil, marsh mermaidweed (*Proserpinaca palustris crebra*), greater water dock (*Rumex orbiculatus*), marsh skullcap (*Scutellaria epilobiifolia*), and hemlock water parsnip (*Sium suave*) (Wilhelm 1990).

However, cattail (*Typha* spp.) dominates many of the marsh communities supported at the national lakeshore. Two of the biggest factors in cattail success over other wetland plants are the unstable water levels and a prolonged lack of fire. Cattail is also among the few plants that can successfully colonize farmed wetlands. (Wilhelm 1990).

Sedge Meadow/Wet Prairie Complex

This complex is the transition between the marsh community, the mesophytic prairie, and the savanna complex and is dependent on the ecological health of these communities. In wetter areas, sedges common to the marsh community provide fuel for regular fires; in drier areas near the wet prairie, fuel plants are more likely to be grasses (Wilhelm 1990).

Plants that dominate the sedge meadow include northern bog aster (*Aster junciformis*), threelobe beggarticks (*Bidens comosa*), eastern marsh fern (*Dryopteris thelypteris pubescens*), common boneset (*Eupatorium perfoliatum*), bluntleaf bedstraw, Fraser's marsh St. Johnswort (*Hypericum virginicum fraseri*), northern bugleweed (*Lycopus uniflorus*), wild mint (*Mentha arvensis villosa*), dotted smartweed (*Polygonum punctatum*), and arrowleaf tearthumb (*Polygonum sagittatum*). Plants that dominate the wet prairie include white colicroot (*Aletris farinose*), greater fringed gentian (*Gentiana crinita*), Canadian rush (*Juncus canadensis*), seedbox (*Ludwigia alternifolia*), stiff cowbane (*Oxypolis rigidior*), smooth sawgrass (*Cladium mariscoides*), blackfruit spikerush (*Eleocharis melanocarpa*), bristly dewberry (*Rubus hispidus obovalis*), eastern blue-eyed grass (*Sisyrinchium atlanticum*), and nodding ladies'-tresses (*Spiranthes cernua*) (Wilhelm 1990).

Wooded Wetlands

Bottomland

Bottomland refers to plant communities that develop in the floodplains of streams and rivers, particularly those with gentle gradients. These communities are generally characterized by trees with an understory of herbaceous flora. They adapt to regular deposits of silt during spring floods and to drier conditions that occur during the summer months. The bottomland community at the national lakeshore is presently confined to the floodplain of the Little Calumet River, where dominant species include sugar maple (*Acer saccharium*), green ash (*Fraxinus pennsylvanica*), eastern cottonwood (*Populus deltoides*), big shellbark hickory (*Carya laciniosa*), black willow (*Salix nigra*), bulbous bittercress (*Cardamine bulbosa*), narrowleaf sedge (*Carex amphibola turgida*), spreading chervil (*Chaerophyllum procumbens*), false mermaid-weed (*Floerkea proserpinacoides*), and striped violet (*Viola striata*) (Wilhelm 1990).

Swamp Complex

The term "swamp" in this context applies to wooded wetlands in which a nonfloating underlying layer is kept moist by groundwater or rain throughout most of the growing season, as compared to a bog or certain phases of the fen, which are developed on a floating mat of peat. At the national lakeshore, the swamp complex includes the hydromesophytic forest, the conifer swamp, and the pin-oak flat (Wilhelm 1990).

Hydromesophytic Forest

The hydromesophytic forest community is characterized by a mix of mesophytic forest species, including some species common to bogs and fens; several shade-tolerant species supported by the marsh-community species; and other species more common to the forests of northern Wisconsin and Michigan. Within the national lakeshore, hydromesophytic forests are found primarily along the subdunal margins of the Great Marsh. Plants that dominate the hydromesophytic forest include white baneberry (*Actaea pachypoda*), wild leek (*Allium tricoccum*), big leaf aster (*Aster macrophyllus*), alternate leaf dogwood (*Cornus alternifolia*), broad beechfern (*Dryopteris hexagonoptera*), American beech (*Fagus grandifolia*), bearded shorthusk (*Brachyelytrum erectum*), American cancer-root (*Conopholis americana*), northern red oak (*Quercus rubra*), and maple leaf viburnum (*Viburnum acerifolium*) (Wilhelm 1990).

Conifer Swamp

The conifer swamp at the national lakeshore is a disturbed plant community, having been locally logged and drained several years ago. This swamp is a transition between the bog and the hydromesophytic forest. Plants that dominate the conifer swamp include red maple (*Acer rubrum*), yellow birch (*Betula lutea*), leatherleaf (*Chamaedaphne calyculata angustifolia*), roundleaf

Roundleaf sundew

sundew (*Drosera rotundifolia*), tamarack, mountain holly (*Nemopanthus mucronata*), royal fern (*Osmunda regalis spectabilis*), poison sumac (*Rhus vernix*), purple pitcherplant (*Sarracenia purpurea*), and cranberry (*Vaccinium macrocarpon*) (Wilhelm 1990).

Pin-Oak Flat

The pin-oak flat is dominated by species that are typically more hydrophytic members of the savanna complex or certain phases of the hydromesophytic forest. This community typically develops in sandy depressions, often in pockets within savannas that are topographically low enough that they are kept moist by interaction with groundwater or the collection of rain water. In most cases, the pin-oak flat becomes dry in the summer. Plants that dominate the pin-oak flat include small beggarticks (*Bidens discoidea*), ribbed sedge (*Carex virescens*), common buttonbush (*Cephalanthus occidentalis*), northern spicebush (*Lindera benzoin*), northern bugleweed, blackgum (*Nyssa sylvatica*), cinnamon fern (*Osmunda cinnamomea*), pin oak, white meadowsweet (*Spiraea alba*), and highbush blueberry (*Vaccinium corymbosum*) (Wilhelm 1990).

Panne

The term “panne” refers to wet, interdunal depressions that have formed near the water table on the leesides of the first or second line of dunes along Lake Michigan. This community is confined primarily to the Miller Woods and West Beach deer management zones and supports indigenous plant species that grow nowhere else in either the Chicago region or the state of Indiana. Pannes reflect long-standing ecological stability and are characterized by numerous perennial species and aging Jack pines (*Pinus banksiana*). Other plants that typify the panne include prairie goldenrod (*Aster ptarmicoides*), elk sedge (*Carex garberi*), little green sedge (*Carex viridula*), greater fringed gentian, yellow widelip orchid (*Liparis loeselii*), Ontario lobelia (*Lobelia kalmii*), needle beaksedge (*Rhynchospora capillacea*), rosepink (*Sabatia angularis*), low nutrush (*Scleria verticillata*), and horned bladderwort (*Utricularia cornuta*) (Wilhelm 1990).

Dune Complex

The dune complex is a narrow, east-west band of primarily wooded plant communities that occur inland of Lake Michigan. This complex also includes a nonforested portion of the dune that is under the direct influence of surface winds off Lake Michigan. The forested dunes are successional foredune communities that mainly support stabilized dune forests or leeside dune forests. A phase of the prairie/savanna complex, as well as small pockets of mesophytic forest, also occurs. Foredune, blowout, and beach communities are supported in the nonforested portions of the dune complex (Wilhelm 1990).

Dune vegetation

Stabilized Dune Forests

Stabilized dune forests are mesic successional woodland communities that have stabilized the dune slopes. This community is usually hard to delineate from the leeside dune and is dominated by vegetation consisting of red maple, red columbine (*Aquilegia canadensis*), bluebell bellflower (*Campanula rotundifolia*), flowering dogwood (*Cornus florida*), round leaf dogwood (*Cornus *rugosa*), white pine (*Pinus strobes*), hairy Solomon's seal (*Polygonatum pubescens*), common hoptree (*Ptelea trifoliata mollis*), red oak, and round leaf greenbriar (*Smilax rotundifolia*) (Wilhelm 1990).

Leeside Dune Forests

Leeside dune forests are similar to stabilized dune forests but are not as mesic. The leeside dune forest is dominated by vegetation that includes common serviceberry (*Amelanchier arborea*), late coralroot (*Corallorhiza odontorhiza*), white ash (*Fraxinus Americana*), hairy bedstraw (*Galium pilosum*), eastern teaberry (*Gaultheria procumbens*), smooth yellow false foxglove (*Gerardia flava*), Indianpipe (*Monotropa uniflora*), tall rattlesnakeroot (*Prenanthes altissima*), white oak (*Quercus alba*), and showy goldenrod (*Solidago speciosa*) (Wilhelm 1990).

Mesophytic Pockets

The mesophytic pockets, when fully developed, are rare in the national lakeshore. They are dominated by vegetation that includes sugar maple (*Acer saccharum*), bristleleaf sedge (*Carex eburnean*), white ash, American witchhazel (*Hamamelis virginiana*), hophornbeam (*Ostrya virginiana*), American ginseng (*Panax quinquefolius*), red oak, wreath goldenrod (*Solidago caesia*), American basswood (*Tilia americana*), and maple leaf viburnum (Wilhelm 1990).

Beach Community

The beach community is restricted to a narrow strip adjacent to the shoreline zone of Lake Michigan. During presettlement times, the beach ran along the entire length of Indiana's border with Lake Michigan, interrupted only occasionally by the mouths of creeks and streams. Few species are supported by this community, which often consists only of American searocket (*Cakile edentula*) (Wilhelm 1990).

Foredune Community

The foredune community occupies the windward exposure of the first line of dunes next to Lake Michigan and tends to become larger from west to east. Its extent and species composition are related to the degree to which the dune is developed. The foredune community is dominated by vegetation that includes American beach grass (*Ammophila breviligulata*), little bluestem, field sagewort (*Artemisia caudata*), prairie sandreed (*Calamovilfa longifolia*), Pitcher's thistle, redosier dogwood (*Cornus stolonifera baileyi*), beach pea (*Lathyrus japonicus glaber*), eastern cottonwood, fragrant sumac (*Rhus aromatica arenaria*), and Rand's goldenrod (*Solidago racemosa gillmani*) (Wilhelm 1990).

Blowout Community

The blowout community occurs in the breaks of foredune communities that open to the leeside of the dunes. These blowouts are formed by heavy, sand-laden offshore winds from Lake Michigan. The blowout community, in advanced stages, can extend for hundreds of yards inland. In comparison to the foredune community, the blowout community is usually dominated by annual, biennial, or short-lived perennial herbaceous species, suggesting a relatively recent origin. The more stabilized blowout communities are characterized by long-lived perennials, many of which are also members of the foredune community, including kinnikinnick (*Arctostaphylos uva-ursi*) and eastern cottonwood (Wilhelm 1990).

Pine Forest/Woodland

Pine woodlands are generally supported on the national lakeshore dunes (Wilhelm 1990). However, for this plan's purposes, this vegetation type is discussed separately from the dune complex as it represents a unique coniferous type when compared to the primarily deciduous wooded dunes discussed above. In addition, pine plantations have been established in and around Indiana Dunes National Lakeshore and are considered a component of the pine woodlands. This community also includes the Jack pine foredune and white pine/black oak community.

Jack Pine Foredune Community

This community occurs on well-stabilized foredunes and often represents the transition to wooded dune-vegetation types. This vegetation type supports dense pockets of Jack pine in some areas and is typified by a mix of Jack pine and shrubs in other areas. Plants that typify the Jack pine foredune community include American beach grass, little bluestem, kinnikinnick, lyrate rockcress (*Arabis lyrata*), field sagewort, prairie sandreed, flowering spurge (*Euphorbia corollata*), common juniper (*Juniperus communis*), Carolina puccoon (*Lithospermum croceum*), spotted beebalm (*Monarda punctata*), devil's-tongue (*Opuntia humifusa*), Heller's rosette-grass (*Dichanthelium oligosanthes*), switchgrass, Jack pine, sandcherry (*Prunus pumilla*), common hoptree, fragrant sumac, eastern poison ivy (*Toxicodendron radicans*), gray goldenrod (*Solidago nemoralis*), Rand's goldenrod, American basswood, and riverbank grape (*Vitis riparia*) (NPS 1989).

White Pine/Black Oak Community

The white pine/black oak community was historically found in extensive stands on dunes from the national lakeshore to the oldest dune ridges. As a result of logging, it is now restricted to isolated pockets scattered throughout the dunes. This community is typically co-dominated by white pine, black oak (*Quercus velutina*), and one or more of the following: white oak, sassafras (*Sassafras albidum*), and American basswood. Other species supported by this vegetation type include Pennsylvania sedge (*Carex pensylvanica*), American witch hazel, Canada mayflower (*Maianthemum canadense interius*), western brackenfern (*Pteridium aquilinum*), eastern poison ivy, lowbush blueberry (*Vaccinium angustifolium laevifolium*), and Blue Ridge blueberry (*Vaccinium vacillans*) (NPS 1989).

Mesophytic Forest

A mesophytic forest is likely to provide habitat for 70 or more different native plant species. During presettlement times, mesophytic forests evolved where frequent fire suppression led to the establishment of such tree species as sugar maple, American beech, and American basswood. These trees provided intense shade during the growing season, served as a buffer against drying winds, enhanced a moist microclimate, and moderated temperature extremes—all ecological conditions that contribute to the proliferation of the mesophytic forest community. The suppression of fire has encouraged the development of woody species of the mesophytic forest in areas where they had not existed before human settlement. Conditions in the national lakeshore that were suitable for supporting succession to the mesophytic forest community prevailed on steep, northeast-facing slopes, as well as deep ravines and other topographically extreme conditions. All these conditions were more successful in retarding fire in the eastern portions of the national lakeshore (Wilhelm 1990).

Plants that typify the average mesophytic conditions include sugar maple, bearded shorthusk, American hornbeam (*Carpinus caroliniana virginiana*), broad beech fern, American beech, eastern false rue anemone (*Isopyrum biternatum*), twoleaf miterwort (*Mitella diphylla*), Christmas fern (*Polystichum acrostichoides*), zigzag goldenrod (*Solidago flexicaulis*), and nodding wakerobin (*Trillium flexipes*) (Wilhelm 1990).

Plants that typify drier mesophytic conditions include red maple, jack-in-the-pulpit (*Arisaema atrorubens*), Short's aster (*Aster shortii*), blue cohosh (*Caulophyllum thalictroides*), nodding fescue

(*Festuca obtuse*), sharplobe hepatica (*Hepatica acutiloba*), red oak, bloodroot (*Sanguinaria canadensis*), bloody butcher (*Trillium recurvatum*),and downy yellow violet (*Viola pubescens*) (Wilhelm 1990).

Prairie/Savanna Complex

The term "prairie" can apply to any treeless or nearly treeless plant community that is maintained by fire. In most cases, prairies consist of numerous forbs, grasses, and sedges. Mesophytic prairie at the national lakeshore is limited to two areas that could also have been categorized as marsh complex or savanna complex. The mesophytic prairie species are integral components of the prairie/savanna. Plants that dominate the mesophytic prairie community include big bluestem, largeleaf wild indigo (*Baptisia leucantha*), arctic brome (*Bromus kalmii*), pale Indian plantain (*Cacalia atriplicifolia*), button eryngo (*Eryngium yuccifolium*), wild quinine (*Parthenium integrifolium*), tall cinquefoil (*Potentilla arguta*), Virginia mountainmint (*Pycnanthemum virginianum*), Riddell's goldenrod (*Solidago riddellii*), and Indiangrass (*Sorghastrum nutans*) (Wilhelm 1990).

Plant communities dominated by grasses occur throughout the national lakeshore but occupy only about 6 percent of the total area. The largest grassland areas occur in the Hoosier Prairie and the West and East Units; however, they vary by location. For example, the grass species composition is different in a wet area in the Hoosier Prairie when compared to an isolated foredune in the Cowles Unit. However, grass and shrubs on wet substrata exist only in the Hoosier Prairie Unit and amount to less than 1 percent of the national lakeshore (Reshkin et al. 1981).

Savannas at Indiana Dunes National Lakeshore include the prairie phases in which trees are conspicuous elements. Savannas range from sand prairie, which is sparsely inhabited by black oak, to plants requiring more moisture (mesophytic), such as white oak and shagbark hickory (*Carya ovata*). In the eastern portions of the national lakeshore, black oak sometimes gives way to red oak and bitternut hickory (*Carya cordiformis*). Plants that dominate the sand prairies within the savanna complex include little bluestem, lyrate rockcress, clasping milkweed (*Asclepias amplexicaulis*), Muhlenberg's sedge (*Carex muhlenbergii*), prairie Junegrass (*Koeleria cristata*), twoflower dwarfdandelion (*Krigia biflora*), Canada toadflax (*Linaria Canadensis*), devil's tongue, Engelmann's knotweed (*Polygonum tenue*), and birdfoot violet (*Viola pedata lineariloba*) (Wilhelm 1990).

In those areas where black oak becomes an important element, the following species are likely to be apparent: red columbine (*Aquilegia Canadensis*), wild sarsaparilla (*Aralia nudicaulis*), flaxleaf whitetop aster (*Aster linariifolius*), Pennsylvania sedge, northern bush honeysuckle (*Diervilla lonicera*), tall blazing star (*Liatris aspera*), sundial lupine (*Lupinus perennis occidenetalis*), Canada mayflower, Virginia tephrosia (*Tephrosia virginiana*), and lowbush blueberry (Wilhelm 1990).

Lupine

As black oak begins to give way, the following species often increase with importance with white oak: spreading dogbane (*Apocynum androsaemifolium*), late coralroot, poverty oatgrass (*Danthonia spicata*), hairy bedstraw, smooth yellow false foxglove, fernleaf yellow false foxglove (*Gerardia pedicularia ambigens*), narrowleaf lespedeza (*Lespedeza hirta*), Indianpipe, white rattlesnakeroot (*Prenanthes alba*), and sassafras (Wilhelm 1990).

In areas where white oak and hickory become the principal trees, the savanna complex begins to take on a more mesophytic aspect and is typified by the following plants: two leaf anemone (*Anemone quinquefolia interior*), rue anemone (*Anemonella thalictroides*), eastern star sedge (*Carex rosea*), Virginia springbeauty (*Claytonia virginica*), shining bedstraw (*Galium concinnum*), wild blue phlox (*Phlox divaricata*), Greek valerian (*Polemonium reptans*), smooth Solomon's seal (*Polygonatum canaliculatum*), bristly greenbrier (*Smilax tamnoides hispida*), and bloody butcher (Wilhelm 1990).

Open, grassy areas with scattered trees and shrubs occur mainly in the West Unit of Indiana Dunes National Lakeshore and account for less than 2 percent of the vegetative cover. These areas were generally sand mined or disturbed by other types of human activities. In the West Unit, the vegetation has recovered well since mining stopped and has an open, prairie-savanna appearance. This category exists in small quantities in the East Unit but comprises a distinctive area in the West Unit (Reshkin et al. 1981).

Agricultural Areas

Agricultural areas, including orchards, cropland, and pastures, occur primarily in the Little Calumet, Pinhook Bog, and Heron Rookery deer management units and amount to less than 5 percent of the national lakeshore. A few orchards exist and are characterized by planted stands of fruit trees, some of which have been abandoned but persist untended. Cropland consists of land presently or recently tilled for row crops, such as, corn, wheat, and soybeans, and is common in the Heron Rookery and Pinhook Bog. Pastures include areas presently (or very recently) used for livestock grazing that are usually a mix of pasture grasses, such as meadow fescue (*Festuca elatior*) and orchard grass (*Dactilus glomerata*), as well as less palatable forbs, such as bull thistle (*Cirsium vulgare*), golden ragwort (*Senicio aureus*), and ironweed (*Vernonia altissima*) (NPS 1989).

Revegetation

Old fields, razed residential sites, planted grasslands, abandoned sand mines, old roadbeds, and other areas that were once developed but are now abandoned are in various stages of being revegetated by native species. These areas are primarily revegetating passively and are in various stages of succession; species composition is highly variable and depends on the soil type, soil moisture, and the surrounding vegetation (NPS 1989). As cultivation ceases in old fields, they are invaded by a variety of species, and an old field plant succession begins. Grassy vegetation becomes established first, then woody vegetation, and the area eventually becomes woodland, consisting of shrubs and trees (Reshkin et al. 1981). Abandoned sand mines are being revegetated by such species as prickly pear and little bluestem. In addition, some of the razed residential sites and old fields at the national lakeshore, as well as clay soil prairies, are actively being revegetated by the NPS (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. June 2006).

Invasive Plant Species

Invasive (nonnative or exotic) plant species have the potential to become a serious threat to the vegetation at the Indiana Dunes National Lakeshore. Although no formal invasive-plant management plan exists for the national lakeshore, the staff there is working to reduce the population of these undesirable species with a goal of eventually eliminating them. NPS staff periodically treats and removes invasive species throughout NPS lands mechanically, sometimes in conjunction with prescribed burning in prairie areas. (Prescribed fire does not occur in Pinhook Bog or the Heron Rookery.) Mechanical removal can include pulling, cutting, sawing, delimbing, and applying herbicides to stumps. No chemical treatment methods are currently used. Intensive programs to remove purple loosestrife, garlic mustard, and an invasive hybrid cattail are presently underway. Table 16 lists the exotic vegetation found at the national lakeshore (Wilhelm 1990).

TABLE 16: EXOTIC PLANT SPECIES FOUND AND CONTROLLED AT INDIANA DUNES NATIONAL LAKESHORE

Common Name	Scientific Name
Tree of heaven	Ailanthus altissima
Garlic mustard	Alliaria petiolata
Japanese barberry	Berberis thunbergii
Oriental bittersweet	Celastrus orbiculatus
Spotted knapweed	Centaurea maculosa
Thistle	Cirsium sp.
Olive	Eleagnus sp.
Burning bush	Euonymus alatus
Common baby's breath	Gypsophila paniculata
Dame's rocket	Hesperis matronalis
Honeysuckle	Lonicera sp.
Purple loosestrife	Lythrum salicaria
Sweet clover	Melilotus sp.
Reed canary grass	Phalaris arundinacea
Common reed	Phragmites australis
Japanese knotweed	Polygonum cuspidatum
Buckthorn	Rhamnus sp.
Black locust	Robinia pseudoacacia
Multiflora rose	Rosa multiflora
Narrow-leaved cattail	Typha angustifolia

Influences of Deer Browsing on Plant Community Composition

Part of the purpose and need for this plan is to manage the deer population within the national lakeshore to protect native, rare plant species from detrimental browsing impacts. Numerous studies throughout the country have shown that white-tailed deer browsing can influence the reproductive success of plants and, therefore, the population stability of various plants within a plant community (Hough 1965; Frelich and Lorimer 1985; Alverson 1988; Strole and Anderson 1992; Balgooyen and Waller 1995; Redding 1995; Rooney and Dress 1997; Webster and Parker 1997; Augustine and McNaughton 1998; Van Deelen 1999; Parker et al. n.d.). Long-term alterations of vegetation structure and composition by excessive deer browsing can have a negative impact on rare plant species, as well as secondary effects on other species that rely on these rare plants (Miller et al. 1992).

Research has shown that impacts on plant communities from deer browse consist of three primary effects: (1) failure to reproduce, especially in slowly maturing, woody species where seedlings are killed; (2) alteration of species composition, which occurs where deer remove preferred-browse species and indirectly create opportunities for less preferred or unpalatable species to proliferate; and (3) extirpation of highly palatable plants, especially those that were naturally uncommon or of local occurrence (Langdon 1985). Impacts from deer browsing range from light to heavy, where light browsing is considered background browsing. However, moderate or greater impacts from browsing can cause changes to the species composition of plant communities (G. Parker, Purdue University, pers. comm. 2004). For example, sweet cicely (*Osmorhiza* spp.) is the first plant to be affected in plant communities that support this species (as well as white baneberry and jack-in-the-pulpit); it is also usually the first to disappear from a site.

Vegetation stem heights in these communities can also be an indicator of the impact from deer browsing. For example, if there is a decrease in the height of jack-in-the-pulpit in the plant

CHAPTER 3: AFFECTED ENVIRONMENT

community, it can be assumed that deer have browsed the preferred forage to the point that deer are then browsing on secondary preferred species (G. Parker, Purdue University, pers. comm. 2004). The national lakeshore has some limited monitoring data collected from three 20-square-meter exclosures between 1997 and 2000, which includes stem heights for sweet cicely, white baneberry, and jack-in-the-pulpit. There is a clear difference in average stem heights for these species inside and outside of the exclosures, and these heights correlate with findings from other research (Webster and Parker 2000). Because all three species show signs of impact, and given that stem heights for jack-in-the-pulpit have decreased, it can be assumed that deer have browsed preferred forage within some areas of the national lakeshore to the point that they are browsing on secondary preferred species. Although this study has shown an increase in the density of woody-stemmed plants and an increase in percent cover in the exclosure areas, it did not provide enough data to indicate that cover types were changing (increasing or decreasing) more rapidly in these areas versus the control areas (NPS 1999b).

SOILS AND WATER QUALITY

Soils

The primary concern related to soils and deer management identified in this plan is the potential for increased erosion as a result of increased deer browsing, which can reduce vegetative ground cover and result in sedimentation into the surface waters of Indiana Dunes National Lakeshore. The USDA conducted a comprehensive soil survey of Lake, Porter, and LaPorte counties in 1972, 1981, and 1982, respectively (USDA 1972, 1981, 1982), as described below.

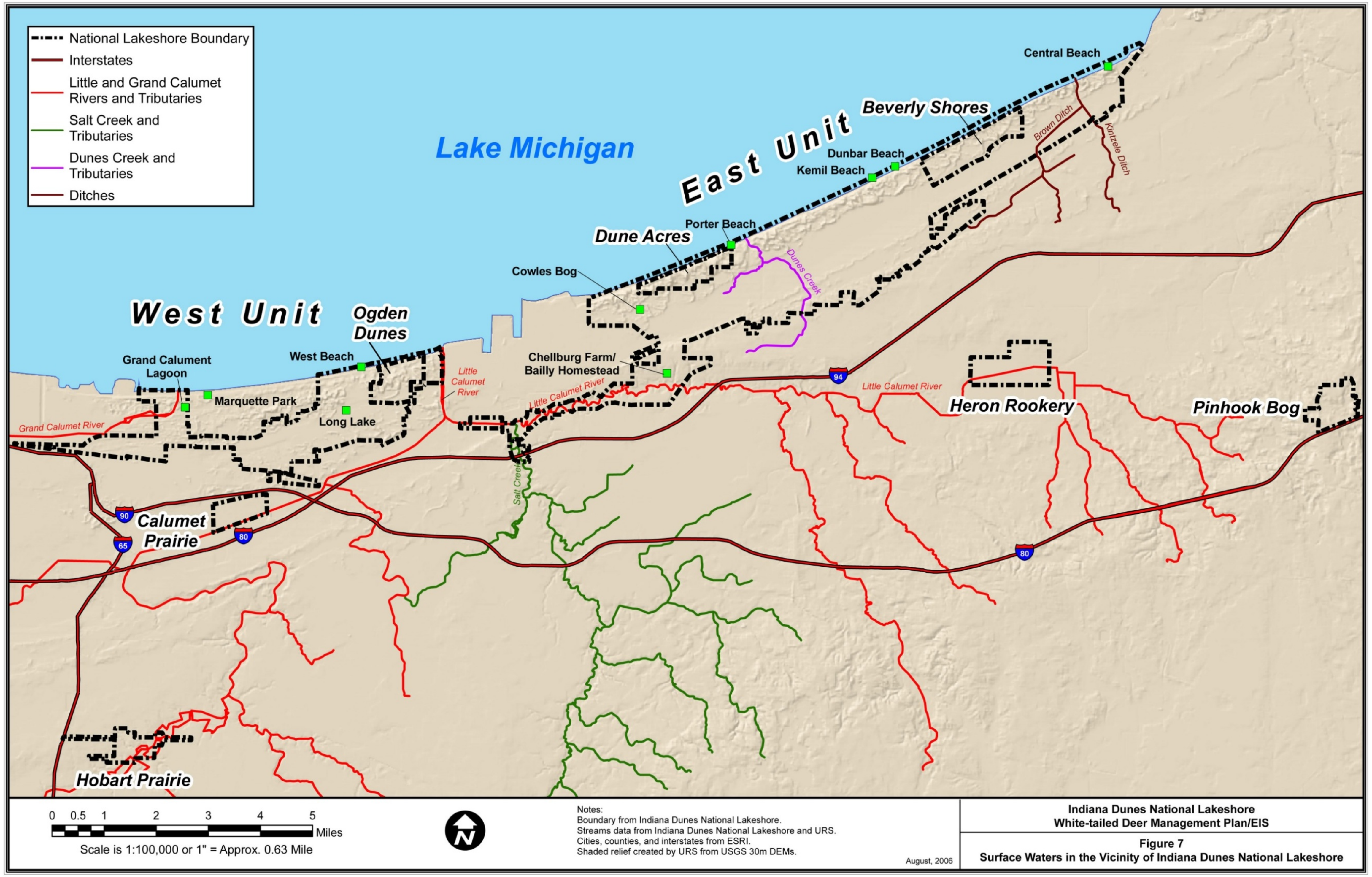
Twenty-eight soil types identified during the Lake County soil survey occur in the Indiana Dunes National Lakeshore. Of these, six have a soil erosion hazard classification of either moderate (Class 1) or severe (Class 5). Three of the soils with severe erosion hazards were classified as such only because of their susceptibility to wind erosion. Twenty-four soil types identified during the LaPorte County soil survey occur within the boundaries of the national lakeshore; three of these have a moderate soil erosion classification. Forty-two soil types identified during the Porter County soil survey occur within the national lakeshore. Of these, seven have a soil erosion classification of moderate (Class 4) or severe (Class 5). Of the soils with moderate or severe erosion hazards, three were classified as such only due to the susceptibility to wind erosion. The remaining soils in these counties have no or slight erosion hazards (USDA 1972, 1981, 1982).

Based on the mapping from the USDA, approximately 5 percent of the soils in the national lakeshore have a moderate or severe soil-erosion hazard. Soils in the national lakeshore with moderate or severe erosion hazard classifications are found on slopes of up to 40 percent on uplands, small knolls, wooded breaks along major streams, narrow ridges, escarpments, outwash plains, moraines, lake plains, sand dunes, and beach ridges and along drainageways and streams.

Water Quality

Figure 8 shows the surface waters in the vicinity of the Indiana Dunes National Lakeshore, including Lake Michigan, as well as several rivers, creeks, and ditches. The surface waters of the national lakeshore are located within the 722-square-mile Little Calumet River-Galien watershed (Hydrologic Unit Code 04040001), which covers the entire Lake Michigan coastline of Indiana and extends to the northeast into Michigan and west into Illinois (EPA 2006; IDNR 2001b). Within the state of Indiana, this watershed covers approximately 536 square miles and is part of the Great Lakes system that drains the northern one-quarter of the state (IDEM 2004a, 2004b).

FIGURE 8: SURFACE WATERS IN THE VICINITY OF INDIANA DUNES NATIONAL LAKESHORE



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Lake Michigan is the most prominent surface water feature associated with the Indiana Dunes National Lakeshore, which encompasses approximately 25 miles of shoreline. In addition, several tributaries, including ditches, flow through the national lakeshore and discharge to the lake. The headwaters of the Little Calumet River are located southeast of the Pinhook Bog unit. The river flows east to west through the Heron Rookery unit and the Chellberg Farm/Bailly Homestead areas and drains agricultural, residential, and industrial land uses. Both the watershed and the river have been extensively altered by human activity. During historic times, the river flowed through the area that is now the national lakeshore and into Illinois. Today, the western portion is ditched and actually flows to the east through the Burns Ditch, which replaced a large part of the Little Calumet River in the vicinity of the West Unit of the national lakeshore. The Burns Ditch and the East Branch of the Little Calumet merge just east of Ogden Dunes and drain to Lake Michigan through the Portage Burns Waterway.

Salt Creek joins the Little Calumet River from the south, just west of Burns Harbor. The Salt Creek watershed also includes agricultural, residential, and industrial land uses. More than 30 tributaries feed Salt Creek between its headwaters and the confluence with the Little Calumet River. Ultimately, flow from Salt Creek is discharged to Lake Michigan through Burns Ditch and the Portage Burns Waterway (IDEM 2004c).

The Dunes Creek watershed is located primarily within the Indiana Dunes National Lakeshore, in the vicinity of Cowles Bog. Although the Dunes Creek watershed has been ditched in the past and the hydrology in the area has not recovered, it now supports a diversity of plants and wildlife.

Long Lake is a large expanse of open water within the West Unit of the national lakeshore. The surface area and shoreline of the lake fluctuate with precipitation levels, as evidenced by the presence of swamps that exist to the south that were once part of Long Lake (NPS 1981).

Historically, the Grand Calumet River flowed to the east and discharged to Lake Michigan in the vicinity of the Grand Calumet Lagoons found north of the Miller Woods area in the West Unit of the national lakeshore. Siltation and the resultant damming of the former outlet to the lake during the latter half of the 19th century created the Grand Calumet Lagoons, which now form the headwaters of the westerly flowing river. The lagoons have minimal flow and are generally divided into eastern, middle, and western portions. The eastern and middle portions are connected by a wide channel that flows under the Lake Street Bridge, and the middle and western portions are connected by a small stream that normally flows to the west. Ultimately, the Grand Calumet River flows west to the Indiana Harbor Canal into Lake Michigan (NPS 1999a).

Other surface waters at Indiana Dunes National Lakeshore include ditches that were constructed throughout this area to drain wetlands and consolidate surface water flow. County-designated drainages in or adjacent to the national lakeshore include (from east to west) Kintzele, Brown, Wieland, Samuelson, Kemper (Little Calumet River in Heron Rookery), Lawson-Swanson, and Burns ditches. Nondesignated but named include: Munson (in the national lakeshore), Highway 12 Ditch near Inland Marsh, County Road Ditch, and Tolleston Ditch. Hundreds of drainage ditches and swales designed to drain wetlands in and around the national lakeshore are nondesignated and unnamed.

The Indiana Dunes National Lakeshore is partly located in a Great Lakes Area of Concern, one of 43 regions of the Great Lakes watershed identified as having severe environmental contamination (NPS 1999a). Water quality is an issue of concern because of the many sources of contamination that exist within the watershed and in proximity to the national lakeshore, including heavy industry, transportation corridors, and agricultural lands. These activities and land-use patterns occurring outside of the national lakeshore have contributed to the current water quality conditions within it.

Potential industrial sources of water pollution in the vicinity of the Indiana Dunes National Lakeshore include three large steel mills and several smaller steel-processing plants, can-coating operations, and two coal-fired power plants. Pollution from these sources includes the discharge of toxicants, heavy metals, and other pollutants from local industry into nearby surface waters; waste treatment and industrial effluent; and leaching from industrial landfills and settling ponds. Potential sources of water pollution from transportation include two federal highways, two interstate highways, and several railroad lines (NPS 1999a). Road-salt runoff and hazardous chemical spills along the highways and railroads whose drainage ditches flow into national lakeshore waters are pollutants of special concern from these sources. Pesticide/herbicide runoff from adjacent agricultural lands may contribute to current water quality conditions at Indiana Dunes National Lakeshore. Nonchemical water quality parameters, such as turbidity (from increased erosion and sedimentation associated with the destruction of local riparian zones) and bacterial contamination (from point and nonpoint sources), are also of concern at the national lakeshore (NPS 1999a).

Indiana has defined water quality standards to maintain the chemical, physical, and biological integrity of the state's waters. In 1990, these water quality standards underwent substantial revisions, and all streams, rivers, lakes, and other waters of the state within the drainage basin of the Great Lakes in Indiana, including those within the national lakeshore, were designated for warm-water, aquatic-life use; full-body-contact recreational use (primary); and industrial and agricultural uses (IDEM 2004b). In addition, all waters within the Indiana Dunes National Lakeshore have been designated as Outstanding State Resource Waters, by virtue of being located within the national lakeshore boundaries (327 Indiana Administrative Code [IAC] 2-1.5-18(b)(2)(D)). Per the antidegradation standard found at 327 IAC 2-1.5-4(c), such waters shall be maintained and protected in their present high quality without degradation. Also, the East Branch of the Little Calumet River and a portion of Burns Ditch (from its confluence with the East Branch of the Little Calumet River to the mouth), a portion of Salt Creek (above the confluence with the Little Calumet River), Kintzele Ditch (from Beverly Drive downstream to Lake Michigan), and the open waters of Lake Michigan are designated as salmonid waters (327 IAC 2-1.5-5(a)(3)(C)). This designation requires that, where natural temperatures permit, these surface waters shall be capable of supporting put-and-take trout fishing, supporting salmonid fisheries, and maintaining the natural reproduction of trout (327 IAC 2-1.5-5(a)(3)).

However, not all of these uses are supported in all state waters. In particular, high *Escherichia coli* (*E. coli*) levels are responsible for many of these waters being listed by the state of Indiana as "impaired" under Section 303(d) of the Clean Water Act. This section of the Clean Water Act requires the state to identify those surface waters that do not meet the water quality standards applicable to the designated use of the water body. Section 303(d) also requires the state to establish total maximum daily loads (TMDLs) for each of these impaired water bodies. The TMDL is the total pollutant load from point and nonpoint sources that can be assimilated by a water body while maintaining the designated use. Though the water quality issues at Indiana Dunes National Lakeshore are multifaceted, the remainder of this discussion focuses on *E. coli* (bacterial) contamination and sedimentation, the two water quality parameters that could be affected by deer management actions implemented under this plan.

Table 17 lists the waters within the national lakeshore that are on the 303(d) impaired waters list prepared by the state of Indiana, the parameters of concern (reasons for the listing), and whether a TMDL has been established.

Though the water quality issues at Indiana Dunes National Lakeshore are multifaceted, the remainder of this discussion focuses on *E. coli* (bacterial) contamination and sedimentation, the two water quality parameters that could be affected by deer management actions implemented under this plan.

TABLE 17: 303(D) WATERS AT INDIANA DUNES NATIONAL LAKESHORE

Water Body	Parameter(s) of Concern	TMDL?
Lake Michigan Shoreline	E. coli, mercury	Yes, E. coli
Dunes Creek	E. coli, impaired biotic communities	Yes, E. coli *
Grand Calumet River	Cyanide, oil and grease, ammonia	No
Little Calumet River-Portage Burns Waterway	E. coli, polychlorinated biphenyls (PCBs), mercury	Yes, E. coli
Salt Creek	E. coli	Yes, E. coli
Burns Ditch	E. coli, PCBs, mercury	Yes, E. coli *
Kintzele Ditch (including Brown Ditch)	E. coli	Yes, E. coli *
Munson Ditch	E. coli	No

Source: IDEM 2004d, 2005.
*TMDLs for Dunes Creek, Burns Ditch, and Kintzele Ditch were developed as part of the Lake Michigan shoreline TMDL. The Lake Michigan shoreline TMDL also included a TMDL for Derby Ditch, which is not listed by the state of Indiana as a 303(d) water.

Fecal coliform bacteria are a subset of coliform bacteria and are found in the intestinal tracts of mammals and birds. One species of fecal coliform bacteria, *E. coli*, is used to test water quality because it is typically found in water containing harmful viruses and bacteria, and high levels of *E. coli* are an indicator of possible contamination. Indiana water quality standards for *E. coli* within the Great Lakes system limit concentrations to a geometric mean that does not exceed 125 colonies (also called colony forming units [cfu]) per 100 milliliters (cfu/100 ml), based on no fewer than five samples equally spaced over a 30-day period from April 1 through October 31. In addition, any one sample in a 30-day period cannot exceed 235 cfu/100 ml (IDEM 2004e). Point and nonpoint sources of *E. coli* in the vicinity of the Indiana Dunes National Lakeshore include discharges from municipal and industrial wastewater treatment plants, combined sewer overflows (overflows during rain events or snow melts from combined sewer systems designed to collect stormwater runoff, domestic sewage, and industrial wastewater into the same pipe), sanitary system overflows (equipment failures and other sewer overflows not related to combined systems), illicit discharges (illegal or improper connection to a storm drain or a “straight pipe” to receiving waters), and stormwater runoff (including runoff from pastureland/cropland; residential septic systems; pets; wildlife; livestock; swimmers, beach sands, and algae; boaters; and contaminated sediment) (IDEM 2004a, 2004c, 2004e).

Data on *E. coli* levels in open water, streams, and beaches have been collected as part of the water quality monitoring program at the Indiana Dunes National Lakeshore. Other agencies, such as the Indiana Department of Environmental Management (IDEM) and the USGS, as well as the *E. Coli* Task Force (composed of several local, state, and federal agencies in Indiana) have also collected *E. coli* data for beaches and ditches or streams in the vicinity of the national lakeshore. Tables 18 and Table 19 provide average monitoring results for both beach and ditch/stream locations from 1997 to 2005, compiled from NPS databases, as well as the database from the *Final Report for Data Compilation and Analysis for the Coastal Nonpoint Source Management Plan* (IGS 2005). Although data for all the beaches and ditches/streams included in Tables 18 and 19 are not available for each of these years, the values indicate that *E. coli* concentrations tend to reach much higher levels in the ditches than in beach waters, and exceedances occur more frequently in the ditches.

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TABLE 18: AVERAGE *E. COLI* LEVELS AT INDIANA DUNES NATIONAL LAKESHORE BEACHES AND SURROUNDING AREAS

Year	Lake Street	Marquette Park	West Beach	Ogden Dunes	Porter Beach	Dune Acres	Indiana Dunes State Park – East	Indiana Dunes State Park – West	Kemil	Lake View	Central	Mount Baldy	Dunbar
1997	NA	183.88	98.71	133.50	107.89	70.67	118.00	135.65	59.89	103.55	57.37	80.53	NA
Exceedances/ Samples	NA	3/13	2/12	2/12	0/10	1/10	1/11	1/11	0/10	1/11	0/10	0/10	NA
1998	NA	NA	32.28	86.42	60.06	26.85	57.73	97.66	78.92	40.12	77.15	88.44	NA
Exceedances/ Samples	NA	NA	0/32	2/33	1/34	0/33	1/33	3/34	4/36	1/35	2/34	4/34	NA
1999*	NA	NA	69.07	NA	61.27	50.03	81.75	240.03	48.83	6.43	149.5	115.87	NA
Exceedances/ Samples*	NA	NA	2/30	NA	2/30	2/30	1/28	6/30	0/30	0/30	6/30	3/30	NA
2000	NA	NA	52.42	64.77	91.72	57.74	97.54	142.37	81.44	80.63	213.4	193.96	172.06
Exceedances/ Samples	NA	NA	1/22	2/26	3/24	1/24	3/24	5/27	1/22	3/22	4/24	6/26	4/23
2001	63.82*	47.96*	65.32	65.50	98.85	70.28	123.55	210.57	184.52	104.95	416.35	181.38	151.73
Exceedances/ Samples	0/17*	0/17*	1/19	1/19	3/20	1/18	3/20	6/23	5/21	3/19	4/20	8/24	6/22
2002	NA	NA	35.55	28.29	88	49.57	364.88	194.33	63.37	194.94	64.17	180.86	84.76
Exceedances/ Samples	NA	NA	0/19	0/19	3/22	2/21	5/23	6/24	1/20	3/21	0/19	1/20	2/21
2003	93.26	93.28	191.08	222.30	28.40	22.31	38.07	61.43	32.55	24.23	31.91	60.84	28.96
Exceedances/ Samples	1/19	2/18	4/23	3/22	1/17	0/17	1/18	1/18	1/17	0/16	0/16	2/17	0/16
2004	94.26	55.38	67.68	NA	70.54	NA	181.75	79.78	52.71	70.80	44.71	93.03	91.72
Exceedances/ Samples	10/105	5/105	5/85	NA	4/69	NA	8/60	7/59	3/69	6/71	3/85	9/86	3/69
2005	NA	NA	64.15	NA	58.84	NA	NA	NA	33.20	46.00	142.53	194.28	91.81
Exceedances/ Samples	NA	NA	2/20	NA	1/17	NA	NA	NA	0/15	0/15	1/17	2/18	1/16

NA: Not Available
*Data from IGS 2005, "Compilation and Analysis for the Coastal Nonpoint Source Management Plan"

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TABLE 19: AVERAGE *E. COLI* LEVELS IN DITCHES AND CREEKS AT INDIANA DUNES NATIONAL LAKESHORE

Year	Little Calumet River*	Grand Calumet River*	Salt Creek*	Dunes Creek	Derby Ditch	Kintzele Ditch	Brown Ditch	Burns Ditch*
1997	568.72	839.56	605.30	648.89	632.50	160.50	NA	633.23
Exceedances/ Samples	16/32	5/36	17/50	10/11	7/11	0/2	NA	22/44
1998	1189.15	384.74	492.11	727.45	866.30	181.76*	NA	2025.47
Exceedances/ Samples	82/150	16/110	70/152	27/33	24/33	6/21*	NA	43/72
1999	627.94	145.88	425	2774.2*	86.47*	415.79*	NA	540.48
Exceedances/ Samples	57/82	1/4	5/8	25/30*	3/30*	16/30*	NA	8/23
2000	400.17	471.96	738.78	1073.57	505.2	672.29	938.95	368.46
Exceedances/ Samples	32/60	37/125	57/82	14/23	11/23	15/21	16/21	15/46
2001	541.43	124.78	1283.33	927.93*	1157.95*	905.29*	NA	416.57
Exceedances/ Samples	4/7	1/9	3/3	37/41*	33/40*	20/21*	NA	5/14
2002	NA	NA	NA	2047.07	1155.80	1161.93	1042.36	91.00
Exceedances/ Samples	NA	NA	NA	16/19	14/19	1/19	16/18	0/2
2003	NA	NA	NA	248.53	150.11	549.90	423.02	111.00
Exceedances/ Samples	NA	NA	NA	5/17	3/15	4/16	12/16	0/5
2004	NA	NA	NA	NA	NA	NA	NA	329.01
Exceedances/ Samples	NA	NA	NA	NA	NA	NA	NA	16/45
2005	NA	NA	NA	NA	NA	NA	NA	NA
Exceedances/ Samples	NA	NA	NA	NA	NA	NA	NA	NA

Note: Exceedances in table are those samples that were above the 235 cfu/100 ml standard set by the state of Indiana.
NA: Not Available
*Data from IGS 2005, "Compilation and Analysis for the Coastal Nonpoint Source Management Plan"

The national lakeshore beaches are typically sampled once every week between Memorial Day and Labor Day, and if the 235 cfu/100 ml standard is exceeded, a swimming advisory may be issued because of the potential for human health risks. Samples are then taken daily at the beaches until the *E. coli* levels drop below the standard. The beach is closed or swimming advisories are issued because of the associated health hazard for visitors. Beach closures and/or advisories are also issued preemptively when an odor is detected or a combined sewer overflow occurs. Table 20 summarizes beach closure/advisory data for the Indiana Dunes National Lakeshore from 1998 to 2005.

TABLE 20: BEACH CLOSURE DATA SUMMARY

Year	Number of Closures/Advisories[a]	Number of Results Greater than 1000 cfu/100 ml	Highest Recorded *E. coli* Level (cfu/100 ml)
1998	23	6	2000
1999	47	4	2346
2000	17	2	2000
2001	2	27	4392
2002	20	4	2068
2003	8[b]	2	3104
2004	62	4	2420
2005	4	2	2419

[a] Beach closures/advisories are issued when the state standard of 235 cfu/100 ml is exceeded, or preemptively, when an odor is detected or a combined sewer overflow occurs.

[b] The eight closures/advisories listed for 2003 were assumed to have occurred based on the number of times that the 235 cfu/100 ml standard was exceeded; data on preemptive closures are not available (S. Hicks, Indiana Dunes National Lakeshore, pers. comm. 2006).

According to the TMDL report for the Lake Michigan shoreline (IDEM 2004a), tributaries that enter the lake are considered the largest source of *E. coli* to the shoreline. This is supported by existing data from the national lakeshore that indicate the streams and ditches are the primary sources for high levels of bacteria and beach closures (NPS 1999a). In addition, the results of a study conducted during the summer of 2005 indicated that Kintzele Ditch and Trail Creek (located east of the national lakeshore) were contributing large amounts of *E. coli* to Lake Michigan (Nevers and Whitman 2005), providing further support for the conclusion in the Lake Michigan shoreline TMDL report.

Soil Erosion and Sedimentation

Turbidity is an indirect measure of sediment in surface waters and can be used as a gauge for soil erosion problems. The state of Indiana has not established numeric limits on turbidity levels of surface waters (EPA 2003). However, as a general guide, water begins to appear cloudy when turbidity is greater than 5 nephelometric turbidity units (NTU). Generally, high-turbidity (greater than 20 NTU) streams and rivers tend to be located in watersheds that have erodible soils and substantial agricultural farming activity and may also receive runoff from urban and industrialized areas (EPA 1999). Values less than 50 NTU are typically considered acceptable for aquatic life, while values over 200 NTU are considered evidence of severely degraded water (IDNR 2001b).

Despite a long-term, water quality monitoring program at the Indiana Dunes National Lakeshore, information on turbidity is limited to data acquired during monthly sampling events between March and November 1999. Table 21 summarizes the average annual turbidity level for several of the surface waters at the national lakeshore, based on this sampling. The IDNR compiled turbidity data acquired from samples collected within the Little Calumet-Galien watershed from 1991 to 2001. Based on these samples, the upper reaches of Salt Creek had the highest turbidity levels in the watershed, with nine sampling locations reporting turbidity levels greater than 50 NTU and two samples measuring 560 and 1,681 NTU. The Little Calumet River had eight sample sites with elevated turbidity levels (with many showing elevated turbidity at several different times); the highest turbidity reading in the Little Calumet River was 736 NTU (IDNR 2001b).

Although other organizations have analyzed turbidity levels in samples taken from Derby Ditch, Dunes Creek, Kintzele Ditch, and the Little Calumet River, the data are also sparse and limited to one or two samples in a given year (Hoosier Riverwatch 2006). In addition, the EPA maintains historic water quality data, including turbidity levels, collected from locations in the vicinity of the Indiana Dunes National Lakeshore; however, the data are not reported in the appropriate units (NTU) for comparison.

TABLE 21: 1999 AVERAGE ANNUAL TURBIDITY LEVELS (NEPHELOMETRIC TURBIDITY UNIT [NTU]) IN SURFACE WATERS OF INDIANA DUNES NATIONAL LAKESHORE

Water Body	Turbidity (NTU)	Number of Samples
Burns Ditch	20.74	8 (April – November)
Derby Ditch	4.31	7 (April – October)
Dunes Creek	7.15	8 (April – November)
Grand Calumet River	33.48	8 (April – November)
Kintzele Ditch	18.31	7 (May – November)
Little Calumet River (at Heron Rookery)	19.25	4 (July - October)
Little Calumet River (at Howe Road)	26.64	8 (April – October)
Long Lake	11.71	9 (March – November)
Salt Creek	58.37	3 (August – October)

Given that approximately 5 percent of the soils at the Indiana Dunes National Lakeshore have moderate or severe erosion hazard, it is likely that elevated turbidity levels observed are a result of erosion from the cropland, pastureland, and industrialized areas surrounding the national lakeshore.

Based on the data from 1999, turbidity levels have exceeded 5 NTU in 85.5 percent of the samples (53 of 62). Few states set specific numeric turbidity values when classifying state waters as salmonid or trout waters. For the few states that do designate numeric turbidity levels for such waters, most indicate that turbidity shall not exceed 10 NTU (EPA 2003). In 1999, turbidity levels in the Little Calumet River and Burns Ditch, both designated as salmonid waters by the state of Indiana, exceeded 10 NTU in 90 percent of the samples (18 of 20). The maximum turbidity level recorded in 1999 was 75.0 NTU at a sampling station in the Grand Calumet River.

WHITE-TAILED DEER AND DEER HABITAT

The management of white-tailed deer herds within the national lakeshore must take into account the species' biology and its interactions with the habitat's key components.

General Ecology

White-tailed deer are medium-sized ungulates, native to North America and regarded as one of the most adaptable mammals in the world (Hesselton and Hesselton 1982). Among the reasons for this adaptability are their hardiness, their reproductive capability, the wide range of plant species accepted as food, and the tolerance deer express for close contact with humans.

White-tailed deer are typically forest dwellers but often frequent wetlands or woodland openings while feeding. Deer also forage along forest margins, in orchards, and on farmlands. When deer populations become excessive, damage to crops and forests may result, and their winter food may be reduced to the point where starvation results (Martin et al. 1951).

The diet of white-tailed deer consists of twigs from shrubs and trees, as well as herbaceous (non-woody) plants, which are eaten frequently in spring and summer when they are abundant. Acorns are consumed in late summer and fall as a mainstay. Some of the plants that deer browse heavily in the winter season are selected by necessity rather than choice (Martin et al. 1951), especially in areas of high deer density where the more palatable foods are depleted. Therefore, extensive use is made of unpalatable foods (IDNR 2006).

White-tailed deer are well known for their ability to rapidly increase reproductive productivity, given abundant food resources, and to limit productivity in the presence of less nutritious forage (Verme 1965, 1969; Hesselton and Hesselton 1982). On a good range containing abundant food, deer tend to produce more than one young, usually twins and sometimes triplets. Where food is limited, the number of births may be restricted to a single fawn, and sometimes the doe does not ovulate (Morton and Cheatum 1946; Verme 1965; Hesselton and Hesselton 1982). Nutrition plays an important role in influencing the onset of puberty, with yearling does (1.5 years) on a submarginal range possibly remaining sexually immature, while doe fawns on a nutritious range possibly becoming reproductively active as early as six or seven months of age (Verme and Ullrey 1984). The potential for rapid expansion of deer populations, coupled with the wide variety of plant species deer consume, can result in substantial impacts on plant communities (Marquis 1981; Shafer 1965).

Home Range

The Indiana Dunes National Lakeshore has not conducted a home range study on the white-tailed deer within the national lakeshore. Home range can be influenced by many factors, including food availability and quantity, deer density, family bonds (matriarchal groups), available fawning sites, and human disturbance. The home range of deer within the national lakeshore boundaries may vary from management zone to management zone due to the factors listed above.

Deer home ranges may also vary by sex and age, as well as habitat type. The average annual home range of deer within the state of Indiana is estimated at 1 to 2 square miles (640 to 1,280 acres) (IDNR 2006). Research in southern Illinois documented that suburban deer have smaller home ranges of 40 to 100 acres (Cornicelli et al. 1996). Research at the University of Wisconsin documented that bucks had a larger home range (0.61 square mile, or 400 acres) than does (0.31 square mile, or 200 acres) (Mathews et al. 2003).

Population Density

At the Indiana Dunes National Lakeshore, both infrared imaging and spotlight surveys have been conducted on portions of the national lakeshore over the last several years. Spotlight surveys have been conducted along a number of travel routes in the East and West Units of the national lakeshore every year between 1991 and 2006, with the exception of 1994. All surveys were conducted in February or March. As of 2006, deer densities across the national lakeshore ranged from about 50 deer/mi2 to just under 150 deer/mi2 (Underwood and Nystrom 2008). All the data collected are being modeled using distance-sampling methods to determine an estimated population size. The current travel route locations and lengths would be evaluated to determine if they produce adequate data for modeling.

The aerial imaging collected to date, including portions of the East Unit, was done in conjunction with surveys completed by the towns of Beverly Shores and Dune Acres. Aerial counts have also been conducted over the Indiana Dunes State Park, adjacent to the national lakeshore's West Unit. The East Unit counts were done annually between 1998 and 2002 but did not cover the entire unit in all years. Those aerial surveys estimated the deer population at an average of 70 deer/mi2 within the deer management zones of the East Unit. The state park aerial counts estimated its deer population at 35 deer/mi^2, which has been used as an estimate of the deer population within the deer management zones of the national lakeshore's West Unit and outlying units, such as Pinhook Bog.

To date, there has been no comprehensive census of the deer population within all units of the Indiana Dunes National Lakeshore. Before implementing any management alternative, such a survey would be conducted for the affected management unit. As described in chapter 2, the distance-sampling method would be the primary survey method used to count deer.

The deer population density in the national lakeshore has varied and will continue to vary over time, depending on such factors as winter temperatures, snow depth and duration, disease, habitat conditions, deer movements, hunting pressure outside the national lakeshore, acorn production, and availability of other foods (herbaceous vegetation). However, based on national lakeshore observations and trends in other units of the national park system, the deer population is likely increasing. In the absence of any deer management measures, this increase is expected to continue over time, with some fluctuations due to weather and other factors.

Factors That Can Affect Deer Health

Deer herds in poor physical condition have typically exceeded the nutritional carrying capacity (the point at which deer herd health is at equilibrium with nutritional value obtained from forage). Poor herd health indicates that the habitat has been stressed and is no longer supporting healthy deer (Eve 1981).

When deer density is high, signs of nutritional stress (such as low body and internal organ mass, low fecal nitrogen levels, and high prevalence of parasitic infections) typically occur. When deer density is reduced to the nutritional carrying capacity, all these indicators show improved condition (Sams et al. 1998).

The national lakeshore intends to implement a herd health check program that would be conducted every five years as funds and partners are available to do the checks. This health check would involve random collection of a limited number of deer (5 to 10) every five years to document the physical condition of each deer tested. Conditions evaluated would include fat content, blood analysis, presence of parasites, and overall body weight and appearance. The national lakeshore is in the process of identifying a local university or laboratory to conduct these checks.

Diseases of Concern

A number of diseases can affect midwestern deer populations. These include parasites, malnutrition, bovine tuberculosis, epizootic hemorrhagic disease, cranial abscessation syndrome, and CWD. CWD has recently been documented within 80 miles of the national lakeshore and is being watched, as it is thought to spread easily in areas with high concentrations of deer. These diseases are briefly described below.

Parasitism

Parasitism occurs when an organism grows, feeds, and is sheltered on or in a different organism, resulting in a type of symbiosis in which one species benefits at the expense of the other. There are many varieties of parasites, both internal and external. Parasites can have a variety of consequences—from minimal to marked—on an individual or a population.

Malnutrition

Malnutrition is the condition that develops when the body does not get adequate amounts of the vitamins, minerals, and other nutrients necessary to maintain healthy tissues and organ function.

Bovine Tuberculosis

Bovine tuberculosis (TB) is a respiratory disease caused by the bacterium *Mycobacterium bovis*. This slowly progressive disease may advance for years before the typical yellow or tan lumps appear inside a deer's ribcage or on the lungs. Bovine TB can infect most warm-blooded animals, including humans (Wisconsin DNR 2006). Bovine TB is often a sporadic disease, in many instances confined to one or two animals in a herd. The severity of disease varies with the dose of infectious organisms and individual immunity. Infected animals may remain asymptomatic; become ill only after stress or in old age; or develop a fatal, chronically debilitating disease (Iowa State University 2005).

The federal government has done nationwide testing of cattle herds to control bovine TB, but it still occurs in cattle, penned exotic livestock (such as elk), and wild deer (Wisconsin DNR 2006). Bovine TB has been found in free-ranging deer in northeastern Michigan. The Indiana Board of Animal Health is monitoring Indiana's deer herd for signs of the disease. No deer have tested positively for bovine TB in Indiana to date (Indiana Board of Animal Health n.d.). There are no effective vaccines for disease prevention and no effective medications for treatment of bovine TB in wild deer (State of Michigan n.d.).

Transmission of bovine TB to people can occur, but it is rare. Bovine TB is generally transmitted through the air by coughing and sneezing. It is highly unlikely a person would contract the disease from field dressing or from eating the meat of an infected animal (Wisconsin DNR 2006).

Epizootic Hemorrhagic Disease

Epizootic hemorrhagic disease is an insect-borne viral disease of ruminants.[4] The disease causes widespread hemorrhages in mucous membranes, skin, and viscera, the result of disseminated intravascular clotting. Strains of epizootic hemorrhagic disease can cause widespread vascular lesions. Degenerative changes (focal hemorrhage or dry and gray-white appearance, or both) in striated musculature are prominent in the esophagus, larynx, tongue, and skeletal muscles. Epizootic hemorrhagic disease in white-tailed deer can lead to death. Often, deer are found dead around waterholes, suggesting that they had a high fever and were dehydrated (U.S. Animal Health Association 1998).

Not all deer infected with epizootic hemorrhagic disease die from it; many healthy deer have antibodies that indicate prior exposure to various viruses. Deer that recover develop immunity to the specific virus, which protects against reinfection by the same virus. However, it is not known how well this immunity cross-protects deer against other hemorrhagic viruses. When deer survive infection with a virus from one virus type (e.g., epizootic hemorrhagic disease), good evidence exists to indicate they are not protected from disease caused by subsequent infection with a different virus strain (Southeastern Cooperative Wildlife Disease Study 2000).

Cranial Abscessation Syndrome

Cranial abscessation syndrome (CAS) usually is caused when *Actinomyces pyogenes* bacteria enter a wound in the velvet of a buck's antlers, through a broken antler, or through the pedicle (antler base) after antlers shed. After entering through a wound, the bacteria can eat through the skull, causing an abscess in the brain. CAS may account for up to 6 percent of natural mortality in bucks (Wisconsin DNR 2006).

Adult antlered deer from neighboring states, such as Wisconsin, have been diagnosed with CAS. Bucks appear blind, uncoordinated, and may show abnormal behavior, such as aggression toward

[4] A ruminant animal is an even-toed, hoofed mammal (such as sheep, oxen, and deer) that chews the cud and has a complex three- or four-chambered stomach.

people and stationary objects, or may remain motionless when approached by people or dogs. Signs of CAS include swollen eyes, broken antlers, weeping fluid, swollen ankles, foot sores, and lameness. Pus may be observed at the pedicle or in the eye socket (Wisconsin DNR 2006).

Harvested adult bucks with CAS may have infected meat with the *Actinomyces pyogenes* bacteria, although the infection is usually limited to the head. Normal cooking temperatures destroy the bacteria and provide safe meat; however, no part of the head should be eaten (Wisconsin DNR 2006).

Chronic Wasting Disease

CWD belongs to a group of diseases known as transmissible spongiform encephalopathies, which include scrapie, bovine spongiform encephalopathy, and Creutzfeldt-Jacob disease. The diseases are grouped because of a similarity in clinical features or symptoms, pathology, and presumed etiology. The infectious agents are hypothesized to be prions (infectious proteins without associated nucleic acids). Transmissible spongiform encephalopathies cause distinctive lesions in the brain and consistently result in death.

Deer and elk affected by CWD show loss of body condition and changes in behavior. Animals that have been affected may demonstrate a variety of behavioral signs, including decreased fear of humans and isolation from the remainder of the herd. Animals in the later stages of the disease become emaciated. Excessive drinking and urination are common in the terminal stages because of specific lesions in the brain. Many animals in terminal stages have excessive salivation and drooling. Death is inevitable once clinical signs are visible.

The clinical course of CWD varies from a few days to approximately one year, with most animals surviving from a few weeks to several months. While a protracted clinical course is typical, occasionally, death may occur suddenly; this may be more common in the wild than in the relative security of captivity.

The health risk for humans that consume elk or deer infected with CWD is unknown, although the risk is extremely low. This risk is based on an analysis of existing research studies that indicate no established link exists between the disease and similar human transmissible encephalopathy diseases. However, current literature reviews and experts agree that more information is needed and that many questions remain unanswered about the transmissibility of CWD to humans. (Appendix C: Chronic Wasting Disease provides additional information on diagnosis and management.)

OTHER WILDLIFE AND WILDLIFE HABITAT

Many species of wildlife are supported in the varied habitats found at the Indiana Dunes National Lakeshore, including approximately 37 species of mammals, 352 species of birds, 28 reptiles, 22 amphibians, and 50 fish. Extirpated species that were known to historically occur in the vicinity of the national lakeshore include the common porcupine (*Erethizon dorsatum*), gray wolf (*Canis lupus*), black bear (*Ursus americanus*), fisher (*Martes pennanti*), northern river otter (*Lutra canadensis*), mountain lion (*Felis concolor*), lynx (*Lynx lynx*), bobcat (*L. rufus*), elk (*Cervus elaphus*), and bison (*Bos bison*) (Whitaker et al. 1994). Common wildlife at the Indiana Dunes National Lakeshore include bats, eastern chipmunks (*Tamias striatus*), mice, squirrels, white-tailed deer (*Odocoileus virginianus*), raccoons (*Procyon lotor*), northern water snake (*Nerodia sipedon sipedon*), Chicago garter snake (*Thamnophis sirtalis semifasciatus*), redback salamander (*Plethodon cinereus*), and the midland painted turtle (*Chrysemys picta marginata*). A variety of wading birds, shorebirds, gulls, raptors, woodpeckers, and other migratory songbirds are also found at the national lakeshore.

White-tailed deer are the primary focus of this deer management plan and, therefore, are addressed in a separate section from other wildlife covered in this section. The role deer have played in the state of the current wildlife habitat is included at the end of this section.

Mammals

Thirty-seven species of mammals have been documented at the Indiana Dunes National Lakeshore. These include small mammals, bats, carnivores, and one ungulate—the white-tailed deer. Some of the most abundant mammals include the eastern cottontail (*Sylvilagus floridanus*), the eastern fox squirrel (*Sciurus niger*), the white-footed mouse (*Peromyscus leucopus*), the white-tailed deer, and the meadow vole (*Microtus pennsylvanicus*) (Whitaker et al. 1994). The northern myotis (*Myotis septentrionalis*), the evening bat (*Nycticeius humeralis*), the hoary bat (*Lasiurus cinereus*), and the southern bog lemming (*Synaptomys cooperi*) may also occur within the national lakeshore but have not been documented (Whitaker et al. 1994). Table 22 lists those mammals known or likely to occur at the Indiana Dunes National Lakeshore, their abundance within the national lakeshore, and the habitat(s) in which they are supported. (Colors shown in the columns of this and the following tables for wildlife and sensitive and rare species correspond to the vegetation community types shown in the maps in Figures 6 and 7).

TABLE 22: MAMMALS OF INDIANA DUNES NATIONAL LAKESHORE

		National Lakeshore Communities[a]									
Common Name	Scientific Name	Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Local Abundance[b]
Virginia opossum	Didelphis virginiana					■	■	■	■	■	Common
Northern short-tailed shrew	Blarina brevicauda	■			■	■	■	■	■		Common
Least shrew	Cryptotis parva							■	■		Rare[c]
Eastern mole	Scalopus aquaticus					■	■	■	■	■	Common
Masked shrew	Sorex cinereus	■	■	■	■				■		Common
Big brown bat	Eptesicus fuscus					■	■			■	Common
Eastern red bat	Lasiurus borealis					■	■	■	■		Common
Silver-haired bat	Lasionysteris noctivagans	■	■			■	■				Common
Little brown myotis	Myotis lucifugus	■	■			■	■				Unknown
Northern myotis	Myotis septentrionalis					■	■				Uncommon
Indiana bat	Myotis sodalis		■	■			■				Rare[c]
Evening bat	Nycticeius humeralis	■	■	■		■	■				Uncommon
Hoary bat	Lasiurus cinereus	■	■	■		■	■				Rare[c]
Eastern cottontail	Sylvilagus floridanus			■	■	■	■	■	■		Common
Eastern chipmunk	Tamias striatus			■		■	■	■	■		Common
Woodchuck	Marmota monax			■		■	■	■	■	■	Common
Franklin's ground squirrel	Spermophilus franklinii				■			■	■	■	Uncommon[c]
Thirteen-lined ground squirrel	Spermophilus tridecemlineatus				■				■	■	Uncommon
Eastern gray squirrel	Sciurus carolinensis			■		■	■				Uncommon

Common Name	Scientific Name	National Lakeshore Communities[a]									Local Abundance[b]
		Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	
Eastern fox squirrel	Sciurus niger			■		■	■	■	■	■	Common
Red squirrel	Tamiasciurus hudsonicus			■		■	■				Common
Southern flying squirrel	Glaucomys volans			■		■	■				Common[c]
Beaver	Castor canadensis	■	■	■							Uncommon
White-footed mouse	Peromyscus leucopus	■	■	■	■	■	■	■	■		Abundant
Prairie deer mouse	Peromyscus maniculatus bairdii				■			■	■		Common
Norway rat	Rattus norvegicus	■		■						■	Common[c]
House mouse	Mus musculus	■		■						■	Common
Prairie vole	Microtus ochrogaster							■	■		Common
Meadow vole	Microtus pennsylvanicus	■		■	■						Abundant
Woodland vole	Microtus pinetorum			■		■	■	■	■		Common
Common muskrat	Ondata zibethicus	■		■							Common[c]
Southern bog lemming	Synaptomys cooperi	■		■				■	■		Uncommon[c]
Meadow jumping mouse	Zapus hudsonius	■		■	■						Uncommon
Coyote	Canis latrans							■	■		Rare[c]
Red fox	Vulpes vulpes							■	■	■	Uncommon[c]
Common gray fox	Urocyon cinereoargenteus			■		■	■	■	■		Rare
Raccoon	Procyon lotor	■		■		■	■	■	■	■	Abundant
Long-tailed weasel	Mustela frenata	■		■		■	■			■	Common
Least weasel	Mustela nivalis									■	Rare
Mink	Mustela vison	■	■	■							Uncommon
American badger	Taxidea taxus								■		NA
Stripped skunk	Mephitis mephitis			■	■	■	■	■	■		Uncommon
White-tailed deer	Odocoileus virginianus		■	■		■	■	■	■	■	Abundant

Source: NPS 1981.
[a]Adapted from NPS 1981.
[b]Abundance defined as follows (NPS 2006d):
Abundant: May be seen daily in suitable habitat and season and counted in relatively large numbers.
Common: May be seen daily in suitable habitat and season but not in large numbers.
Uncommon: Likely to be seen monthly in appropriate season/habitat. May be locally common.
Rare: Present but usually seen only a few times each year.
Unknown: Abundance unknown.
NA: Not applicable (not known to occur; potential to occur based only on historic records).
[c]Abundance taken from NPS 1981, which defines rare as “very seldom encountered” but does not define uncommon or common.

Birds

Approximately 352 avian species have been identified in the area along the entire southern shore of Lake Michigan (Brock 1997). Of these, 6 have become extinct or have been extirpated from the area; approximately 113 species are considered regular nesters; 24 species formerly nested (or nested at least once) in the area; and unconfirmed breeding evidence exists for another 9 species (Brock 1997).

A list of birds that was compiled and revised in May 2002 (NPS 2002d) indicated that approximately 297 species are known to or have the potential to occur in the Indiana Dunes National Lakeshore. Breeding birds of the national lakeshore occupy a variety of different habitats, and although many species have adapted to several habitats, some remain quite habitat-specific (Brock 1982). Table 23 lists some of the breeding birds that occur at the Indiana Dunes National Lakeshore.

The most obvious feature influencing birdlife at the Indiana Dunes National Lakeshore is the presence of Lake Michigan. Unique islands of habitat created by the geologic history of Lake Michigan, plus the stabilizing effects of temperature and moisture in the region, have created nesting conditions for several passerines that are more typical of geographic regions located both north and south of the area. For example, the veery (*Catharus fuscescens*), chestnut-sided warbler (*Dendroica pensylvanica*), and Canada warbler (*Wilsonia citrina*) typically occur to the north of the national lakeshore. The white-eyed vireo (*Vireo griseus*), prairie warbler, Louisiana waterthrush (*Seiurus motacilla*), and hooded warbler (*Wilsonia citrina*) are among those species that typically nest south of the national lakeshore but breed at the national lakeshore (Brock 1997). All these northern and southern species are considered locally rare or uncommon except for the veery, which is common (NPS 1981).

More than any other factor, Lake Michigan affects the movement and distribution of birds within the area and specifically in the national lakeshore. The deep lake and beach habitats associated with Lake Michigan attract large numbers of bay and sea ducks, wading birds, and beach residents, such as the purple sandpiper (*Calidris maritime*), sanderling (*Calidris alba*), Baird's sandpiper (*Calidris bairdii*), Glaucous gull (*Larus hyperboreus*), Iceland gull (*Larus glaucoides*), Thayer's gull (*Larus thayeri*), Sabines' gull (*Xema sabini*), little gull (*Larus minutus*), and black-legged kittiwake (*Rissa tridactyla*). These species prefer the sand rather than mudflats for resting and feeding (Brock 1997). The lake and its beaches also draw transitory and wintering birds into flight paths along the shores. During the fall and spring, the migrants navigate along the shores, converging at the bottom of Lake Michigan. This convergence is called the funnel effect. This funneling explains the unusually high occurrence of shorebirds and maritime wanderers in northwestern Indiana (Brock 1997).

Heavy deer browsing decreases habitat available for species that use understory and ground-cover levels of the forest. Researchers have documented that as deer densities increase, the number of understory nesting bird species and their abundance decreases (McShea and Rappole 2000). For example, the ovenbird (*Seiurus aurocapillus*), which is a medium ground-walking warbler that prefers to nest in deciduous woodlands with well-developed leaf litter, has had a reduction of habitat as deer browsing reduces the ground cover.

Most of the migratory birds in the United States are protected by the Migratory Bird Treaty Act (MBTA). The MBTA implements treaties and conventions among the United States, Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds, including those not otherwise listed under federal or state endangered species laws. Unless otherwise permitted by regulations, the MBTA makes it unlawful to pursue, hunt, take, capture, or kill; attempt to take, capture, or kill; possess, offer to sell, barter, purchase, or deliver; or cause to be shipped, exported, imported, transported, carried, or received any migratory bird, part, nest, egg, or product, manufactured or not. The MBTA also makes it unlawful to ship, transport, or carry from one state, territory, or district to another, or through a foreign country, any bird, part, nest, or egg that was captured, killed, taken, shipped, transported, or carried contrary to the laws from where it was obtained. It is unlawful to import from Canada any bird, part, nest, or egg obtained contrary to the laws of the province from which it was obtained. In March 2005, the USFWS published a list of 125 species not covered by the MBTA as part of the Migratory Bird Treaty Reform Act of 2004.

TABLE 23: BREEDING BIRDS OF INDIANA DUNES NATIONAL LAKESHORE

Common Name	Scientific Name	National Lakeshore Communities [a]									Local Abundance [b]			
		Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Spring (March-May)	Summer (June-August)	Fall (September-November)	Winter (December-February)
American goldfinch	Carduelis tristis							■	■	■	Common	Common	Common	Common
American woodcock	Scolopax minor			■		■	■				Common	Common	Uncommon	-
Bank swallow	Riparia irparia				■						Common	Common	Common	NA
Blue jay	Cyanocitta cristata			■		■	■				Abundant	Abundant	Abundant	Abundant
Blue-winged teal	Larus delawarensis	■		■							Common	Uncommon	Common	NA
Common yellowthroat	Geothlypis trichas		■								Abundant	Abundant	Common	NA
Downy woodpecker	Picoides pubsescens			■		■	■				Abundant	Abundant	Abundant	Abundant
Eastern bluebird	Sialia sialis							■	■	■	Common	Uncommon	Uncommon	Rare
Eastern kingbird	Tyrannus tyrannus							■	■	■	Common	Common	Uncommon	NA
Eastern meadowlark	Sturnella magna							■	■	■	Common	Common	Common	Accidental
Eastern wood-pewee	Contopus virens			■		■	■				Common	Common	Common	NA
Field sparrow	Spizella pusilla							■	■	■	Common	Common	Uncommon	Rare
Great blue heron	Ardea herodias	■		■							Abundant	Abundant	Abundant	Rare
Great crested flycatcher	Mylarchus crinitus			■		■	■				Common	Common	Uncommon	NA
Horned lark	Eremophila alpestris							■	■	■	Uncommon	Uncommon	Uncommon	NA
Killdeer	Charadrius vociferous				■						Common	Common	Common	Rare
Mallard	Anas platyrhynchos	■		■							Common	Common	Common	Common
Mourning dove	Zenaida macroura							■	■	■	Common	Common	Common	Common
Northern cardinal	Cardinalis cardinalis			■		■	■				Common	Common	Common	Common
Pied-billed grebe	Podilymbus podiceps	■		■							Common	Common	Common	Rare
Prairie warbler	Dendroica discolor				■						Uncommon	Uncommon	Accidental	NA
Red-headed woodpecker	Melanarpes erythrocephalus			■		■	■				Common	Common	Common	Uncommon
Red-shouldered hawk	Buteo lineatus		■								Uncommon	Rare	Uncommon	Rare
Red-winged blackbird	Agelaius phoeniceus	■		■							Abundant	Abundant	Abundant	Rare
Sora	Porzana carolina	■		■							Common	Uncommon	Uncommon	NA
Spotted sandpiper	Actitis macularia							■	■	■	Common	Common	Uncommon	NA
White-breasted nuthatch	Sitta carolinensis			■		■	■				Common	Common	Common	Common
Wood duck	Aix sponsa		■								Common	Common	Common	Rare

[a] Adapted from Brock 1982, NPS 2002d.
[b] Abundance defined as follows (NPS 2002d):
Abundant: Almost always seen or heard in habitat.
Common: Often seen or heard in habitat.
Uncommon: Sometimes seen or heard in habitat.
Rare: At least one individual present.
Accidental: Not present every year.
NA: Not applicable (not known to occur).

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Reptiles and Amphibians

The status of herptile inventory in the national lakeshore is good (Great Lakes Inventory and Monitoring Network, 2004) and is being actively updated through ongoing research. A listing of voucher specimens representing a permanent, verifiable record is available (Resetar 1994). Several recent inventory projects have been completed, including a three-year drift fence study concluded in 2002, annual anuran calling surveys, and the eastern massasauga (*Sistrurus catenatus catenatus*) surveys using cover objects, drift fences, and visual searches (Casper 2004).

The national lakeshore provides habitat for about 50 species of reptiles and amphibians. Reptiles within the national lakeshore include snakes, turtles, skinks, and lizards (NPS 1981). Of the 16 species of snakes found in the national lakeshore, only the eastern massasauga (discussed further in the "Sensitive and Rare Species" section on page 134) is venomous. To date, 22 species of amphibians—salamanders, frogs, and toads—have been identified at the Indiana Dunes National Lakeshore.

The northern banded watersnake and Chicago garter snake are the most abundant reptiles known to occur at the national lakeshore. The only lizards that have been observed within the national lakeshore include the six-lined racer and the glass snake. Of the turtles known to occur, the midland painted turtle is the only species that is considered abundant within the national lakeshore. Chorus frogs and spring peepers are the most abundant frogs in the national lakeshore; Fowler's toad and the green frog also occur. The redbacked salamander is the only salamander, siren, or newt that is considered abundant (NPS 1981). Although snakes in the national lakeshore commonly occur in herbaceous layers of plant communities, they use a variety of other habitats, as well. The aquatic areas of the Indiana Dunes National Lakeshore, especially ponds and wetlands, provide suitable habitat for all species of turtles and amphibians. Table 24 lists those reptiles and amphibians known or likely to occur at the Indiana Dunes National Lakeshore, their abundance within the national lakeshore, as well as the habitat(s) in which they are supported.

Northern ringneck snake

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TABLE 24: REPTILES AND AMPHIBIANS OF INDIANA DUNES NATIONAL LAKESHORE

Common Name	Scientific Name	National Lakeshore Communities [a]									Abundance [b]
		Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	
Reptiles											
Black rat snake	Elaphe obsoleta obsoleta		■	■		■	■	■	■	■	NA
Blue racer	Coluber constrictor		■	■		■	■	■	■	■	Common
Common snapping turtle	Chelydra serpentina serpentina	■	■	■							Common
Eastern box turtle	Terrapene carolina carolina					■	■	■	■	■	Uncommon
Eastern hognose snake	Heterodon platirhinos		■	■		■	■	■	■	■	Common
Eastern milk snake	Lampropeltis triangulum triangulum		■	■	■	■	■	■	■	■	Rare
Eastern spiny softshell	Apalone spinifera spinifera	■	■	■	■						Unknown
Five-lined skink	Eumeces fasciatus						■				NA
Western slender glass lizard	Ophisaurus attenuatus attenuatus		■	■		■	■	■	■	■	Uncommon
Map turtle	Graptemys geographica	■	■	■	■						Unknown
Midland brown snake	Storeria dekayi wrightorum	■	■	■		■	■	■	■	■	Common
Midland painted turtle	Chrysemys picta marginata	■	■	■							Abundant
Musk turtle	Sternotherus odoratus	■	■	■							Rare
Northern redbelly snake	Storeria occipitomaculata occipitomaculata	■	■	■		■	■	■	■	■	Uncommon
Northern ringneck snake	Diadophis punctatus edwardsii		■	■		■	■	■	■	■	Occasional
Northern watersnake	Nerodia sipedon sipedon	■	■								Uncommon
Plains garter snake	Thamnophis radix	■	■					■	■	■	Occasional
Red-eared turtle	Trachemys scripta elegans	■	■	■							NA
Western fox snake	Elaphe vulpina vulpina		■	■	■	■	■	■	■	■	Occasional
Amphibians											
American toad	Bufo americanus americanus	■	■	■		■	■	■	■	■	Abundant
Blanchard's cricket frog	Acris crepitans blanchardi	■	■	■				■	■		NA
Bull frog	Rana catesbeiana	■	■	■							Common
Central newt	Notophthalmus viridescens louisianensis	■	■	■		■	■	■	■		Common
Eastern gray tree frog	Hyla versicolor	■	■	■		■	■			■	Common

		National Lakeshore Communities [a]									
Common Name	Scientific Name	Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Abundance [b]
Eastern tiger salamander	Ambystoma tigrinum tigrinum	■	■	■		■	■	■	■	■	Common
Fowler's toad	Bufo fowleri	■	■	■				■	■	■	Common
Green frog	Rana clamitans melanota	■	■	■							Abundant
Marbled salamander	Ambystoma opacum		■	■		■	■	■	■	■	Rare [c]
Pickerel frog	Rana palustris	■	■	■				■	■		NA
Redbacked salamander	Plethodon cinereus		■	■		■	■				Common
Slimy salamander	Plethodon glutinosus		■	■		■	■				NA
Spotted salamander	Ambystoma maculatum	■	■	■		■	■				Uncommon [c]
Spring peeper	Pseudacris crucifer crucifer	■	■	■		■	■				Abundant
Tremblay's salamander	Ambystoma jeffersonianum	■	■	■		■	■				Unknown
Western chorus frog	Pseudacris triseriata	■	■	■		■	■	■	■	■	Abundant
Western lesser siren	Siren intermedia netting	■	■	■							NA
Wood frog	Rana sylvatica	■	■	■							Common

Source: NPS 1981.
[a] Adapted from NatureServe 2006.
[b] Abundance defined as follows (NPS 2006d):
Abundant: May be seen daily in suitable habitat and season and counted in relatively large numbers.
Common: May be seen daily in suitable habitat and season but not in large numbers.
Uncommon: Likely to be seen monthly in appropriate season/habitat. May be locally common.
Rare: Present but usually seen only a few times each year.
Occasional: Occurs in the national lakeshore at least once every few years but not necessarily every year.
Unknown: Abundance unknown.
NA: Not applicable (not known to occur; potential to occur based only on an unconfirmed or historic report).
[c] Abundance taken from NPS 1981, which defines rare as "very seldom encountered" but does not define uncommon.

Fish

Fish occupy a wide variety of aquatic habitats in the area of the Indiana Dunes National Lakeshore, ranging from Lake Michigan to bog and marsh wetlands to the rivers, creeks, and ditches of the interdunal drainage network. The combined property of the Indiana Dunes National Lakeshore and the Indiana Dunes State Park includes several stream segments that represent some of the last relatively intact habitat for native stream fish in the southern coastal region of Lake Michigan. Within the national lakeshore, these habitats support approximately 57 native species of fish and 15 species of nonnative fish (NPS 2006d; Spacie 1988).

Native species supported in the aquatic habitats of the riverine (ditches, creeks, streams, and rivers) and/or palustrine (wetlands dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens) environments at the national lakeshore include gizzard shad (*Dorosoma cepedianum*), white sucker (*Catostomus commersoni*), spotfin shiner (*Cyprinella spiloptera*), common shiner (*Loxilus cornutus*), northern redbelly dace (*Phoxinus eos*), fathead minnow (*Pimephales promelas*), brook stickleback (*Culaea inconstans*), rock bass (*Amblopites rupestris*), bluegill (*Lepomis macrochirus*), white crappie (*Pomoxis annularis*), Iowa darter (*Etheostoma exile*), walleye (*Stizostedion vitreum*), American brook lamprey (*Lampetra appendix*), longnose gar (*Lepisosteus osseus*), and channel catfish (*Ictalurus punctatus*) (NPS 2006d).

Some of the stream segments provide spawning sites for nonnative sport fish, such as rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) (Ledet 1978; Spacie 1988). Other nonnative fish species found in the riverine and palustrine environments include alewife (*Alosa pseudoharengus*), goldfish (*Carassius auratus*), common carp (*Cyprinus carpio*), Chinook salmon (*Oncorhynchus tsawytscha*), and Coho salmon (*Oncorhynchus kisutch*) (NPS 2006d).

Native fish species found in Lake Michigan at the national lakeshore include smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), longnose sucker (*Catostomus catostomnus*), emerald shiner (*Notropis atherinoides*), mimic shiner (*Notropis volucellus*), logperch (*Percina caprodes*), pirate perch (*Aphredoderus sayanus*), and lake trout (*Salvelinus namaycush*). Nonnative species that occur in the lake include threespine stickleback (*Gasterosteus aculeatus*), ninespine stickleback (*Pungitus pungitus*), round goby (*Neogbius melanostomus*), white perch (*Morone Americana*), and striped bass (*Morone saxatalis*) (NPS 2006d).

Invertebrates

The distribution of the blacklegged tick (*Ixodes scapularis*) is linked to the distribution and abundance of its primary reproductive host, white-tailed deer (*O. virginianus*) (Wilson et al. 1985, 1988). Only deer or some other large mammals appear capable of supporting high populations of ticks (Duffy et al. 1994). Secondary-growth forests create “edge” habitats that provide appropriate habitat for deer, resulting in increased populations, and thus, these forests may have increased populations of the blacklegged tick (Severinghaus and Brown 1956). Lyme disease bacterium *Borrelia burgdorferi* is transmitted by blacklegged ticks, which are also known as deer ticks. Deer overpopulation could lead to increased exposure and subsequent infection rates of Lyme disease, which is an illness that can cause lifelong problems, including painful headaches, aching, and swollen joints (Centers for Disease Control 2008).

Current Status of Wildlife and the Role of Deer

The amount of research conducted to link the effects of deer density on populations of other wildlife is not as abundant as it is for the effect of deer density on vegetation. However, a number of studies have shown distinct changes in bird abundance as a result of reduced deer density by means of exclosures (DeCalesta 1994; McShea and Rappole 2000). One researcher found that seedling richness began to decline with just 10 deer/mi^2 and that songbird habitat was negatively affected with 20 to 39 deer/mi^2 within a cherry/maple forest (DeCalesta 1992, 1994). Similarly, a nine-year study found that a reduction in deer density changed the composition of forest bird populations (McShea and Rappole 2000). Three patterns of change were observed in bird populations within exclosures (where there were no deer): (1) species that preferred open understory (e.g., chipping sparrows [*Spizella passerine*]) declined; (2) species that preferred a dense herbaceous ground cover (e.g., the indigo bunting [*Passerina cyanea*]) immediately increased but then decreased as herbaceous species were replaced by woody species; and (3) species that preferred a dense, woody understory (e.g., ovenbirds [*Seiurus aurocapillus*]) gradually increased.

The habitat most affected by heavy deer browsing is the herbaceous and woody vegetation of a forest understory, as deer can directly browse vegetation from ground level to an average of 5 feet (150 centimeters) above the ground. A variety of other wildlife also uses this understory habitat and competes with deer for available resources. This wildlife includes squirrels and mice, which feed on acorns; rabbits and woodchucks, which feed on young woody stems and green vegetation; and box turtles, which are dependent on the vegetation, fruits, and insects of the forest understory (Martin et al. 1951; McShea and Rappole 2000). High deer numbers also cause a reduction in ground cover that affects the ability of small mammals, such as moles and squirrels, as well as ground-nesting or feeding birds, to conceal themselves from such predators as hawks, owls, coyotes, foxes, skunks, and raccoons.

Species that primarily depend on other habitats would be less affected by high deer numbers. The upper canopy of the forest does not change noticeably as a result of high deer numbers. Therefore, those species that depend on the forest's upper canopy (such as woodpeckers and other birds that nest high in the trees) do not generally experience any noticeable change in their habitat. Most frogs, salamanders, and turtles live in close proximity to water during much of their lives. Heavy deer browsing does not directly change fish habitat (although erosion, sedimentation, and other impacts on water quality from deer can degrade aquatic habitat).

Species that benefit from high deer numbers and resulting habitat effects include those that prey on deer (e.g., coyotes) or that feed on carrion (e.g., eagles and vultures). However, areas with less ground cover would be less suitable to support small mammals because lower-density ground cover provides predators with a better line of sight when hunting and reduces the ability of their prey to hide.

SENSITIVE AND RARE SPECIES

For the purposes of this plan, sensitive and rare species are defined as those listed by either the USFWS as endangered, threatened, candidate, or of special concern or by the state of Indiana as endangered, threatened, rare, extirpated (no longer present), or on a watch list. The terms "threatened" and "endangered" generally describe the official federal status of sensitive and rare species at the Indiana Dunes National Lakeshore, as defined by the Endangered Species Act of 1973. The term "candidate" is used officially by the USFWS when describing those species for which sufficient information on biological vulnerability and threats is available to support the issuance of a proposed rule to the list, but that action is precluded due to other higher-priority listing actions. NPS *Management Policies 2006* dictates that federal candidate species and state-listed threatened, endangered, candidate, or sensitive species be managed to the greatest extent possible as federally listed threatened or endangered species (NPS 2006b).

Species listed as endangered, threatened, candidate, or of special concern under the Endangered Species Act of 1973 that may exist in the Indiana Dunes National Lakeshore are described below, followed by a discussion of those listed by the state.

Species Listed under the Endangered Species Act

Wildlife

Wildlife species listed by the USFWS and known to exist or that may exist in the Indiana Dunes National Lakeshore (USFWS 2005) include six endangered, one threatened, and one candidate species, as shown in Table 25.

TABLE 25: WILDLIFE SPECIES LISTED UNDER THE ENDANGERED SPECIES ACT

Common Name	Scientific Name	Federal Status	State Status
American burying beetle	Nicrophorus americanus	Endangered	Extirpated
Eastern massasauga	Sistrurus catenatus catenatus	Candidate	Endangered
Hine's emerald dragonfly	Somatochlora hineana	Endangered	Extirpated
Indiana bat	Myotis sodalist	Endangered	Endangered
Karner blue butterfly	Lycaeides melissa samuelis Nabokov	Endangered	Endangered
Mitchell's satyr	Neonympha mitchellii mitchellii	Endangered	Endangered
Piping plover	Charadrius melodus	Endangered	Endangered

American Burying Beetle (Federal Endangered, State Extirpated)

The American burying beetle is a large, shiny, black burying beetle found in a variety of upland terrestrial habitats, from grasslands to old field shrublands and hardwood forests (see Table 26 for the national lakeshore communities in which this species may occur). Breeding occurs from early April to mid-August, and eggs are laid in a chamber built in a buried vertebrate carcass. Larvae and adults also feed on buried carcasses; adults are characterized as opportunistic scavengers, feeding on anything dead (NatureServe 2006). The IDNR Division of Nature Preserves lists this species as extirpated from the state, and it is not known to occur at the Indiana Dunes National Lakeshore.

Eastern Massasauga (Federal Candidate, State Endangered)

The eastern massasauga is a snake that prefers seasonal herbaceous wetlands with a mixture of open grass-sedge areas and short, closed canopy (edge situations) but is also found in other habitats (see Table 28 for the national lakeshore communities in which this species may occur). Females appear to breed biennially in late summer, and their young are typically born between late July and early September. They are most active from about April to October and are generally inactive during cold periods, hibernating in burrows, rock crevices, and tree-root systems. Their primary prey are small mammals, although birds and other snakes may also be eaten (NatureServe 2006). The eastern massasauga is thought to occur only in the East Unit of the national lakeshore and is observed at least once every few years but not necessarily every year. A juvenile was identified in the national lakeshore in 2002, and it is, therefore, assumed that the population of eastern massasaugas at the national lakeshore is reproducing (NPS 2003g, 2006c).

Hine's Emerald Dragonfly (Federal Endangered, State Extirpated)

The Hine's emerald dragonfly is a fairly large, metallic-brown dragonfly with two yellow stripes and bright, emerald-green eyes. Females lay their eggs in shallow water, and larvae occur in shallow streams for two to four years. Adult habitat consists of herbaceous wetlands often dominated by cattail. Breeding occurs in late July to August, and larvae emerge as early as late May and throughout summer. Adults and larvae both feed on other insects (NatureServe 2006). The IDNR Division of Nature Preserves lists this species as extirpated from the state, and it is not known to occur at the Indiana Dunes National Lakeshore.

Indiana Bat (Federal Endangered, State Endangered)

The Indiana bat is a migratory species found throughout much of the eastern United States. Beginning in late August to mid-October, these bats congregate at hibernaculum in caves or mines that meet very specific temperature and moisture requirements. Following emergence from hibernation in late March or April, most Indiana bats migrate north to summer habitat, roosting in trees and foraging exclusively for flying insects, primarily in riparian and upland forests. Roosting trees are dead or dying trees with exfoliating bark that provide enough space to allow the bats to roost between the bark and bole of the tree; to a lesser extent, the bats also use crevices and cavities. Mating occurs from late August to early October, before hibernation, or during the spring. The young are born in June or July in hollow trees or under the loose bark of living or dead trees; maternity colonies use multiple roosts with at least one primary roost used by the majority of the bats (NatureServe 2006; NPS 2003g).

Suitable habitat for the Indiana bat occurs in the wooded wetlands and mesophytic forests of the national lakeshore; however, its abundance there is currently unknown (NPS 2006d). Despite systematic studies of mammals at the national lakeshore, only two specimens have been recorded during mist-net surveys at the Heron Rookery. It is not clear whether these individuals were part of a larger colony of resident bats or was migrating through the national lakeshore (NPS 2003g).

Karner Blue Butterfly (Federal Endangered, State Endangered)

The Karner blue butterfly is a silvery to dark blue (male) or grayish brown (female) butterfly whose sole larval food source is wild lupine (*Lupinus perennis*). Adults rely on a variety of nectar-producing plants, and both lupine and nectar plants are found primarily in the prairie/savanna complex at the national lakeshore (NPS 2003g; see Table 26 for other national lakeshore communities in which this species may occur). Karner blue butterflies produce two broods each year. Eggs that have overwintered from the previous summer hatch in April. Generally, the larvae become pupae near the end of May or early in June, and adult butterflies emerge very late in May and well into June. New eggs are laid on or near lupine plants in early to mid-June and hatch in about one week. The larvae feed for about three weeks and then pupate, and a second brood of adults appears in the second or third week of July. These adults typically fly from late July to early August, and females lay their eggs among plant litter or on grass blades at the base of the lupines or on lupine pods or stems. These eggs do not hatch until the following spring as the first brood of the year (NatureServe 2006).

Karner blue butterflies

Karner blue butterflies were extirpated from the East Unit but were restored to a small section of the East Unit in 2006. The butterfly is considered abundant in two separate areas of the West Unit, the Inland Marsh Complex and Miller Woods (defined from the Indiana Dunes National Lakeshore's 2006 NP Species Database for Indiana Dunes National Lakeshore), as they may be seen daily, in suitable habitat and season, and counted in relatively large numbers (NPS 2006d, 2003g).

Mitchell's Satyr (Federal Endangered, State Endangered)

The Mitchell's satyr is a small butterfly found in herbaceous wetlands dominated by sedges and bulrushes, but little is known about its life history. Larvae have been found from about the end of July to the next June, and adults typically fly between June 25 and July 20. Larval food plants almost certainly include sedges; however, adult food sources are unknown (NatureServe 2006). While Mitchell's satyr is known to occur in Indiana, it is presumed extirpated from the national lakeshore.

Piping Plover (Federal Endangered, State Endangered)

The piping plover is a migratory shorebird that forages along open shoreline areas, avoiding vegetated beaches. It is found in the dune complex at the national lakeshore and eats worms, fly larvae, beetles, crustaceans, mollusks, and other invertebrates from the surface or, occasionally, by probing into sand or mud (NatureServe 2006). Although the USFWS has formally designated critical habitat for the endangered piping plover in the national lakeshore, it is not known to breed there (NPS 2003g) and is considered a migrant, with one to three birds seen each year (NPS 2002d).

Plants

Pitcher's Thistle (Federal Threatened, State Threatened)

Pitcher's thistle

Pitcher's thistle (*Cirsium pitcheri*) is the only plant listed under the Endangered Species Act that occurs at Indiana Dunes National Lakeshore. This plant is endemic to the Great Lakes dunes formed by the retreat of the last glaciers 14,000 to 10,000 years ago. It is found on patches of open, windblown ground and requires 70 percent open sand for successful seedling establishment and continued survival. Although Pitcher's thistle occurs most frequently in near-shore plant communities, it may be found in all nonforested areas of the Great Lakes dunes; blowout communities serve as important refugia. Pitcher's thistle blooms from May to August, and flowers are either insect- or self-pollinated. Seed dispersal, primarily by wind, begins in June and may continue through September. Individuals flower and set seed only once during their life cycle and populations are relatively short-lived (NPS 2003g).

Pitcher's thistle is considered uncommon at the Indiana Dunes National Lakeshore. "Uncommon" for plants is defined as a few to moderate number of individuals that occur either sporadically in commonly encountered habitats or in uncommon habitats (NPS 2006d). Historically, it was found along the beaches but is presently supported primarily in the blowout communities within the dune complex at the national lakeshore (NPS 2003g).

Species Listed by the State of Indiana

The IDNR Division of Nature Preserves lists sensitive and rare animals and plants in Indiana in one of the five categories described previously. State-listed wildlife species that are known to occur or that may occur in the Indiana Dunes National Lakeshore are discussed in Tables 26 through 29 (IDNR 2005a). State-listed plant species are discussed in Table 30. These tables provide listing status, information on the national lakeshore communities in which the species may occur, natural history information, and information on the species' local abundance.

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TABLE 26: SENSITIVE AND RARE INVERTEBRATES OF INDIANA DUNES NATIONAL LAKESHORE

Common Name	Scientific Name	State Status	Federal Status	National Lakeshore Communities: Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Natural History Information	Local Abundance10
American burying beetle[1]	Nicrophorus americanus	Extirpated	Endangered			■		■	■	■	■	■	These beetles are found in a variety of upland terrestrial habitats. Breeding occurs from early April to mid-August; eggs are laid in chambers built in buried vertebrate carcasses. Larvae and adults also feed on buried carcasses; adults are characterized as opportunistic scavengers (NatureServe 2006).	Presumed Extirpated
Band-winged meadow hawk[1, 2]	Sympetrum semicinctum	Rare	Not Listed	■									Limited information is available. The species breeds in ponds; the adult flight period is July through October (NatureServe 2006).	Unknown
Barrens metarranthis moth[1]	Metarranthis apiciaria	Endangered	Not Listed			■		■	■	■	■		Adults are seen in June and into July. Eggs hatch in late June, and larvae occur from July to August. Pupae hibernate in soil; foodplant is unknown but is thought to be a tree or shrub (NatureServe 2006).	Unknown
Big broad-winged skipper[3]	Poanes viator viator	Threatened	Not Listed	■									Hairy sedge is the only known larval and pupae host plant for inland populations of this species. Adults fly from late June to early August, and females lay eggs under leaves of host plants. Adults feed on nectar from swamp milkweed (Asclepias incarnata), purple loosestrife, and blue vervain (Verbena hastate) (USGS 2006).	Unknown
Bunchgrass skipper[3, 4]	Problema byssus	Threatened	Not Listed							■	■		Host plants include eastern grama grass (Tripasacum dactyloides) and big bluestem. Adults fly from June to July, and females lay eggs on host plant leaves. Pupae overwinter and finish growing in spring, feeding on leaves of host plant. Adults eat nectar from flowers, including pickerelweed (Pontederia cordata) (USGS 2006).	Rare
Columbine borer[4]	Papaipema leucostigma	Threatened	Not Listed							■	■		Limited information is available. Larval food plant is columbine (Aquilegia spp.) (Opler and Vichai 1992).	Unknown
Dusted skipper[1]	Atrytonopsis hianna	Threatened	Not Listed			■	■	■		■	■		Larval food plants include big and little bluestem, while adults feed on nectar from Japanese honeysuckle (Lonicera japonica), blackberry (Rubus spp.), wild strawberry (Fragaria virginiana), vervain (Verbena spp.), red clover (Trifolium pratense), phlox (Phlox spp.), and wild hyacinth. Adult flight period lasts from mid-May to early June, and larvae overwinter within a tent of several leaves sewn together and attached to host plant well off the ground. Mature larvae found at the base of food plant, 1 to 3 inches aboveground, hatching in late May or June (NatureServe 2006).	Rare
Frosted elfin[1]	Callophrys irus	Endangered	Not Listed			■		■	■	■	■		Primarily found in anthropogenic habitats, such as power line and railroad rights of way, along sand or gravel roads through dry woods or pine barrens, and around old gravel pits. Larval food plants include wild indigo (Baptisia tinctoria) and lupine. Most of the life cycle is spent in the pupae stage. Adults fly from April to June and are nectarivores (nectar feeders) (NatureServe 2006).	Unknown
Great copper[1, 3]	Lycaena xanthoides	Endangered	Not Listed	■	■					■	■		Limited information is available. Host plants include several dock species, including bitterdock (Rumex obtusifolius) (NatureServe 2006). Adults are nectarivores (USGS 2006).	Unknown
Hine's emerald dragonfly[1]	Somatochlora hineana	Extirpated	Endangered	■									Larvae occur in shallow streams for two to four years. Adult habitat consists of herbaceous wetlands often dominated by cattail. Breeding occurs late July to August; larvae emerge as early as late May and throughout summer. Adults and larvae feed on other insects (NatureServe 2006).	Presumed Extirpated
Kansas prairie leafhopper[5]	Prairiana kansana	Endangered	Not Listed			■		■	■	■	■		Leafhoopers feed on plant sap, vascular plants (including grasses, sedges, broad-leafed woody vegetation, and herbaceous plants of many families), and conifers. Females deposit eggs into the living tissue of the host plant, and they develop and hatch within a month to more than a year. Once nymphs emerge, they reach the adult stage within several weeks to several months (Dietrich 2006).	Unknown
Karner blue butterfly[1, 4]	Lycaeides melissa samuelis Nabokov	Endangered	Endangered			■	■	■	■	■	■		These butterflies lay eggs on wild lupine in early to mid-June; adults emerge in mid- to late July and lay eggs again in mid-August among plant litter or on grass blades at the base of the lupines or on lupine pods or stems. These eggs do not hatch until the following spring as the first brood of the year. Eggs that have overwintered from the previous summer hatch in April and become adults by late May. Larva feed solely on wild lupine, while adults feed on a variety of nectar plants (NatureServe 2006).	Abundant
Leonard's skipper[3, 4]	Hesperia leonardus	Rare	Not Listed				■			■	■		This species prefers grassy areas. Eggs are laid on or near host plants, including little bluestem, blue grama (Bouteloua gracilis), and other perennial grasses. Adults are nectarivores and feed on a variety of flowers, including blazing star (Liatris punctata), thistles, asters, and teasel (Dispacus spp.). Adults generally fly from August to October (USGS 2006).	Rare

Common Name	Scientific Name	State Status	Federal Status	National Lakeshore Communities: Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Natural History Information	Local Abundance10
Mitchell's satyr[1, 3]	Neonympha mitchellii mitchellii	Endangered	Endangered	■									Typically found in herbaceous wetlands dominated by (Carex stricta). Larval host plants include sedges and bulrush, although exact species are unknown. Larvae occur most of the year and hibernate partially grown. Adults occur in late June to mid-July, and females lay eggs on leaves of host plants. Adult food habits are unknown (NatureServe 2006).	Presumed Extirpated
Mottled duskywing[1, 4]	Erynnis martialis	Threatened	Not Listed				■			■	■		Host plants include New Jersey tea (Ceanothus americanus) and redroot (Ceanothus herbaceous). Eggs are laid on flowers or other parts of host plants, and larvae overwinter in leaf litter and live in rolled leaf nests. Adults eat nectar of host plants and typically fly in two broods from April to May and June to July (NatureServe 2006).	Uncommon
Olympia marblewing[6]	Euchloe olympia	Threatened	Not Listed				■			■	■		found in dry meadows and open sandy woodlands on old dunes. Eggs are laid on flower buds and leaves of the larval host plant, which is primarily rockcress. Adults eat nectar of various plants, including wood vetch (Vicia caroliniana), garlic mustard (Alliaria petiolata), dwarf cinquefoil (Potentilla canadensis), narrow-leaved spring beauty (Claytonia virginica), wild strawberry, and various species of rockcress. Adults typically fly from mid-April to mid-June (USFS 2002).	Rare
Ottoe skipper[1]	Hesperia ottoe	Endangered	Not Listed							■	■		Found in dry fields and prairies in the Great Lakes region. Larval host plants include a variety of grasses, such as little bluestem, big bluestem, sideoats grama (Bouteloua curtipendula), and fall rosette grass (Dichanthelium wilcoxianum). Adults fly from mid-June through early August, reaching peak abundance in early July. Eggs are laid on host plants, and larvae overwinter in grass tents. Adults feed on nectar of prickly pear cactus (Opuntia spp.), knapweed (Centaurea spp.), milkweed, vetches (Vicia spp.), coneflower (Rudbeckia spp.), sunflower (Helianthus spp.), blacksamson echinacea (Echinacea agustifolia), blazing star, pearly everlasting (Anaphalis spp.), hoary vervain (Verbena stricta), Flodman thistle (Cirsium flodmanii), and green milkweed (Asclepias virdiflora) (NatureServe 2006).	Unknown
Phlox moth[1]	Schinia indiana	Endangered	Not Listed			■		■		■	■		Host plant is primarily downy phlox (Phlox pilosa). Adults typically occur in late May or June and lay eggs that emerge very quickly. Larval stage is brief, followed by a long pupal stage that may overwinter multiple times. Adults feed on nectar of host plant and other flowers (NatureServe 2006).	Unknown
Regal fritillary[1]	Speyeria idalia	Endangered	Not Listed	■	■					■	■		Host plant includes several species of violets (Viola spp.). Adults occur from June to July. Eggs are laid from August to September, often very near, but not on, host plant. Larvae appear in September or October or overwinter and emerge the next June or July. Adults are nectarivores, and blazingstar and milkweed are the primary food plants; however, a variety of nectar sources may be used (NatureServe 2006).	Unknown
Silvery blue[3]	Glaucopsyche lygdamus couperi	Endangered	Not Listed			■	■	■	■	■	■	.	found in a variety of upland terrestrial habitats, especially along woodland edges. Eggs are laid on flower buds and young leaves of host plants, including milkvetch (Astragalus spp.), trefoil (Lotus spp.), lupine, sweet clover, locoweed (Oxytropis spp.), beach pea, and vetches. Adults are nectarivores and generally fly from March to June[12]	Unknown
Spatterdock darner[1, 7, 8]	Aeshna mutata	Threatened	Not Listed	■									Adults are found at breeding sites, which frequently support spatterdock, in early June through early July. Eggs are laid in emergent or aquatic vegetation near the water's surface and hatch approximately 30 days later. They feed on other flying insects (WDNR 2011; Massachusetts Division of Fish and Wildlife Natural Heritage Endangered Species Program 2003).	Unknown
Swamp lymnaea[1, 9]	Lymnaea stagnalis	Special Concern	Not Listed	■									Found in permanent, standing, intermittent, and flowing water. These freshwater snails are hermaphroditic (have both sex organs), and eggs are typically laid in the spring on the substrate of aquatic habitats. Lymnaea species are generally scavengers and eat living algae, dead plant material, and dead animal material (NatureServe 2006; Pennak 1978).	Unknown
Two-spotted skipper[3]	Euphyes bimacula	Threatened	Not Listed	■									Limited information is available. Larval host plants include sedges; adults feed on the nectar of pickerelweed (Pontederia cordata), sweet pepperbush (Clethra sp.), blue flag (Iris versicolor), common milkweed, and spiraea. Adults fly from June to July (USGS 2006).	Unknown

[1] National lakeshore communities adapted from NatureServe 2006.
[2] National lakeshore communities adapted from Smith et al. 2004.
[3] National lakeshore communities adapted from USGS 2006a.
[4] National lakeshore communities adapted from Opler and Vichai 1992.
[5] National lakeshore communities adapted from Dietrich 2006.
[6] National lakeshore communities adapted from USFS 2002.
[7] National lakeshore communities adapted from WDNR 2011.
[8] National lakeshore communities adapted from Massachusetts Division of Fish and Wildlife Natural Heritage Endangered Species Program 2003.
[9] National lakeshore communities adapted from Pennak 1978.
[10] Abundance defined as follows (from NPS 2006d):
Abundant: May be seen daily, in suitable habitat and season, and counted in relatively large numbers.
Uncommon: Likely to be seen monthly in appropriate season/habitat. May be locally common.
Rare: Present but usually seen only a few times each year.
Unknown: Abundance unknown.

TABLE 27: SENSITIVE AND RARE BIRDS OF INDIANA DUNES NATIONAL LAKESHORE

Common Name	Scientific Name	State Status	Federal Status	National Lakeshore Communities[1] Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Breeds within Area?[2]	Natural History Information	Local Abundance[3] Spring (March-May)	Summer (June-August)	Fall (September-November)	Winter (December-February)
BREEDING BIRDS																		
Bald eagle	Haleatus leucocephalus	Endangered	Not Listed	■	■								No	Bald eagles potentially are found primarily near aquatic habitats along the national lakeshore and are most often observed foraging during spring migration. Although the national lakeshore may provide nesting habitat (tall trees or cliffs along shorelines in remote areas with little disturbance), bald eagles are not known to nest there. Also, there is little, if any, preferred wintering habitat (areas providing a readily available food supply and night roosts offering isolation and thermal protection from winds) within the national lakeshore (NPS 2003g, 2002d).	Rare	Rare	–	Accidental
Black tern	Chlidonias niger	Endangered	Not Listed	■									Yes	This species returns to breeding sites in early to mid-May. Typically nests in shallow water, close to open water or openings in stands of emergent vegetation, such as cattails, bulrushes, burreed, and phragmites. Eggs are laid in late May and hatch by about mid-June. Young are fully fledged at about 4 weeks, or in late June. Forages for insects and fish (NatureServe 2006).	Accidental	Accidental	Rare	–
Black-and-white warbler	Mniotilta varia	Special Concern	Not Listed		■	■			■				Yes	Breed between mid-April and late July. Eggs hatch within 10 to 12 days, and fledging occurs 8 to 10 days after hatching. Typically nest on the ground, often adjacent to a tree, shrub, rock, stump, or log; under a shrub or dead branches; or more rarely, atop stumps. The birds forage for insects principally by creeping along tree trunks and branches (NatureServe 2006).	Common	Rare	Common	–
Broad-winged hawk	Buteo platypterus	Special Concern	Not Listed		■	■			■				Yes	Regularly nest near wet areas and forest openings, edges, and woodland roads, typically in the crotch of a moderate- to large-sized tree or on a branch next to the trunk, about 12 to 39 feet above ground, in the bottom third of the forest canopy. Eggs are typically laid in mid- to late July, and hatching occurs by late June to early July. Fledging typically occurs from mid-August to September. They hunt from perches on stubs or dead limbs of trees, typically at a clearing, along woodland roads, at forest edge, or at the margin of seasonal and permanent waters. They eat small vertebrates (small mammals, birds, snakes, frogs, etc.) and large invertebrates (NatureServe 2006).	Uncommon	Rare	Uncommon	–
Cerulean warbler	Dendroica cerulea	Special Concern	Not Listed		■	■			■				Yes	Nest in tall trees, about 15 to 88 feet up (typically high in the tree), well out on large branches. They breed from mid-May and early June to July. Eggs hatch within 10 to 12 days, and fledging occurs approximately 10 to 11 days after hatching. They forage in and about the foliage of deciduous trees for small insects (Dietz 2001; NatureServe 2006).	Common	Common	–	–
Golden-winged warbler	Vermivora chrysoptera	Endangered	Not Listed	■	■	■			■	■	■	■	Yes	Nest on or a little above the ground, in grass tufts, fern, or weed clumps or concealed in herbage at the base of shrubs, trees, ferns, briars, or goldenrod. The clump often includes a taller stem used for descent to the nest. Nests are usually at the ecotone of a forest with a field or marsh or in a small opening in a forest. Eggs are laid in May to June and hatch approximately 10 to 11 days later. Fledging occurs approximately 8 to 10 days after hatching. They forage among foliage and twigs from treetops to lower shrubs, eating insects and spiders (NatureServe 2006).	Uncommon	Rare	Uncommon	–
Hooded warbler	Wilsonia citrina	Special Concern	Not Listed		■							■	Yes	Nests are placed in saplings or shrubs in dense deciduous undergrowth, usually between 1 and 5 feet above the ground, especially along stream and ravine edges and thickets in riverine forests. Nesting occurs from mid- to late May to July, and eggs are laid after mid-June. Eggs hatch after approximately 12 days of incubation, and fledging occurs approximately 10 to 12 days later. Eat a wide variety of insects and spiders; gleans and flycatches in undergrowth, rarely more than 14.8 feet above the ground when foraging (NatureServe 2006).	Uncommon	Rare	Rare	–
King rail	Rallus elegans	Endangered	Not Listed	■									Yes	Nest on an elevated platform, often with a canopy and ramp, attached to plants growing in shallow water (0 to 10 inches) or placed in a tussock or other waterside vegetation. They forage in shallow water (less than 10 inches) and on mud flats, eating crustaceans, insects and other invertebrates, small fish, tadpoles, seeds of weeds and aquatic plants, and grain (NatureServe 2006).	Accidental	Accidental	Accidental	–
Least bittern	Ixobrychus exilis	Endangered	Not Listed	■	■								Yes	Nest among dense, tall growths of emergent vegetation (particularly cattail, sedges, bulrush, or common reed, interspersed with some woody vegetation and open, fresh water). Nests are generally found in water approximately 4 to 20 inches deep, approximately 6 to 30 inches above the water surface. They forage in shallow water or along banks for small fish, amphibians, leeches, slugs, snails, crustaceans, insects, and occasionally, small mammals (NatureServe 2006).	Rare	Rare	Rare	–
Marsh wren	Cistothorus palustris	Endangered	Not Listed	■									Yes	Breeding typically occurs in April or May (Lesperance 2001). Nests are built in marsh vegetation, and eggs are laid in two broods. Eggs hatch after approximately 12 to 16 days of incubation, and fledging occurs within 11 to 16 days after hatching. They forage on insects and other invertebrates (NatureServe 2006).	Common	Common	Common	–

Common Name	Scientific Name	State Status	Federal Status	National Lakeshore Communities[1]: Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Breeds within Area?[2]	Natural History Information	Local Abundance[3]: Spring (March-May)	Summer (June-August)	Fall (September-November)	Winter (December-February)
Peregrine falcon	Falco peregrinus	Endangered	Delisted			■	■	■		■			Yes	Breeding occurs from March to May, and eggs are typically laid by mid-May. Eggs hatch in mid-June, and fledging occurs 35 to 42 days after hatching (Dewey and Potter 2002). They primarily nest on ledges or holes on the face of rocky cliffs or crags; also uses river banks, open bogs, large stick nests of other species, tree hollows, and man-made structures (e.g., ledges of city buildings) locally. They feed primarily on birds (medium-size passerines up to small waterfowl), hunting from perches or while soaring (NatureServe 2006).	Uncommon	Uncommon	Uncommon	Rare
Red-shouldered hawk	Buteo lineatus	Special Concern	Not Listed		■				■				Yes	Breeding occurs from March to April. Eggs are laid from March to June, and incubation lasts approximately 33 days. Fledging generally occurs from late June to early July. Nests are built in large living trees, generally far from the edge of mature forests, usually in the main crotch, at heights of approximately 36 to 49 feet. They forage beneath the forest canopy and in more open terrain, preferably moist areas or near water. They eat snakes, amphibians, small mammals, and large insects (NatureServe 2006).	Uncommon	Rare	Uncommon	Rare
Sedge wren	Cistothorus platensis	Endangered	Not Listed	■						■	■	■	Yes	Nesting occurs from May to June. Eggs are typically laid within 3 days of breeding, and incubation lasts approximately 14 days. Fledging generally occurs 13 to 14 days after the eggs. Nests are built in dense, tall sedges and grasses in wet meadows, hayfields, retired croplands, and upland margins of ponds and marshes. They eat insects and spiders, picking food from the ground or foliage (NatureServe 2006).	Uncommon	Rare	Rare	–
Virginia rail	Rallus limicola	Endangered	Not Listed	■									Yes	Breeding generally occurs from April to May, and eggs are laid from May to June or July. Eggs incubate for 19 to 20 days, and fledging occurs shortly after hatching. Nests are built in dense marsh vegetation over water or in vegetation next to open water, usually less than 12 inches above water level. They forage in mud with their bills, often among or next to vegetation adjacent to open water; they eat insects, worms, crustaceans, and other invertebrates; seeds of aquatic plants (especially in fall); duckweed; and occasionally, small fishes (NatureServe 2006).	Common	Uncommon	Uncommon	Rare
Barn owl	Tyto alba	Endangered	Not Listed	■						■	■	■	Un-known	Nest in buildings (church steeples, attics, platforms in silos and barns, wooden water tanks, duck blinds), caves, crevices on cliffs, burrows, and hollow trees, but rarely in trees with dense foliage. Nesting takes place in late winter, spring, and summer, but the peak egg-laying period occurs in mid-April. Egg hatching peaks in mid-May, and fledging peaks in mid- to late July. They forage primarily for small mammals while flying or from a perch in dense grass fields, including wet meadows, lightly grazed pastures, grass hayfields, and recently abandoned agricultural fields (NatureServe 2006).	Unknown	Unknown	Unknown	Unknown
MIGRATORY BIRDS																		
American bittern	Botaurus lentiginosus	Endangered	Not Listed	■	■								No	During migration, found in areas of dense, emergent, wetland vegetation, such as lake and pond edges; they forage on fish, crayfish, amphibians, mice and shrews, insects, and other animals (NatureServe 2006).	Rare	Accidental	Accidental	–
Bald eagle	Haliaeetus leucocephalus	Endangered	Threatened	■	■								No	Use tall trees near water for roosting and foraging during migration; avoid areas of human disturbance. They feed primarily on fish but also eat waterfowl, shorebirds, and carrion (NatureServe 2006).	Rare	Rare	Accidental	–
Black-crowned night heron	Nycticorax nycticorax	Endangered	Not Listed	■	■								No	Roost in wooded wetlands. Forage in shallow water for fish, amphibians, and invertebrates and on land for small mammals and young birds (NatureServe 2006).	Uncommon	Uncommon	Uncommon	Uncommon
Double-crested cormorant	Phalacrocorax auritus	Extirpated	Not Listed	■	■								No	During migration, they roost in trees. They forage in aquatic habitats by diving for fish (NatureServe 2006).	Common	–	Abundant	Rare
Great egret	Ardea alba	Special Concern	Not Listed	■	■					■	■		No	Commonly found in marshes, wooded wetlands, and shallow water of ponds, as well as in fields. They forage for fish, amphibians, snakes, snails, crustaceans, insects, and small mammals (NatureServe 2006).	Uncommon	Rare	Uncommon	–
Henslow's sparrow	Ammodramus henslowii	Endangered	Not Listed							■	■	■	No	During migration, they are found in grassy areas adjacent to pine woodlands or second-growth woodlands. They forage on the ground for insects, spiders, and seeds of herbaceous plants (NatureServe 2006).	Accidental	–	Accidental	–
Loggerhead shrike	Lanius ludovicianus	Endangered	Not Listed							■	■	■	No	Prefer open areas with scattered trees and primarily forage from a perch but also by hovering or walking. They eat primarily large insects (especially beetles and orthopterans), other invertebrates, small birds, lizards, frogs, and rodents in habitat (NatureServe 2006).	Rare	Accidental	–	–
Northern harrier	Circus cyaneus	Endangered	Not Listed	■						■	■	■	No	During migration, they forage over open land or marshes, capturing prey on ground. They roost on agricultural lands and old fields and eat small mammals (especially voles and cotton rats), small and medium-size birds (especially passerines), and some reptiles, amphibians, large insects, and carrion (NatureServe 2006).	Uncommon	Rare	Uncommon	Rare

Common Name	Scientific Name	State Status	Federal Status	National Lakeshore Communities[1]: Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Breeds within Area?[2]	Natural History Information	Local Abundance[3]: Spring (March-May)	Summer (June-August)	Fall (September-November)	Winter (December-February)
Piping plover	Charadrius melodus	Endangered	Endangered				■						No	Forage along open shoreline areas, avoiding vegetated beaches and eating worms, fly larvae, beetles, crustaceans, mollusks, and other invertebrates. Typically leave breeding grounds in the Great Lakes region from mid-July through early September and return beginning in mid-February through March (NatureServe 2006).	Accidental	Accidental	Accidental	–
Upland sandpiper	Bartramia longicauda	Endangered	Not Listed	■						■	■	■	No	Forage on the ground in grassy fields with low vegetation, eating insects and other small invertebrates (NatureServe 2006).	Rare	–	–	–
Western meadowlark	Sturnella neglecta	Special Concern	Not Listed							■	■	■	No	Forage on the ground in open, treeless areas for invertebrates (beetles, cutworms, caterpillars, grasshoppers, spiders, sow bugs, snails, etc.); also eat some grain and seeds (NatureServe 2006).	Rare	Rare	–	–
Wilson's phalarope	Phalaropus tricolor	Extirpated	Not Listed	■	■					■	■		No	Forage for insects along lakeshores, mudflats, and freshwater marshes, by walking along muddy shores, wading in shallow water, or swimming in whirls.	Accidental	Accidental	Accidental	–
Yellow-crowned night heron	Nyctanassa violacea	Endangered	Not Listed	■	■								No	Forage in shallows or among marsh vegetation, primarily for crayfishes and other small aquatic animals (NatureServe 2006).	Accidental	Accidental	Accidental	Accidental
Yellow-headed blackbird	Xanthocephalus xanthocephalus	Endangered	Not Listed	■								■	No	Primarily found in cultivated lands, pastures, and fields during migration. They forage for insects, seeds, and grains in fields and on muddy ground near water (NatureServe 2006).	Accidental	–	–	–

[1] National lakeshore communities adapted from NatureServe 2006.
[2] Breeding information from NPS 2002d.
[3] Abundance defined as follows (from NPS 2002d):
Abundant: Almost always seen or heard in habitat.
Common: Often seen or heard in habitat.
Uncommon: Sometimes seen or heard in habitat.
Rare: At least one individual present.
Accidental: Not present every year.
–: Not known to occur

TABLE 28: SENSITIVE AND RARE FISH, REPTILES, AND AMPHIBIANS OF INDIANA DUNES NATIONAL LAKESHORE

				National Lakeshore Communities[1]										
Common Name	Scientific Name	State Status	Federal Status	Aquatic/ Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Natural History Information	Local Abundance[2]
FISH														
Lake sturgeon	Acipenser fulvescens	Endangered	Not Listed	■									Primary habitat is the bottom of large, clean, freshwater rivers and lakes. In the Great Lakes region, these fish live in shoals (shallow waters with sandy substrates). Spawning general occurs in spring or early summer, and eggs hatch within days of spawning. They feed on small, bottom-dwelling aquatic invertebrates (NatureServe 2006).	Unknown
Popeye shiner	Notropis ariommus	Extirpated	Not Listed	■									Limited information is available. Found in warm, relatively clear, flowing waters of large creeks and small-to-medium rivers, closely associated with gravel substrate. Spawning probably occurs from late May to late June. Food habits are unknown (NatureServe 2006).	Unknown
REPTILES														
Blanding's turtle	Emydoidea blandingii2	Endangered	Not Listed	■	■								This turtle primarily breeds from March to May and nests from mid-May to July. Eggs are typically laid in sandy soil in upland areas, usually in warm sunny sites that have been disturbed. Eggs hatch mid-August to October, and juveniles move to preferred habitat within days. They prefer water with soft bottom and aquatic vegetation; hibernation most often occurs within organic substrate of ponds and creeks. They eat aquatic vegetation, invertebrates, fish, fish eggs, frogs, crawfish, and snails (NatureServe 2006).	Uncommon
Butler's garter snake	Thamnophis butleri	Endangered	Not Listed	■	■					■	■	■	This snake prefers open, moist grassy situations, meadows, marshes, margins of lakes and streams in open country, vacant lots, and grassy roadside areas; partly fossorial in summer. They breed in early spring after emerging from hibernation; young are born from July through September. Primarily eats earthworms (NatureServe 2006).	Unknown
Eastern massasauga	Sistrurus catenatus catenatus	Endangered	Candidate	■	■				■	■	■	■	This rattlesnake prefers seasonal wetlands with a mixture of open grass–sedge areas and short closed canopy (edge situations). They breed biennially in late summer, and young are typically born between late July and early September. They are most active from about April to October and are generally inactive during cold periods, hibernating in burrows, rock crevices, and tree root systems. Their primary prey is small mammals, although birds and other snakes may also be eaten (NatureServe 2006).	Occasional
Kirtland's snake	Clonophis kirtlandii	Endangered	Not Listed	■	■				■	■	■	■	This snake often occupies vacant lots associated with streams or wetlands and is most readily found in habitats with abundant debris on the ground surface. Hibernation apparently occurs underground, possibly in crayfish burrows, in or near the wetlands that are inhabited the remainder of the year. Breeding occurs from February to September, and females give birth in late summer or early fall. They mainly eat earthworms (NatureServe 2006).	Presumed extirpated
Ornate box turtle	Terrapene ornata	Endangered	Not Listed		■		■		■	■	■		This turtle is often inactive, burrowing into soil. Eggs are laid from May to mid-July in nests dug in soft. well-drained soil in open areas and hatch approximately 9 to 11 weeks later. They eat mainly insects (especially beetles, grasshoppers, and caterpillars) but also consume worms, carrion, and berries (NatureServe 2006).	Unknown
Smooth green snake	Liochlorophis vernalis	Endangered	Not Listed	■	■				■	■	■	■	Eggs are laid under rotting wood, underground, or under rocks in late June to late July and hatch by mid-August. Primary diet is small terrestrial invertebrates (NatureServe 2006).	Uncommon[3]
Spotted turtle	Clemmys guttata	Endangered	Not Listed	■	■								This turtle favors waters with soft bottom and aquatic vegetation. It often basks along the water's edge, on brush piles in water, and on logs or vegetation clumps. Mating occurs from March to May, and eggs are laid in late May to June in well-drained soil of marshy pasture; in grass, sedge tussock, or mossy hummock; and in open areas (e.g., dirt path or road) at the edge of thick vegetation or a similar site in the sun. Sandy, sparsely vegetated strips and washouts along agricultural field edges are favorable for nesting. Eggs typically hatch from late August through September, and hatchlings eat insects, worms, and snails. The primary adult diet includes various aquatic and terrestrial invertebrates (NatureServe 2006).	Uncommon
Western ribbon snake	Thamnophis proximus	Special Concern	Not Listed	■	■								This semi-aquatic snake is often found in vegetation at the water's edge. It mates in April or May and gives birth from July to October. It hibernates in rock crevices and burrows. This snake primarily eats frogs, toads, tadpoles, salamanders, fish, insects, and earthworms (Illinois Natural History Survey 2004; NatureServe 2006).	Uncommon
AMPHIBIANS														
Blue-spotted salamander	Ambystoma laterale	Special Concern	Not Listed	■	■				■				Generally associated with lowland swamps and marshes and surrounding uplands with sandy or loamy soils. Eggs are laid from March to April and are attached to submerged sticks or the bottom of shallow forest ponds and pools. Metamorphosis occurs from late June through August, or larvae may overwinter. Larvae eat small aquatic animals (zooplankton and benthic invertebrates). Adults are typically found underground or under objects and eat snails, earthworms, beetles, beetle larvae, springtails, spiders, and other small invertebrates (NatureServe 2006).	Common
Four-toed salamander	Hemidactylium scutatum	Endangered	Not Listed	■	■				■				Sphagnum moss is commonly abundant in a suitable habitat. Eggs are laid in moss or other protected sites immediately above or next to a pool. They breed in the fall and lay eggs in the spring. Eggs hatch after approximately two months, and the aquatic larvae metamorphose by late summer. Larvae eat small aquatic invertebrates. and adults eat a variety of small terrestrial invertebrates (NatureServe 2006).	Uncommon
Mudpuppy	Necturus maculosus	Special Concern	Not Listed	■									Found in permanent lakes, ponds, impoundments, streams, and rivers and spawn in spring or early summer. Eggs are attached to undersides of objects in water and hatch in approximately 5 to 9 weeks. They feed opportunistically on small aquatic animals (NatureServe 2006).	Unknown
Northern leopard frog	Rana pipiens	Special Concern	Not Listed	■	■					■	■		Usually found in permanent water with rooted aquatic vegetation. In summer, they commonly inhabit wet meadows and fields. Typically, they overwinter underwater. Eggs are typically laid in April, and larvae develop during summer in shallow, still, permanent water (typically), generally in areas well exposed to sunlight. Larvae may overwinter and eat algae, plant tissue, organic debris, and probably some small invertebrates. Adults eat various small invertebrates and rarely eat small vertebrates (NatureServe 2006).	Uncommon

[1] National lakeshore communities adapted from NatureServe. 2006.
[2] Abundance defined as follows (NPS 2006d):
Common: May be seen daily, in suitable habitat and season, but not in large numbers. Uncommon: Likely to be seen monthly in appropriate season/habitat. May be locally common.
Occasional: Occurs in the national lakeshore at least once every few years but not necessarily every year. Unknown: Abundance unknown.
[3] Abundance for the smooth green snake taken from NPS 1981 and is not defined.

TABLE 29: SENSITIVE AND RARE MAMMALS OF INDIANA DUNES NATIONAL LAKESHORE

Common Name	Scientific Name	State Status	Federal Status	National Lakeshore Communities[1]: Aquatic/Herbaceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Natural History Information	Local Abundance[2]
Franklin's ground squirrel	Spermophilus franklinii	Endangered	Not Listed				■			■	■	■	These squirrels have a strong affinity for tallgrass prairies and the "edge" between open areas and weeds; less than 10% of their time is spent aboveground. Breeding occurs in spring, immediately after emerging from hibernation (which begins in September). Nests are built in underground burrows, and their young are born in May or June. They eat fruits, seeds, grains, and insects (NatureServe 2006).	Uncommon*
Indiana bat	Myotis sodalis	Endangered	Endangered		■	■			■				These bats prefer dead or dying trees for roost and maternity sites and hibernate in caves. Mating occurs from late August to early October in caves, before hibernation or in the spring. Young are born in June or July in hollow trees or under loose bark of living or dead trees. Typical prey includes flying insects (NatureServe 2006).	Rare*
Least weasel	Mustela nivalis	Special Concern	Not Listed	■	■	■	■	■	■	■	■	■	The least weasel generally avoids deep, dense forest and breeds in spring and summer. They spend time underground in burrows when inactive. Young are born after approximately 33 to 37 days, in abandoned underground burrows made by other mammals. Their primary prey is small mammals (NatureServe 2006).	Rare
Star-nosed mole	Condylura cristata	Special Concern	Not Listed	■	■								These moles prefer wet soils in floodplains, swamps, meadows, and other openings near water. Tunnels may be shallow or deep and may open at ground surface or underwater. Breeding occurs in late winter to early spring. Nests are usually placed in a hummock, under a stump or log, in humus among rotten tree roots, or in other areas above high water, often near a stream. Young are born in spring or early summer. They primarily eat invertebrates (NatureServe 2006).	Unknown

[1] National lakeshore communities adapted from NatureServe 2006.
[2] Abundance defined as follows (NPS 2006d):
Rare: Present but usually seen only a few times each year.
Unknown: Abundance unknown.
NA: Not available.

* Abundance taken from NPS 1981, which defines rare as "very seldom encountered" but does not define uncommon or common.

TABLE 30: SENSITIVE AND RARE PLANTS OF INDIANA DUNES NATIONAL LAKESHORE

Common Name	Species	State Status	Federal Status	National Lakeshore Community[1]: Aquatic/Herba-ceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Natural History Information[2]: Description	Flowering Period	Palatability to White-Tailed Deer[3]: Palatable?	Explanation	Local Abun-dance[4]
American bluehearts	Buchnera americana	SE	Not listed					■		■			This is a perennial herb, fire-maintained species that occupies sandy or gravelly upland woods or prairies (NatureServe 2006).	July–Sept.	Unknown	No information.	Rare
American golden saxifrage	Chrysosplenium americanum	ST	Not listed		■				■				This perennial forb/herb requires moist or wet soil and can grow in semi-shade (light woodland) or no shade (Plants for a Future 2003).	April–May		White-tailed deer not listed as a browse animal for this species (Martin et al. 1951).	Uncommon
American millet grass	Milium effusum	SR	Not listed		■				■				This perennial grass is found in springs and wetlands, as well as forests and floodplain forests (Iverson et al. 1999).	June–Aug.	√	Not considered "deer resistant" (Crescent Bloom 2004).	Rare
American wintergreen	Pyrola americana	SR	Not listed				■	■	■				This perennial forb is found in upland forests, woods, and clearings (Iverson et al. 1999; Fernald 1950).	July–Aug.	√	Considered "not resistant" (Crescent Bloom 2004). Wintergreen foliage used by white-tailed deer. Wintergreen constitutes 5-10% white-tailed deer diet in the states of PA, WI, and MN (Martin et al. 1951).	Uncommon

TABLE 30: SENSITIVE AND RARE PLANTS OF INDIANA DUNES NATIONAL LAKESHORE

Common Name	Species	State Status	Federal Status	National Lakeshore Community[1]									Natural History Information[2]		Palatability to White-Tailed Deer[3]		Local Abundance[4]
				Aquatic/Herba-ceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Description	Flowering Period	Palatable?	Explanation	
American wisteria	Wisteria frutescens	SR	Not listed						■				This deciduous, climbing vine requires moist soil found in woodland edges (Plants for a Future 2003).	June–Aug.	√	Considered "not resistant" (Crescent Bloom 2004). USDA rates this species as having high palatability for browse animals (USDA 2006b; NRCS 2006).	Rare
Baltic rush	Juncus balticus var. littoralis	SR	Not listed	■		■							Perennial rush requiring moist or wet soils, usually saline conditions. Can grow in water (Plants for a Future 2003).	June–Aug.	√	Juncus spp. not considered "deer resistant" (Crescent Bloom 2004).	Common
Bayonet rush	Juncus militaris	SE	Not listed	■		■							Perennial herb found in mucky bottoms of shallow lakes and rivers; wet shores; and sandy, gravelly, or peaty margins of lakes and ponds, usually in standing water (eFlora n.d.; Fernald 1950).	June–Sept.	√	Juncus spp. not considered "deer resistant" (Crescent Bloom 2004).	NA
Beach pea	Lathyrus japonicus var. maritimus	SE	Not listed				■						Perennial forb found along Lake Michigan beaches and national lakeshore foredunes (Iverson et al. 1999)	June–Aug.	√	Lathyrus spp. not considered "deer resistant" (Crescent Bloom 2004).	Uncommon
Bebb's sedge	Carex bebbii	ST	Not listed	■		■				■			Perennial grass found in wetlands, prairies, and lake borders (Iverson et al. 1999). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	June–Aug.	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered "deer resistant" (Crescent Bloom 2004). USDA rates this specific species as having "low" palatability for browse animals (USDA 2006b; NRCS 2006).	Uncommon
Bicknell's cranesbill	Geranium bicknellii	SE	Not listed					■		■	■		Annual/biennial herb found in dry, sandy, or gravelly ground; open woods; clearings; and disturbed sites (ODNR 2006).	July–Sept.	Unknown	No information.	Rare
Blackfruit spikerush	Eleocharis melanocarpa	ST	Not listed	■									Perennial grass (USDA 2006b; NRCS 2006) found in fresh, oligotrophic, acid, sandy or peaty, often drying shores, ponds, ditches, sandy or peaty shores, and pine barrens (eFlora n.d.; Fernald 1950). Some spikerush species are present near margins of aquatic areas (Martin et al. 1951).	June–Oct.		White-tailed deer not listed as a browse animal for this species (Martin et al. 1951).	Rare
Blackseed ricegrass	Piptatherum racemosum	ST	Not listed				■						Perennial grass found on limestone wooded slopes and along ledges and ravines in rocky, sandy soil (Iverson et al. 1999).	July–Sept.	√	Ricegrass species are "extensively browsed" by mule deer; less so by white-tailed deer. Constitutes 0.5-2% of white-tailed deer diet in WI. (Martin et al. 1951).	Rare
Blackseed speargrass	Piptochaetium avenaceum	ST SR?	Not listed				■		■	■			Herbaceous perennial found in dry woods, especially oak woods, and dry openings (ODNR 2006).	April–June	√	Stipa species are "consumed by hoofed browsers," including mule deer and white-tailed deer. Constitutes 0.5-2% of white-tailed deer diet in TX (Martin et al. 1951).	Rare
Bluebead	Clintonia borealis	SE	Not listed		■				■				Perennial forb/herb requiring moist soil and found in woodlands and thickets (Plants for a Future 2003; Fernald 1950).	May–Aug.	√	Not considered "deer resistant" (Crescent Bloom 2004).	Rare
Bog bluegrass	Poa paludigena	WL	Not listed	■	■								Perennial grass found in wetlands and bogs (Iverson et al. 1999).	June–July	Unknown	No information.	Rare
Bog rosemary	Andromeda polifolia var. glaucophylla	SR	Not listed	■									Evergreen shrub found in bogs, peats, and margins of pools (Plants for a Future 2003).	April–June	Unknown	No information.	Rare
Bristleleaf sedge	Carex eburnea	SR	Not listed	■			■		■				Perennial grass found in rocky soil in low sand ridges by Lake Michigan in upland oaks and northern hardwood forests (Iverson et al. 1999). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	May–Aug.	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered "deer resistant" (Crescent Bloom 2004).	Rare
Bristly sarsaparilla	Aralia hispida	SE	Not listed				■						Deciduous shrub found in rocky or sandy, sterile soils (Plants for a Future 2003).	May–June	Unknown	Aralia spp. eaten by "a few mammals"; no specific information about white-tailed deer (Martin et al. 1951).	Uncommon
Brownfruit rush	Juncus pelocarpus	ST	Not listed				■						Perennial herb found in shores, peat bogs, sandy soils, pools, damp shores, pools, and wet sand; occasionally submersed in lakes (eFlora n.d.; Fernald 1950).	July–Sept.	√	Juncus spp. not considered "deer resistant" (Crescent Bloom 2004).	Rare

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Common Name	Species	State Status	Federal Status	National Lakeshore Community[1]: Aquatic/Herba-ceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Natural History Information[2]: Description	Flowering Period	Palatability to White-Tailed Deer[3]: Palatable?	Explanation	Local Abun-dance[4]
Bunchberry dogwood	Cornus canadensis	SE	Not listed	■	■								Perennial forb found in forested wetlands and bogs and sandstone cliffs and bluffs (Iverson et al. 1999).	May–June	√	Genus cornus constitutes 2-5% of white-tailed deer diet in WI, MN, NY, NC, AL, SD, although deer are not listed as browse animals for this species specifically, which is considerably distinct from other dogwoods (Martin et al. 1951). Cornus spp. considered "not deer resistant" (Crescent Bloom 2004). USDA rates this specific species as having "low" palatability for browse animals (USDA 2006b; NRCS 2006).	Rare
Canada spikesedge	Eleocharis geniculata	ST	Not listed	■		■							Annual grass found in wet sand in limestone marsh borders (Iverson et al. 1999).	June–Sept.		White-tailed deer not listed as a browse animal for this species (Martin et al. 1951).	Uncommon
Clinton's woodfern	Dryopteris clintoniana	SX	Not listed	■	■								Shade-tolerant perennial forb/herb found in swamp woods (ODNR 2006). Dryopteris cristata found in forest thickets, wetlands, marshes, swamps, and bogs (Iverson et al. 1999).	July–Aug.	√	"Members of this genus are rarely, if ever, troubled by browsing deer" (Plants for a Future 2003). Ferns in general browsed by deer in seasons when other green plants are scarce. Ferns constitute 2-5% of white-tailed deer diet in PA, WI, MN, and NC (Martin et al. 1951).	Common
Clustered broomrape	Orobanche fasciculata	SE	Not listed				■			■			Perennial forb found in dry sand prairies (Iverson et al. 1999).	June	Unknown	No information.	Rare
Coastal jointweed	Polygonella articulata	SR	Not listed				■						Annual forb found in shores along Lake Michigan in bare sand areas, lakeshores, and beaches (Iverson et al. 1999).	July–Oct.	Unknown	No information.	Common
Cream pea	Lathyrus ochroleucus	SE	Not listed				■	■		■			Perennial herb found in dry upland woods, thickets, wooded slopes, and rocky banks (ODNR 2006).	May–July	√	Lathyrus spp. not considered "deer resistant" (Crescent Bloom 2004).	Rare
Creeping sedge	Carex chordorrhiza	SE	Not listed	■		■							Perennial grass found in wetlands and bogs (Iverson et al. 1999). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	May–June	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. ranked overall as "not deer resistant" (Crescent Bloom 2004).	Rare
Cypress panicgrass	Dichanthelium dichotomum var. dichotomum	SE	Not listed	■	■				■	■			Perennial grass found in forests, savannas, and glades (Iverson et al. 1999).	May–Oct.	√	Panicgrasses (Dishanthelium aka Panicum) constitute 0.5-2% white-tailed deer diet in AL (Martin et al. 1951).	Rare
Deeproot clubmoss	Lycopodium tristachyum	ST	Not listed				■	■		■			Perennial small shrub/forb/herb requiring moist soil in coniferous woods and dry siliceous (containing silica) or acidic woods, thickets, and clearings (Plants for a Future 2003; USDA, NRCS 2006; Fernald 1950).	June–Sept.	Unknown	No information.	Rare
Drummond's halfchaff sedge	Lipocarpha drummondii	SX	Not listed	■						■			Annual grass found in sand plains influenced by high water tables, although seldom covered by surface water (ODNR 2006).	July–Oct.	√	White-tailed deer considered "most destructive" to woodland orchid species (Iowa Natural Heritage Program 2006). Many orchids are palatable to deer (Stuckey 1967).	Rare
Dwarf umbrella-sedge	Fuirena pumila	ST	Not listed	■						■			Annual herb found in moist-to-wet pond shores; seeps; savannas and swales; moist, sandy places; bogs; and wet, peaty or sandy shores (eFlora n.d.; Fernald 1950).	July–Oct.	Unknown	No information.	Rare
Elk sedge	Carex garberi	ST	Not listed	■		■							Perennial grass found in a variety of wet, open situations; limestone exposures; quarries; seepages; beach pools; and interdunal swales (ODNR 2006). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	May–June	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered "deer resistant" (Crescent Bloom 2004).	Uncommon
Fireweed	Chamerium angustifolium	SE	Not listed					■	■	■			Perennial forb/herb found in rocky ground and woodland edges in well-drained soil. Can grow in semi-shade (light woodland) or no shade (Plants for a Future 2003).	July–Sept.	√	Epilobium species constitute 2-5% of black-tailed deer diet in OR. "It is probable that fireweed is used by western hoofed browsers to a greater extent" (Martin et al. 1951). Not considered "deer resistant" (Crescent Bloom 2004).	NA
Forked aster	Eurybia furcata	SR	Not listed	■					■				Perennial forb found in woods and edges in upland forests, wetland seeps and springs, and bluffs (Iverson et al. 1999).	Aug.–Oct.	√	Aster spp. considered "not deer resistant" (Crescent Bloom 2004). Asters constitute 2-5% of white-tailed deer diet in NE.	Rare
Forked bluecurls	Trichostema dichotomum	SR	Not listed							■			Annual forb found along edges of fields, gravelly or sandy railroad ballast, and sandy black oak woods (Iverson et al. 1999).	Aug.–Oct.		White-tailed deer not listed as a browse animal for this species (Martin et al. 1951).	Uncommon

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Common Name	Species	State Status	Federal Status	National Lakeshore Community[1]									Natural History Information[2]		Palatability to White-Tailed Deer[3]		Local Abundance[4]
				Aquatic/Herba-ceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Description	Flowering Period	Palatable?	Explanation	
Gaywings	Polygala paucifolia	SE	Not listed				■	■					Perennial forb found in upland forests and woods in light soil (Iverson et al. 1999; Fernald 1950).	May–June	Unknown	No information.	Rare
Globe beaksedge	Rhynchospora globularis	SE	Not listed	■									Perennial grass found in peaty, sandy, or clayey depressions (USDA 2006b; NRCS 2006; Fernald 1950).	June–July	Unknown	No information.	Unknown
Globefruit primrose-willow	Ludwigia sphaerocarpa	SE	Not listed	■	■								Perennial herb found in sandy and peaty pond margins and swamps (Fernald 1950).	July–Sept.	Unknown	No information.	Rare
Golden sedge	Carex aurea	SR	Not listed	■		■							Perennial grass found in a variety of wet, open situations on calcareous or sandy substrates, wet prairies, fens, meadows, beach pools, and interdunal swales (ODNR 2006). In general, species of Carex primarily grow in moist soils of meadows, marshes, amd bogs and near ditches and roadsides (Martin et al. 1951).	May–June	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered “deer resistant” (Crescent Bloom 2004). USDA rates this specific species as having “low” palatability for browse animals (USDA 2006b; NRCS 2006).	Rare
Goosefoot cornsalad	Valerianella chenopodiifolia	SE	Not listed		■				■				Annual forb found in moist habitats of upland and floodplain forests (Iverson et al. 1999).	April–June	Unknown	No information.	Rare
Gray birch	Betula populifolia	SX	Not listed		■		■						Perennial, deciduous tree found in margin of swamps and ponds and dry sandy or gravelly, barren soils (Plants for a Future 2003).	April	√	Birches constitute 2-5% of white-tailed deer diet in NY State (Martin et al. 1951). USDA rates this species as having medium palatability for browse animals; white-tailed deer browse the twigs (USDA 2006b; NRCS 2006).	Rare
Green adder's-mouth orchid	Malaxis unifolia	SR	Not listed		■		■	■					Perennial forb found in forested upland slopes or ridges, ravine bottoms, and lake borders (Iverson et al. 1999).	June–Aug.	√	White-tailed deer considered “most destructive” to woodland orchid species (Iowa Natural Heritage Program 2006). Many orchids are palatable to deer (Stuckey 1967).	Rare
Ground juniper	Juniperus communis var. depressa	SR	Not listed				■	■					Drought-tolerant, perennial evergreen shrub found in semi-shade woodlands or no shade (Plants for a Future 2003).	May–June	√	Junipers constitute 5-10% white-tailed deer diet in the states of TX, MT, and MO (Martin et al. 1951). Not considered “deer resistant” (Crescent Bloom 2004). Palatability for white-tailed deer ranges from “poor” to “low-medium” in some western states (USFS 2004).	Uncommon
Grove bluegrass	Poa alsodes	SR	Not listed						■				Perennial grass found in ravines bordering Lake Michigan, in upland forests, and in sandstone cliffs and bluffs (Iverson et al. 1999).	May–June	√	Bluegrass leaves are browsed by “big game”; white-tailed deer not specifically mentioned. Constitutes 5-10% of mule deer diet in the states of MT, SD, and CA (Martin et al. 1951).	Uncommon
Hall's bulrush	Schoenoplectus hallii	SE	Not listed	■									Annual grass found along shores and in bottoms of shallow, ephemeral ponds kept free of other vegetation by fluctuating water levels (Iverson et al. 1999).	Aug.–Oct.	Unknown	Tolerates “heavy grazing” (no mention of browsing) (NatureServe 2006).	Rare
Heartleaf willow	Salix cordata	ST	Not listed				■						Perennial shrub found in peaty, sandy depressions (USDA 2006b; NRCS 2006; Fernald 1950).	June–July	√	“Hoofed browsers” eat twigs, foliage, and bark of willows. Constitutes 5-10% of white-tailed deer diet in the states of PA, MT, NY, WI, and MN (Martin et al. 1951). Salix spp. considered “not deer resistant (Crescent Bloom 2004).	Rare
Heavy sedge	Carex gravida	SE	Not listed				■			■			Perennial grass found in prairie swales, dry open banks, and open woods (Iverson et al. 1999). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	May–June[2]	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. ranked overall as “not deer resistant” (Crescent Bloom 2004).	NA
Hemlock rosette grass	Dichanthelium sabulorum var. thinium	SR	Not listed					■	■	■			Perennial grass found in dry sand forests, sandstone glades, rocky sandstone cliffs and bluffs, dry or sandy open ground, or woods (Iverson et al. 1999; Fernald 1950).	May–July	√	Panicgrasses (Dishanthelium aka Panicum) constitute 0.5-2% of white-tailed deer diet in the state of AL (Martin et al. 1951).	Uncommon
Hooker's orchid	Platanthera hookeri	SX	Not listed						■				Perennial forb found in upland mesic forests (Iverson et al. 1999).	May–June	√	White-tailed deer considered “most destructive” to woodland orchid species (Iowa Natural Heritage Program 2006). Many orchids are palatable to deer (Stuckey 1967).	Rare
Houghton's flatsedge	Cyperus houghtonii	SR	Not listed				■				■		Perennial grass found in light, sandy soil of developed land (Iverson et al. 1999).	July–Oct.		White-tailed deer not listed as browse animal for this species (Martin et al. 1951).	Uncommon
Inundated clubmoss	Lycopodiella inundatum	SE	Not listed	■	■								Perennial forb found in wetlands; swamps and bogs; and damp, peaty, or sandy shores (Iverson et al. 1999; Fernald 1950).	July–Aug.	Unknown	No information.	Uncommon

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				National Lakeshore Community[1]									Natural History Information[2]		Palatability to White-Tailed Deer[3]		
Common Name	Species	State Status	Federal Status	Aquatic/Herba-ceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Description	Flowering Period	Palatable?	Explanation	Local Abun-dance[4]
Jointleaf rush	Juncus articulatus	SE	Not listed	■									Perennial grass with high moisture-use requirements found on wet ground (USDA 2006b; NRCS 2006; Fernald 1950).	July–Aug.	√	USDA rates this species as having low palatability for browse animals (USDA 2006b; NRCS 2006). Juncus spp. not considered “deer resistant” (Crescent Bloom 2004).	Rare
Kinnikinnick	Arctostaphylos uva-ursi coactilis	SR	Not listed				■	■					Evergreen shrub found in dry, open woods and sand dunes (Plants for a Future 2003).	April–July	√	Evergreen foliage is extensively browsed by deer (Martin et al. 1951). Not considered “deer resistant” (Crescent Bloom 2004).	Common
Leathery grapefern	Botrychium multifidum	SX	Not listed					■	■	■	■		Perennial forb found in dry, sandy forests and savannas; peaty, loamy, or gravelly slopes; plains, thickets, and clearings, as well as abandoned forage land (Iverson et al. 1999; Fernald 1950).	Aug.–Sept.	√	Grapeferns eaten by “several wildlife species” in seasons when other green plants are scarce. Constitutes 2-5% of white-tailed deer diet in the states of PA, WI, MN, and NC (Martin et al. 1951).	Rare
Lesser purple fringed orchid	Platanthera psycodes	SR	Not listed		■				■				Perennial forb found in wet depressions in woodlands, in sites inundated with springs (Iverson et al. 1999).	July–Aug.	√	White-tailed deer considered “most destructive” to woodland orchid species (Iowa Natural Heritage Program 2006). Many orchids are palatable to deer (Stuckey 1967).	Uncommon
Lesser yellow lady's slipper	Cypripedium parviflorum	SR	Not listed	■						■			Perennial forb found in prairies, wetlands, and bogs (Iverson et al. 1999).	May–June	√	Not considered “deer resistant” (Crescent Bloom 2004).	NA
Limestone calamint	Clinopodium arkansanum	SE	Not listed	■		■				■			Perennial forb found in rocky, wet, moist soils and sand flats of prairies, savannas, wetlands, and limestone glades and bluffs (Iverson et al. 1999).	May–Oct.[2]	Unknown	No information.	Rare
Little evening primrose	Oenothera perennis	ST	Not listed							■			Perennial forb found in rocky prairie slopes and knobs, open woods, and meadows (Iverson et al. 1999).	June–Aug.		Oenothera spp. considered deer resistant (GardenWeb 2006).	Rare
Little grapefern	Botrychium simplex	SE	Not listed					■		■	■	■	Perennial forb found in grassy meadows, as well as upland and sand forests, thickets, prairies, pastures, open shores, and successional fields (Iverson et al. 1999; Fernald 1950).	May–June	√	Grapeferns eaten by “several wildlife species” in seasons when other green plants are scarce. Constitutes 2-5% of white-tailed deer diet in the states of PA, WI, MN, and NC (Martin et al. 1951).	Rare
Longbeak beaksedge	Rhynchospora scirpoides	ST	Not listed	■	■					■			Annual grass found in moist to wet sands or peats of banks of streams and ditches, ponds and lakeshores, depressions in savannas, marshes, peaty and sandy shores and swamps, often in moist to wet disturbed areas (eFlora n.d.; Fernald 1950)	July–Oct.		White-tailed deer not listed as a browse animal for Rhynchospora (Martin et al. 1951).	Rare
Longstalk sedge	Carex pedunculata	SR	Not listed	■					■				Perennial grass found in wooded forest slopes (Iverson et al. 1999). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	April–May	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered “deer resistant” (Crescent Bloom 2004).	Rare
Low serviceberry	Amelanchier humilis	SE	Not listed				■		■				Deciduous perennial shrub found on moist soils of rocky or sandy shores and banks (Plants for a Future 2003).	April–July	√	Not considered “deer resistant” (Crescent Bloom 2004). “Hoofed browsers” feed on foliage and twigs of certain species of serviceberries, which constitute 2-5% of white-tailed deer diet in the states of SD, PA, NY, and MT (Martin et al. 1951).	Rare
Matricary grapefern	Botrychium matricariifolium	ST	Not listed				■	■	■	■	■		Perennial forb found in dry upland forests and grassy meadows, woods, thickets, and dry to moist old fields (Iverson et al. 1999; Fernald 1950).	June–July	√	Grapeferns eaten by “several wildlife species” in seasons when other green plants are scarce. Constitutes 2-5% of white-tailed deer diet in the states of PA, WI, MN, and NC (Martin et al. 1951).	Rare
Michaux's stitchwort	Minuartia michauxii var michauxii	SR	Not listed							■			Perennial herb found in full sun in well-drained calcareous situations, often on nearly vertical rock exposures, quarries, prairies, and rocky slopes (ODNR 2006).	May–June (fruits June–July)	Unknown	No information.	Uncommon
Mountain ricegrass	Piptatherum pungens	SX	Not listed				■						Perennial grass found in rocky, sandy, or peaty soil (USDA 2006b; NRCS 2006; Fernald 1950).	April–June	√	Ricegrass species are “extensively browsed” by mule deer; less so by white-tailed deer. Constitutes 0.5-2% of white-tailed deer diet in the state of WI. (Martin et al. 1951).	Rare
Mud sedge	Carex limosa	SE	Not listed	■									Perennial grass found in wetlands, bogs, and sedge meadows (Iverson et al. 1999). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	May–Aug.	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered “deer resistant” (Crescent Bloom 2004). USDA rates this specific species as having “low” palatability for browse animals (USDA 2006b; NRCS 2006).	Rare

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				National Lakeshore Community[1]									Natural History Information[2]		Palatability to White-Tailed Deer[3]		
Common Name	Species	State Status	Federal Status	Aquatic/Herba-ceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Description	Flowering Period	Palatable?	Explanation	Local Abun-dance[4]
Needlepod rush	Juncus scirpoides	ST	Not listed	■	■	■							Perennial grass found in wet prairies, wetlands, and swamps (Iverson et al. 1999).	July–Aug.	√	Juncus spp. not considered “deer resistant” (Crescent Bloom 2004). USDA rates this species as having “low” palatability for browse animals (USDA 2006b; NRCS 2006).	Common
Nerveless woodland sedge	Carex leptonervia	SE	Not listed	■	■								Perennial grass found in rich, deciduous, mixed or hemlock woods and occasionally in cedar swamps and bogs (NatureServe 2006). In general, species of Carex primarily grow in moist soils of meadows, marshes and bogs and near ditches and roadsides (Martin et al. 1951).	May–July	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered “deer resistant” (Crescent Bloom 2004). USDA rates this specific species as having “low” palatability for browse animals (USDA 2006b; NRCS 2006).	Uncommon
Netted chainfern	Woodwardia areolata	SR	Not listed		■								Perennial forb found in shade or semi-shade in wet, peaty situations; swamp woods; floodplains; thickets; and seeps (ODNR 2006).	July–Sept.	√	Ferns eaten by “several wildlife species” in seasons when other green plants are scarce (Martin et al. 1951).	Rare
Netted nutrush	Scleria reticularis	ST	Not listed	■						■			Annual grass found in moist or wet, sandy or sandy-peaty soil of pond and lake margins; wet savannas; moist swales; and damp, sandy shores and depressions (eFlora n.d.; Fernald 1950).	Aug.–Oct.		White-tailed deer not listed as a browse animal for Scleria species (Martin et al. 1951).	Uncommon
Nodding rattlesnake root	Prenanthes crespidinea	SR	Not listed						■	■			Perennial forb found in rich, moist woods in low ground; open wooded slopes of upland oak; and northern hardwood forests (Iverson et al. 1999).	Aug.–Oct.	√	Deer browse of flower is considered a “threat” (NatureServe 2006).	Rare
Northern bog aster	Symphyotrichum boreale	SR	Not listed	■		■							Perennial forb found in cold bogs and limestone bogs and fens (Iverson et al. 1999).	Aug.–Sept.	√	Aster spp. considered “not deer resistant” (Crescent Bloom 2004). Asters constitute 2-5% of white-tailed deer diet in the state of NE.	Common
Northern bush honeysuckle	Diervilla lonicera	SR	Not listed				■	■	■				Perennial shrub found in rocky, sandy woods and clearings. Tends to grow where vegetation burns occasionally (Iverson et al. 1999).	May–June	√	Not considered “deer resistant” (Crescent Bloom 2004).	Common
Northern catalpa	Catalpa speciosa	SR	Not listed		■				■				Deciduous tree requiring moist soil; found along borders of streams and fertile, often inundated bottomlands and woods (Plants for a Future 2003).	May–June	√	Not considered “deer resistant” (Crescent Bloom 2004).	Common
Northern long sedge	Carex folliculata	ST	Not listed	■	■				■				Perennial grass (USDA 2006b; NRCS 2006) found in wet forests, bogs, seeps, wet meadows, marsh edges, stream banks, and lakeshores, in acidic, sandy, or peaty soils and thickets, swampy woods, and swales (eFlora n.d.; Fernald 1950).	June–Aug.	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered “deer resistant” (Crescent Bloom 2004).	Common
Northern selaginella	Selaginella rupestris	ST	Not listed				■			■			Moss-like evergreen perennial found in open sun on well-drained rock exposures (ODNR 2006), as well as prairies and sandstone glades, cliffs, and bluffs (Iverson et al. 1999).	July–Oct.		Not listed as a browse animal for this species (Martin et al. 1951).	Uncommon
Nuttall's prairie parsley	Polytaenia nuttallii	SE	Not listed							■			Perennial forb found in prairies, savannas, and limestone glades (Iverson et al. 1999).	April–June	Unknown	No information.	Rare
Openfield sedge	Carex conoidea	SE	Not listed	■						■			Perennial grass found in prairies (Iverson et al. 1999). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	May–Aug.	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered “deer resistant” (Crescent Bloom 2004). USDA rates this specific species as having “low” palatability for browse animals (USDA 2006b; NRCS 2006).	Rare
Palegreen orchid	Platanthera flava var. herbiola	SE	Not listed	■	■								Perennial forb found in low woods bordering streams and swamps, marshy meadows, and wooded floodplains (Iverson et al. 1999).	June–July	√	White-tailed deer considered “most destructive” to woodland orchid species (Iowa Natural Heritage Program 2006). Many orchids are palatable to deer (Stuckey 1967).	Uncommon
Pipsissewa	Chimaphila umbellata	ST	Not listed				■	■					Evergreen shrub that grows in full or semi-shaded woodlands in well-drained, acidic soil (Plants for a Future 2003).	July–Aug.	√	Not considered “deer resistant” (Crescent Bloom 2004).	Uncommon
Pitcher's thistle	Cirsium pitcheri	ST	Threatened				■						Biennial forb endemic to areas along the Great Lakes. Found in sand dunes around Lake Michigan (Iverson et al. 1999).	June–July	√	Deer browsing in Canada has been shown to have a severe impact on Pitcher's thistle populations under some circumstances, causing significant reduction in species numbers in lake-level dunes in Ontario (Phillips and Maun 1996, Maun 1999).	Uncommon
Prairie fameflower	Talinum rugospermum	ST	Not listed							■			Perennial forb found in prairies and savannas, dry sands, and sandstone (Iverson et al. 1999; Fernald 1950).	June–Aug.	Unknown	No information.	Uncommon

TABLE 30: SENSITIVE AND RARE PLANTS OF INDIANA DUNES NATIONAL LAKESHORE

Common Name	Species	State Status	Federal Status	National Lakeshore Community[1]									Natural History Information[2]		Palatability to White-Tailed Deer[3]		Local Abundance[4]
				Aquatic/Herba-ceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Description	Flowering Period	Palatable?	Explanation	
Prairie goldenrod	Oligoneuron album	SR	Not listed			■							Perennial forb found in prairies and wetland pannes (Iverson et al. 1999).	Aug.–Sept.	√	Solidago spp. considered “not deer resistant” (Crescent Bloom 2004). Goldenrods constitute 0.5-2% of white-tailed deer diet in the state of PA (Martin et al. 1951).	Uncommon
Prairie pinweed	Lechea stricta	SX	Not listed					■		■			Perennial forb found in dry, sandy forests and prairies (Iverson et al. 1999).	July–Sept.		White-tailed deer not listed as a browse animal for this species (Martin et al. 1951).	Rare
Primrose-leaved violet	Viola primulifolia	SR	Not listed	■									Perennial forb found in wet, moist habitat in wet and shrub prairies (Iverson et al. 1999).	May–June	√	White-tailed deer not listed as a browse animal for this species (Martin et al. 1951). Viola spp. considered both “seldom severely damaged” (Rutgers 2006) and “frequently damaged” by deer (MD Cooperative Extension n.d.), depending on the source.	Rare
Purple flowering raspberry	Rubus odoratus	ST	Not listed				■		■				Deciduous perennial shrub found in moist thickets and woodland borders; requires moist soil (Plants for a Future 2003).	June–Sept.	√	Leaves and stems of Rubus species are “eaten extensively” by deer and constitute 5-10% of white-tailed deer diet in the states of ME, PA, and NY (Martin et al. 1951). Not considered “deer resistant” (Crescent Bloom 2004).	Rare
Rand's goldenrod	Solidago simplex ssp. randii var. gillmanii	ST	Not listed				■						Perennial herb found in granitic, siliceous, or magnesian rocks and gravels near Great Lakes (Fernald 1950).	July–Sept.	√	Goldenrods constitute 2-5% of white-tailed deer diet in the state of PA (Martin et al. 1951). Solidago spp. not considered “deer resistant” (Crescent Bloom 2004).	Uncommon
Rannoch-rush	Scheuchzeria palustris ssp. americana	SE	Not listed	■									Perennial herb found in full sun on sphagnum bog mats (ODNR 2006).	May–June; fruits June–Aug.	Unknown	No information.	Rare
Rare clubmoss	Lycopodium obscurum	SR	Not listed		■				■				Perennial fern requiring moist soil; found in woods, copses, and clearings (Iverson et al. 1999; Fernald 1950).	July–Nov.	√	Lycopodium not considered “deer resistant” (Crescent Bloom 2004).	Rare
Red baneberry	Actaea rubra	SR	Not listed				■		■				Perennial forb/herb found in moist, shady areas, mostly in deciduous forests (Plants for a Future 2003).	June–July	√	Not considered “deer resistant” (Crescent Bloom 2004).	Rare
Rock harlequin	Corydalis sempervirens	SE	Not listed						■	■			Biennial, annual forb found in upland forests, sandstone cliffs and bluffs, and lakeshores (Iverson et al. 1999).	May–Aug.	√	Corydalis spp. considered “rarely damaged” by deer (Rutgers 2006).	Rare
Rough rattlesnake root	Prenanthes aspera	SR	Not listed							■			Perennial forb found in dry, open, and rocky woods; along railroads; and in remnants of dry prairies (Iverson et al. 1999).	Aug.–Sept.	Unknown	No information.	Rare
Roughleaf ricegrass	Oryzopsis asperifolia	SE	Not listed				■						Perennial grass requiring moist soil; cannot grow in shade (Plants for a Future 2003).	April–July	√	Ricegrass species are “extensively browsed” by mule deer; less so by white-tailed deer. Constitutes 0.5-2% of white-tailed deer diet in the state of WI (Martin et al. 1951).	Rare
Roundleaf dogwood	Cornus rugosa	SR	Not listed				■	■	■	■			Perennial shrub distributed in rocky woods. Found in dry, rocky upland forests and national lakeshore foredunes (Iverson et al. 1999).	May only	√	Genus cornus constitutes 2-5% of white-tailed deer diet in WI, MN, NY, NC, AL, and SD (Martin et al. 1951). Cornus spp. considered “not deer resistant” (Crescent Bloom 2004). USDA rates this specific species as having high palatability for browse animals (USDA 2006b; NRCS 2006).	Uncommon
Seaside threeawn	Aristida tuberculosa	SR	Not listed				■			■			Annual grass found primarily along lakeshores and foredunes (Iverson et al. 1999).	Aug.–Sept.	√	Threeawns are browsed by white-tailed deer to an undetermined extent (Martin et al. 1951).	Common
Sevenangle pipewort	Eriocaulon aquaticum	SE	Not listed		■								Herbaceous perennial found in margins of lakes and peaty shores, often in deep water (ODNR 2006).	July–Sept.		No information.	Rare
Shortbeak beaksedge	Rhynchospora nitens	SX	Not listed	■			■			■			Annual grass found in moist to wet sands or peats of stream banks, pond shores, depressions in savannas, and marshes (eFlora n.d.; Fernald 1950)	Aug.–Oct.		White-tailed deer not listed as a browse animal for Rhynchospora (Martin et al. 1951).	Rare
Sidebills wintergreen	Orthilia secunda	SX	Not listed				■	■					Perennial evergreen, low-growing shrub requiring moist soil; found in damp, coniferous woods (Plants for a Future 2003).	July–Aug.	√	Wintergreen foliage used by white-tailed deer. Wintergreen constitutes 5-10% of white-tailed deer diet in the states of PA, WI, and MN (Martin et al. 1951).	Rare
Slickseed fuzzybean	Strophostyles leiosperma	ST	Not listed				■			■	■		Annual vine/forb found in upland and sand forests, prairies, glades, fields, and developed lands (Iverson et al. 1999).	July–Sept.	√	unknown	NA

TABLE 30: SENSITIVE AND RARE PLANTS OF INDIANA DUNES NATIONAL LAKESHORE

				National Lakeshore Community[1]									Natural History Information[2]		Palatability to White-Tailed Deer[3]		
Common Name	Species	State Status	Federal Status	Aquatic/Herba-ceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Description	Flowering Period	Palatable?	Explanation	Local Abun-dance[4]
Slimspike threeawn	Aristida longispica	SR	Not listed							■	■	■	Annual grass found in sandy soil; rocky, dry open woods and prairies; bluff edges; savannas; successional and agricultural fields; developed land; and sandy open ground (Iverson et al. 1999).	Aug.–Oct.	√	Three-awns are browsed by white-tailed deer to an undetermined extent (Martin et al. 1951).	Uncommon
Small enchanter's nightshade	Circaea alpina	SX	Not listed	■	■								Perennial forb found in forests and limestone cliffs and bluffs (Iverson et al. 1999).	May–July		Fruits of nightshades in general are eaten by wildlife, but white-tailed deer are not listed as a browse animal for this species (Martin et al. 1951).	Rare
Small floating mannagrass	Glyceria borealis	SE	Not listed	■									Herbaceous perennial found in wet places and shallow water (ODNR 2006).	June–July		White-tailed deer not listed as a browse animal for this species (Martin et al. 1951). USDA shows no browse animal rating but rates this species as having high palatability for grazing animals (USDA 2006b; NRCS 2006).	Uncommon
Smallfruit spikerush	Eleocharis microcarpa	SE	Not listed	■									Grasslike perennial herb found in damp sands, swamps, and shallow water (Fernald 1950). Some spikerush species are present near margins of aquatic areas (Martin et al. 1951).	June–Sept.		White-tailed deer not listed as a browse animal for this species (Martin et al. 1951).	Rare
Spoonleaf sundew	Drosera intermedia	SR	Not listed	■									Perennial forb found in wetlands and bogs (Iverson et al. 1999).	July–Sept.	Unknown	No information.	Uncommon
Swamp smartweed	Polygonum hydropiperoides	SR	Not listed	■	■								Perennial forb distributed on wet ground and found in floodplain forests (Iverson et al. 1999).	July–Oct.	√	White-tailed deer not listed as a browse animal for this species (Martin et al. 1951). Polygonum spp. considered "not resistant" (Crescent Bloom 2004).	NA
Tall cottongrass	Eriophorum angustifolium	SR	Not listed	■									Perennial grass found in wet soil in bogs and marshes. Can grow in water (Plants for a Future 2003).	May–June	Unknown	No information.	Rare
Tall horned beaksedge	Rhynchospora macrostachya	SR	Not listed	■	■								Perennial grass found in wetlands and swamps (Iverson et al. 1999).	July–Oct.	unknown	No information.	Uncommon
Tower rockcress	Arabis glabra	ST	Not listed							■			Annual/biennial/perennial forb/herb found in moist soil (Plants for a Future 2003).	May–June	√	Arabis spp. not considered "deer resistant" (Crescent Bloom 2004).	Rare
Tussock cottongrass	Eriophorum vaginatum var. spissum	SX	Not listed	■									Perennial grass (USDA 2006b; NRCS 2006) found in acid bogs, meadows, swales, tundra, wet places, and peaty soils (eFlora n.d.; Fernald 1950).	April–July	Unknown	No information.	Rare
Twinflower	Linnea borealis	SX	Not listed		■			■					Perennial evergreen shrub found in pine woods and requiring moist soil (Plants for a Future 2003).	May–Aug.	√	Considered "not deer resistant" (Crescent Bloom 2004).	Rare
Variegated scouringrush	Equisetum variegatum	SE	Not listed	■		■							Perennial forb/herb found along dunes and river banks and in wet ground (Plants for a Future 2003).	July–Aug.	√	White-tailed deer not listed as a browse animal for this species (Martin et al. 1951). However, the species is not considered "deer resistant" (Crescent Bloom 2004).	Rare
Veiny pea	Lathyrus venosus	ST	Not listed							■			Perennial vine/forb found in recently burned prairies and savannas (Iverson et al. 1999).	May–June	√	Lathyrus spp. not considered "deer resistant" (Crescent Bloom 2004).	Rare
Water arum	Calla palustris	SE	Not listed	■	■	■							Perennial forb/herb requiring wet soil and no shade; found in forest swamps and marshes and near ponds and streams (Plants for a Future 2003).	June–July	√	Not considered "deer resistant" (Crescent Bloom 2004).	Rare
Weak stellate sedge	Carex seorsa	SR	Not listed	■	■				■				Perennial grass (USDA 2006b; NRCS 2006) found in acidic, sandy, peaty swamps; thickets; and wet woods (eFlora n.d.; Fernald 1950). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	April–July	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered "deer resistant" (Crescent Bloom 2004).	Common
Western silver aster	Symphyotrichum sericeum	SR	Not listed				■			■			Perennial forb found in limestone soil in prairies, savannas, and glades (Iverson et al. 1999).	Sept.–Oct.	√	Aster spp. considered "not deer resistant" (Crescent Bloom 2004). Asters constitute 2-5% of white-tailed deer diet in the state of NE.	Uncommon
Wheat sedge	Carex atherodes	SE	Not listed	■		■							Perennial grass found in a variety of wet, open situations; marshes; shores; stream banks; swales; and wet prairies (ODNR 2006). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	May–July	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered "deer resistant" (Crescent Bloom 2004). USDA rates this specific species as having "low" palatability for browse animals (USDA 2006b; NRCS 2006).	Rare

TABLE 30: SENSITIVE AND RARE PLANTS OF INDIANA DUNES NATIONAL LAKESHORE

Common Name	Species	State Status	Federal Status	National Lakeshore Community[1]									Natural History Information[2]		Palatability to White-Tailed Deer[3]		Local Abundance[4]
				Aquatic/Herba-ceous Wetlands	Wooded Wetlands	Panne	Dune Complex	Pine Forest/ Woodland	Mesophytic Forest	Prairie/Savanna Complex	Revegetating	Agricultural	Description	Flowering Period	Palatable?	Explanation	
Whip-poor-will flower	Trillium cernuum	SE	Not listed						■				Perennial forb requiring wet, moist soils and found in upland forests and thickets (Iverson et al. 1999).	May–June	√	Considered "not deer resistant" (Crescent Bloom 2004).	Rare
White edge sedge	Carex debilis var. rudgei	ST	Not listed	■	■				■				Perennial grass found in forests, including upland oaks and northern hardwoods (Iverson et al. 1999). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	May–Aug.	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered "deer resistant" (Crescent Bloom 2004).	Uncommon
White lady's slipper	Cypripedium candidum	SR	Not listed	■						■			Perennial forb found in prairies, wetlands, bogs, and lake borders (Iverson et al. 1999).	May–June	√	Not considered "deer resistant" (Crescent Bloom 2004).	Rare
Wild basil	Clinopodium vulgare	SE	Not listed						■				Perennial forb/herb requiring moist soil; prefers sandy, well-drained soil and can grow in semi-shade (light woodlands) or no shade (Plants for a Future 2003).	July–Sept.	Unknown	No information.	Rare
Wolf's spikerush	Eleocharis wofii	SR	Not listed	■						■			Perennial grass found along roadsides, on swales in bottom prairies, and in wetlands (Iverson et al. 1999).	May–July		White-tailed deer not listed as a browse animal for this species (Martin et al. 1951).	Rare
Woolly beach heather	Hudsonia tomentosa	ST	Not listed				■						Perennial shrub found in open sand on lakeshores and beaches (Iverson et al. 1999).	May–Aug.	√	USDA rates this species as having low palatability for browse animals (USDA 2006b; NRCS 2006).	Uncommon
Yellow fringed orchid	Platanthera ciliaris	SE	Not listed	■				■	■	■			Perennial forb found in acid soils of sandy, wet, springing ground; wet-wooded margins of upland sinkhole ponds; moist pine woods; and acid peaty prairies (Iverson et al. 1999).	June–Aug.	√	White-tailed deer "readily consume the foliage" of this and other orchid species (Hilty 2006); considered "highly vulnerable" to white-tailed deer browsing (U. of Penn. n.d.).	Rare
Yellow sedge	Carex flava	ST	Not listed	■						■			Perennial grass found in wet, open situations; wet prairies; fens; and ditches (ODNR 2006). In general, species of Carex primarily grow in moist soils of meadows, marshes, and bogs and near ditches and roadsides (Martin et al. 1951).	May–July	√	Sedges constitute 2-5% of white-tailed deer diet in NC (Martin et al. 1951). Carex spp. not considered "deer resistant" (Crescent Bloom 2004).	Rare

[1] National lakeshore communities based on observations of national lakeshore staff or adapted from sources for the Natural History Information column.
[2] Sources are the same as those for the Natural History Information column.
[3] No definition for palatability rankings (e.g., resistant, low, etc.) provided in sources cited.
[4] Abundance defined as follows (from NPS 2006d):
Common: Large numbers of individuals predictably occurring in commonly encountered habitats, but not those covering a large portion of the national lakeshore.
Uncommon: Few to moderate numbers of individuals; occurs either sporadically in commonly encountered habitats or in uncommon habitats.
Rare: Few individuals usually restricted to small areas of rare habitat.
Unknown: Abundance unknown.
SX = State extirpated
SE = State endangered
ST = State threatened
SR = State rare
SRE = Reintroduced
WL = Watch list

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CULTURAL RESOURCES

The Cultural Resource Management Program at the Indiana Dunes National Lakeshore emphasizes nine areas of concern. Of these, archeological resources and one cultural landscape have the potential to be affected by deer management activity (NPS 1995c). These resources are described below.

Archeological Resources

The Indiana dunes region has been occupied by humans for 9,000 to 12,000 years (NPS 1995c), although there is limited evidence for prehistoric occupation of the Indiana Dunes National Lakeshore (Frost 2001). Although prehistoric sites at the national lakeshore are not exceptionally large or otherwise impressive, they are very numerous in certain topographic settings and typically rather well preserved. Despite the small size of these sites, many have excellent integrity and, as a group, are likely important and eligible for the national Register of Historic Places (Frost 2001).

Because of the region's extensive development and industrialization, the area of the Indiana Dunes National Lakeshore likely provides the best remaining record of early use and occupancy (NPS 1995c). Approximately 240 prehistoric archeological sites have been identified within the national lakeshore. Each year during annual investigations associated with construction or demolition activities at the national lakeshore, archeologists have found projectile points, pottery fragments, scrapers, fire-cracked rock, and other materials (NPS n.d.i). Prehistoric occupations within the national lakeshore are currently interpreted as seasonal campsites focusing on the variety of resources available in the dune and wetland ecosystems. Current information suggests that there are several important Early Archaic, Middle Woodland, and Late Woodland archeological sites located in the national lakeshore (J. Sturdevant, Midwest Archeological Center, pers. comm. 2004).

Archeological investigations at the national lakeshore have been limited in scope. Between 1992 and 1995, an extensive archeological inventory was undertaken. Crews investigated 730 acres at various locations throughout the national lakeshore. Although these investigations encompassed less than 10 percent of the national lakeshore's properties, they constitute the most comprehensive archeological study within the national lakeshore to date (Stadler 2001).

This multiyear archeological inventory indicates occupation of the Indiana dunes area since the Late Paleoindian period (which lasted from about 11,000 years before present [BP] until 8,500 BP). The inventory recorded 1 Late Paleoindian site, 4 Archaic sites (8,500 BP until 2,700 BP), and 35 Woodland sites (2,700 BP until 400 BP). Artifacts recovered from each site ranged from a single artifact to nearly 500. Sites ranged in size from approximately 270 square feet to about half an acre (25 to 6,500 square meters) and covered a range of functions, from small, temporary camps to large, long-term campsites. The sites were in level areas at the edges of wetlands, flat ridge crests, the far ends of spur ridges, and flat areas near entrenched streams. Site density at the East Unit is very high, at about one site per 3 acres. In contrast, density in the West Unit is about one site per 16 acres. The inventory revealed that there are potentially a very high number of undiscovered archeological sites within the national lakeshore (Frost 2001).

Sites from the earliest periods, the Late Paleoindian through the Archaic, are relatively rare in the area of the national lakeshore. However, Woodland period sites are more numerous (Frost 2001). The earliest artifacts found in the vicinity of the national lakeshore were projectile points dating from the Late Paleoindian period that suggest a focus on hunting large game (NPS n.d.i). The recovery of Paleoindian cultural material is rare, with only nine tool types reported from the area's three counties (Frost 2001) and none within the national lakeshore's boundaries (Stadler 2001). Most of the discoveries from this period are from the ground surface (Frost 2001).

The more sedentary, trade-oriented, and ceremonial society of hunter-gatherers of the Archaic period followed, leaving some notched projectile points behind (NPS n.d.i). Materials ascribed to the entire Archaic tradition have been found in seven locations within the national lakeshore (Sturdevant and Bringelson 2003). No sites in northern Indiana have produced large numbers of Early Archaic artifacts. Only two have been found in the vicinity of the national lakeshore (Frost 2001) and three within the national lakeshore boundaries (Sturdevant and Bringelson 2003). However, an artifact collection donated to the national lakeshore suggests that additional Early Archaic material may exist within the national lakeshore. Similarly, no sites from the Middle Archaic period have been reported in the area of the national lakeshore (Frost 2001). Although several sites from the Late Archaic are reported near the national lakeshore, only one site within the national lakeshore has produced Late Archaic materials (Frost 2001).

People of the Woodland tradition left the greatest known archeological mark on the national lakeshore, including many fragments of earthenware pottery. Woodland people led an even more sedentary lifestyle than their predecessors, with elaborate burial customs (mound construction) and movement toward an agricultural economy (NPS n.d.i). Several Early Woodland sites have been recorded in a drainage south of the national lakeshore, and some artifacts were found within the national lakeshore. Two Middle Woodland sites were recorded in 1968 within the national lakeshore, including a possible village site along the Little Calumet River. The discovery of two other sites within the national lakeshore indicates a small but established Middle Woodland presence (Frost 2001). Numerous Late Woodland sites have been found within the national lakeshore, and current archeological data suggest that substantial use of the national lakeshore occurred during the Woodland period (Sturdevant and Bringelson 2003).

Bailly Homestead

Until recently, no sites from the Mississippian period (900 BP until the arrival of the first Europeans in 1679) have been recorded within the national lakeshore boundaries (Frost 2001). However, recently, artifacts collected at the national lakeshore were identified as belonging to this period (Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

In addition to prehistoric artifacts, archeological resources relating to the Bailly Homestead, Chellberg Farm, Swedish homes, and several other historic properties occur within the national lakeshore that could be potentially affected by deer management actions (J. Sturdevant, Midwest Archeological Center, pers. comm. 2004).

In 1822, British Canadian fur trader Joseph Bailly settled on the south shore of Lake Michigan along the Little Calumet River, now within national lakeshore boundaries. Bailly claimed several tracts of land in the area after the signing of the treaties. Several archeological studies at the Bailly Homestead, a national historic landmark, have shed some light on the Bailly history, such as a few early- to mid-19th-century transfer-printed ceramics. In addition, studies conducted at the homestead have revealed the presence of buried features, including remnants from a well house, windmill, and many brick walkways (Sturdevant and Bringelson 2003; NPS n.d.i).

In the 1830s, a second wave of Euro-American settlers moved to the region, and during the mid-1800s, farmers began installing drainage ditches, which changed the landscape drastically. The Chellberg family, who were Swedish immigrants, moved there in 1874. The Chellbergs began a modest farm, later turning to the production and shipment of dairy products. Currently, no substantial archeological studies have been conducted at Chellberg Farm (Sturdevant and Bringelson 2003). More information about Chellberg Farm is included under the "Cultural Landscapes" section below.

Cultural Landscapes—Chellberg Farm

Cultural landscapes, as defined by The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes, consist of "a geographic area (including both cultural and natural resources and the wildlife or domestic animals therein) associated with a historic event, activity, or person exhibiting other cultural or aesthetic values" (NPS 1996).

Of the nine identified cultural landscapes in the national lakeshore, only Chellberg Farm has the potential to be affected by deer management activities. (Other cultural landscapes at the national lakeshore, such as the Bailly Homestead, do not include planned landscapes and, therefore, would not be affected by deer management activities.)


Chellberg farmhouse

Chellberg Farm serves an important role in the national lakeshore's interpretive and environmental education program (NPS 1995c). The NPS acquired the property in 1972 and manages it as a working farm. The overall property maintains a moderate to high level of integrity (NPS 2000e).

The Chellberg Farm complex includes seven structures that were constructed over a number of years by the Chellberg family, Swedish immigrants who bought the first 40 acres of the 80-acre farm in 1872. The farm was found eligible for inclusion in the National Register of Historic Places in 1994 (NPS 1995c; Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

The farm is managed and interpreted as an active, typical northwest Indiana turn-of-the-century farm, with period agricultural and domestic living-history demonstrations. The historic scene is partially maintained through farm activities, such as raising animals and chickens, planting flowers and a vegetable garden, and raising and harvesting crops. Animals, crops, flowers, and garden vegetables typical of the period are raised (NPS 1995c).

Crops, vegetables, and flowers are planted at the farm with historic varieties whenever possible. Crops and flowers are not necessarily of the exact types or in the exact original locations but are representative of those used at the turn of the century (Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006). The national lakeshore is in the process of implementing the recommendations of the Cultural Landscape Report, which includes removing existing flower beds and planting flowers of the period in historic locations (Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

An NPS employee manages the farm property, farm animals, and fields for interpretive purposes but not for farm production. The farmer is a permanent NPS employee and does not rely on the farm for his livelihood (NPS 2000d; Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

The northeastern portion of the farm is composed of small, open fields defined by fences, roads, and fencerow vegetation. The cultivated fields include 16.5 acres of cropland and demonstrate a high level of integrity. As part of the working farm management, the national lakeshore plants corn, wheat, oats, rye, sorghum, grasses, and legumes in these fields on a rotating basis (NPS 2000e). Deer eat these crops and have caused extensive damage, particularly to the corn crop. Raccoons also damage the crop fields. Most of the fields are bordered by a 4.5-foot fence (which would remain in place for the life of this plan), but it does not keep deer out. A 6-foot fence was constructed around the small vegetable garden to protect it from damage. The installation of the fence was not included in the farm management plan, and it is an intrusion on the cultural landscape. Although the purpose of the farm is not to produce a crop, the farmer that works this land harvested 120 bushels of corn in 1997, which was reduced to 25 bushels the following year. (If a crop is harvested, it is used to feed the farm animals.) No bushels of corn have been taken since 1999 due to deer depredation, which has destroyed the corn crop at the farm (Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

In addition to corn, deer also eat the oats and spetzel (a type of grain) crop, which need to be dried in the field after cutting for various amounts of time (fields south of the farmhouse entrance drive are not fenced). If the crops need to dry for four days, the farmer loses 10 percent to deer; if they need to dry for more than seven days, the farmer loses 25 percent of the crop. Deer also eat the crops while they are growing (Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

The farm's historic orchard is barely discernable and has a low level of integrity. A productive apple orchard, as well as crabapple, pear, and peach trees, was south of the farmhouse (NPS 2000e). The orchard has become overgrown, and many of the fruit trees are in poor condition because the last generation of Chellbergs did not maintain the farm, and the NPS was not aware of the orchard when the property was purchased (Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006). Today, there are a few apple trees and a number of medium-sized deciduous trees. There are currently no fruit-bearing trees, and the area does not have the appearance of an orchard (NPS 2000e). The national lakeshore is in the process of planning the restoration of the fruit orchard. After restoration, the trees' branches should be high and strong enough to survive deer browse once the trees begin bearing fruit (Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

The area that historically contained the vegetable garden currently includes turf, undergrowth, and deciduous trees. A vegetable garden is in a nonhistoric location and is enclosed by a 6-foot-high fence (which is not consistent with the historic garden) and includes a wide variety of vegetables and flowers (NPS 2000e). The fence is not keeping the deer out; despite its height, deer can jump over it.

Exotic plant species are being removed, and regular maintenance preserves important features and maintains the present landscape and features. Fences are maintained, although (as mentioned above) they do not keep the deer out (NPS 1995c; Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

The Chellberg sugar maple forest is passively managed as an integral part of Chellberg Farm, where only minimal action is taken, as necessary, to ensure the continuance of a vigorous maple sap production. It is located in a ravine that the national lakeshore has chosen not to restore to its period of significance. During the Chellbergs' time, cows and pigs were allowed to free range in the ravine, keeping it clear of understory vegetation. The maple trees are only part of the overall forested ravine (Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

Because it is part of the original farm, this forest is part of the cultural landscape. Research indicates that a mixed-age stand is currently self-sustaining or perhaps increasing in number. Passive management has a high potential for providing an adequate number of tappable trees into the future and for preserving the character of the forest. Deer are currently browsing the sugar maple saplings, but the national lakeshore is not taking action to protect them; it is anticipated that enough young sugar maples would survive to maturity to maintain a syrup-producing grove of sugar maples. However, this could change with an increasing deer population (NPS 1995c; Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

VISITOR USE AND EXPERIENCE

Deer management activities have the potential to affect the experience of visitors to the national lakeshore. The following sections describe aspects of visitor use and experience.

Visitation

The Indiana Dunes National Lakeshore ranks 39th in visitation out of 349 units in the NPS, comprising 0.72 percent of all national park visitation (NPS 2003b). Visitor data for recent years indicate that visitation varies (see Table 31). Recreational visitation records for the Indiana Dunes National Lakeshore dating to 1973 indicate that visitation steadily increased until the early 1990s, decreased until the late 1990s due to cooler and wetter weather (NPS 1998), and rose again in 2002. The number of visitors in 2002 reached nearly 2 million and peaked in 2005 at more than 2 million. Visitation decreased to 2008 then rose again in 2010 to more than 2.1 million (NPS, 2011).

Proximity to Chicago (the third most populous city in the country) affects visitation at the national lakeshore; approximately 79 percent of the national lakeshore's visitors come from Indiana and Illinois, and more than half (58 percent) are repeat visitors (NPS 1995b). Chicago's population has also increased since 1990, from 2,783,726 to 2,896,016—a 4.03 percent increase (*Chicago Sun-Times* n.d.). An analysis of ZIP codes revealed that the majority of the national lakeshore's visitors originate in the southern Chicago suburbs (NPS 1993a).

TABLE 31: AVERAGE ANNUAL VISITATION AT INDIANA DUNES NATIONAL LAKESHORE, 1990–2010

Year	Number of Visitors	Percentage Change from Previous Year
1990	1,919,901	--
1991	2,058,801	7.2%
1992	1,973,098	-4.2%
1993	1,763,094	-10.6%
1994	1,699,958	-3.6%
1995	1,696,488	-0.2%
1996	1,526,166	-10.0%
1997	1,483,782	-2.8%
1998	2,108,789	42.1%
1999	1,748,047	-17.1%
2000	1,820,228	4.1%
2001	1,735,404	-4.7%
2002	1,989,941	14.7%
2003	1,953,449	-1.8%
2004	1,810,330	-7.3%
2005	2,127,336	17.5%
2006	1,938,132	-8.9%
2007	1,972,344	1.8%
2008	1,833,596	-7.0%
2009	1,944,568	6.1%
2010	2,150,345	10.6%
Average	1,869,228	1.2%*

Source: NPS 2006e, NPS 2011.
* Since 1990.

The national lakeshore's proximity to the Chicago metropolitan area has resulted in an increasingly changing visitor profile. The metropolitan area presents a greater diversity of cultures and differing expectations for recreational opportunities at the national lakeshore (NPS 1997d). The majority of visitors (60 percent) come in family groups, and 26 percent are ages 31 to 45 (NPS 1995b).

Visitor Distribution

The majority of visitors come to the national lakeshore for the beaches (NPS 2003c). During July 2005, touring Lakefront Drive (which is in the East Unit) was the primary visitor activity (132,596 visitors). The East Unit also sees heavy visitation at Mount Baldy (27,781 individuals in the same time period) and the Kemil Visitor Center (37,079 visitors). Porter Beach (25,773 visitors) and Central Beach (24,447) are also strong visitor attractions (NPS 2005c).

However, the West Unit also includes some of the most intensively used recreation areas in the national lakeshore. West Beach, which stretches for more than a mile along the shore of Lake Michigan, is a very popular recreation destination for residents of northern Indiana and the southern Chicago metropolitan area (NPS 1993a). During the month of July in 2005, 36,994 people visited West Beach (NPS 2005c). Swimming, sunbathing, and picnicking are among the most popular activities at West Beach. Recreationists also hike established trails to explore sand dunes, woods, and prairies (NPS 1993a).

Many visitors come to the national lakeshore just to see the Karner blue butterfly. The Karner blue butterfly now exists both in the East and West Units, as the national lakeshore restored the butterfly to the East Unit.

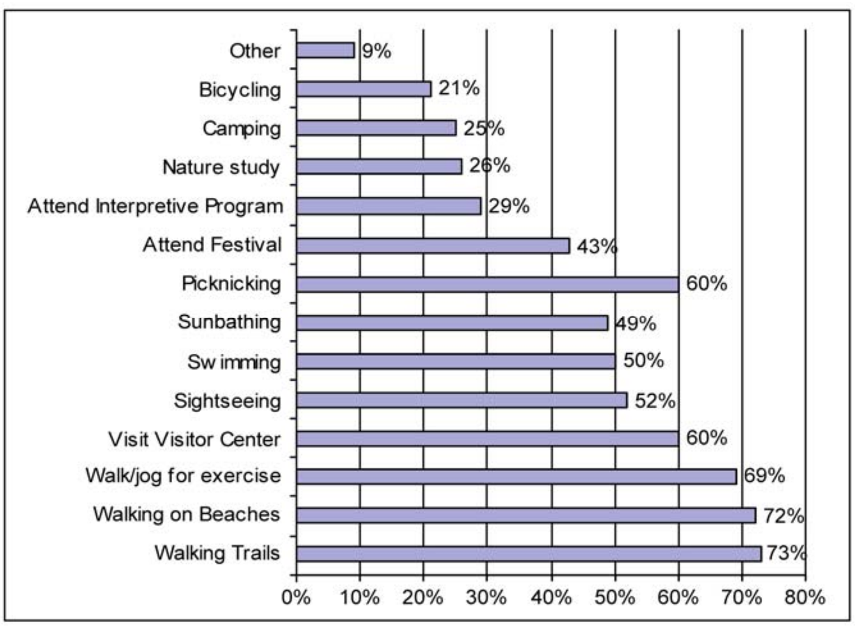
Seasonal Use Patterns

Summer is the busiest visitor use period. July shows the highest visitation, followed by August and June, respectively. Visitation tapers off in the fall, declining rapidly in November. December usually has the lowest visitation, followed by January and February. Visitation increases noticeably in May with the onset of warmer weather (NPS 2003b). Deer are active in the national lakeshore all year, more so during the mating, or rut, season, which occurs mostly in October and November (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 11, 2003), when fewer visitors are at the national lakeshore.

Visitor Activities

Visitors are drawn to the national lakeshore by its miles of beaches, sand dunes, bogs, woodland forests, an 1830s French homestead, and a working, turn-of-the-century farm. Recreational activities include swimming, auto touring, camping, hiking, horseback riding (on designated trails in the Ly-co-ki-we trail system), biking, skiing, picnicking, birdwatching, boating, fishing, wildlife watching, and observation of plant species (NPS 1995b). Seeing deer is generally a positive experience for most national lakeshore visitors (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 11, 2003). The most common activities for visitors during past visits to the national lakeshore are shown in Figure 9 (NPS 1995b).

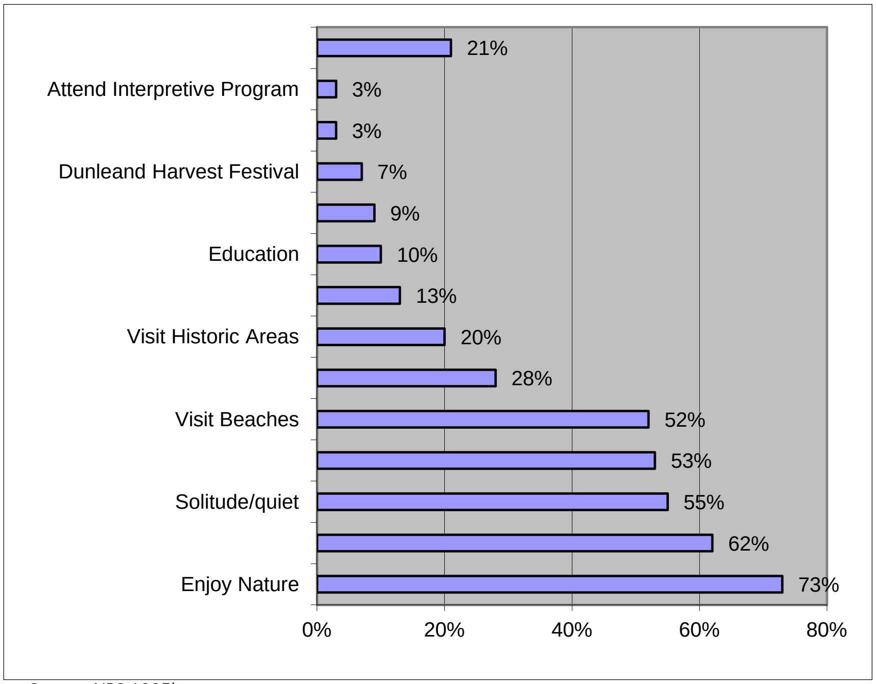
FIGURE 9: BREAKDOWN OF VISITOR ACTIVITIES



Source: NPS 1995b.

Figure 10 shows reasons given by visitors for coming to the national lakeshore.

FIGURE 10: REASONS FOR VISITING THE NATIONAL LAKESHORE



Source: NPS 1995b.

More than half (54 percent) of the general visitors stay one to two hours at the national lakeshore, and the majority (73 percent) come to the national lakeshore to enjoy nature. Trails are the most used natural facilities. Visitors who were asked to identify places they had visited in the area previously indicated that the most visited place is the visitor center (74 percent), followed by the Indiana Dunes State Park (71 percent), Mount Baldy (63 percent), Chellberg Farm (61 percent), and Washington Park (50 percent). The least visited place was the Heron Rookery (NPS 1995b).

Those visitor activities that may be affected by deer management actions are further described below.

Auto Touring

The vast majority of summer visitors in 2002 toured Lakefront Drive (NPS 2003b), which parallels and provides access to the shoreline and three of the national lakeshore's seven swimming beaches, in the East Unit. A picnicking facility also exists along this route.

Camping

The Indiana Dunes National Lakeshore has one campground facility, Dunewood Campground, which is located in the East Unit, is open from April 1 to October 31, and contains 79 sites. The nearby Indiana Dunes State Park also has a campground, and reservations are accepted. Limited group use of the Good Fellow Camp is provided when the camp is not needed for environmental education programs (NPS 1997a).

Currently, deer do not seem to associate campgrounds with food. The national lakeshore has received no complaints about deer and has not seen deer congregate at campgrounds. It is possible that campers may feed deer, but such activity has not yet been observed or reported (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 2, 2003).

Horseback Riding

Horseback riding is permitted only on designated trails in the Ly-co-ki-we trail system, which makes up a small percentage of the national lakeshore's trails. Few people visit the national lakeshore to ride horses. No horse rental concession is available. The trail is open to horses from mid-March through mid-December but is closed to horse riding when conditions are favorable to cross-country skiing (more than 3 inches of snow). National lakeshore staff members have not received complaints from horseback riders regarding problems encountering deer or concerns about CWD (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 2, 2003).

Hiking, Skiing, Biking, Picnicking

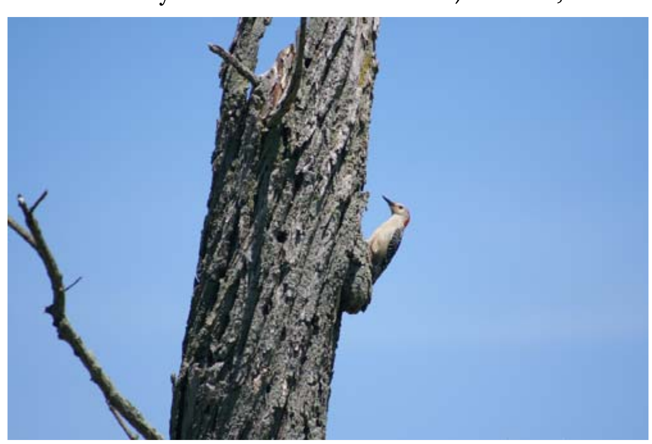
The national lakeshore maintains more than 45 miles of trails for visitor use, designed for specific and multiple purposes. Examples include hiking, cross-country skiing, bicycling, and horseback riding. No off-trail activities are permitted. All hiking trails are also open to skiers; however, few visitors ski at the national lakeshore. All national lakeshore trails provide opportunities to see deer. People who visit in October and November may be more likely to see deer, which are more active during mating season, although the majority of visitation occurs during summer. Seeing deer is a positive visitor experience for most people (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 11, 2003).

All existing trails in the West Unit are in the West Beach, Miller Woods, and Inland Marsh deer management zones. The West Beach succession trail is a 1-mile, self-guiding trail from the parking area to the beach. Deer are not common in this area of the national lakeshore. Deer in the West Unit are most likely to be sighted in the Inland Marsh area, where they are able to feed on nearby agricultural lands (NPS 2003d). Of the national lakeshore's hiking trails, the West Beach experiences the most visitor use in the West Unit (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. May 7, 2004).

Deer are more prevalent in the East Unit, which is larger than the West Unit (NPS 2003d). All trails in the East Unit provide opportunities to see deer (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 11, 2003).

Bicycles are permitted within the national lakeshore on the main roads, the Long Lake Trail between Long Lake parking lot and Ogden Dunes, and the Lake Michigan shoreline from Lake Front Drive to Central Beach. Bicycles are not allowed off-trail or on sand dunes. There are two bike trails within the national lakeshore. Calumet Bike Trail (maintained by the Porter County Parks Department) is a flat, 10-mile, off-road trail that runs from Highway 12 near Mount Baldy to the Cowles Bog parking area at Mineral Springs Road. Marquette Trail (maintained by the national lakeshore) is a flat, multi-use trail that runs about 2 miles from County Line Road at West Beach on the east and Grand Boulevard on the west (http://www.nps.gov/indu). There have been no known collisions with bikers and deer in the national lakeshore (NPS 2003d).

Two picnic areas exist in the West Unit and seven in the East Unit. Deer at the national lakeshore do not seem to associate picnic areas with food. Visitors occasionally feed deer, but this has not yet been a problem (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 11, 2003).



Red-bellied woodpecker

Birdwatching

The national lakeshore provides an excellent opportunity for birders to see a variety of bird species; more than 300 species have been observed. Approximately 113 species of birds are considered regular nesters at the national lakeshore (Brock 1997), which is an extremely important feeding and resting area for migrating land and water birds. The large expanse of open water and miles of shoreline can attract large numbers of wintering birds. During the fall, southbound migrating birds converge at the southern end of the lake, resulting in an unusually high diversity of autumn birds. Migrating hawks concentrate in an area immediately adjacent to the lake, and during March and April, daily flights can consist of 100 to 300 birds. The most notable species observed is the peregrine falcon, with flight peaks in early October (Porter County Convention, Recreation, and Visitor Commission n.d.). Approximately 30 pairs of great blue herons are within the Heron Rookery, which has been set aside, particularly for its value as a site of concentrated nesting activity by this species (NPS 1993b).

National lakeshore staff members are not aware of a reduction in bird sightings as a result of overbrowsing and have not received complaints from birdwatchers about reduced sightings (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 11, 2003).

Amateur Botany

Indiana Dunes National Lakeshore is ranked seventh among national parks in native plant diversity, and many visitors come to find rare plants (Brock 1997). One federally listed and 123 state-listed plant species occur within the national lakeshore. The Heron Rookery and Pinhook Bog offer amateur botanists opportunities to identify plants, particularly in the spring. Visitors tour Pinhook Bog to see its unique habitat, which is Indiana's only true bog and the site of many unique plants, such as lady slipper orchids. Due to the fragility of the bog, Pinhook Bog is accessible to visitors only through guided, ranger-led tours (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. May 7, 2004).

Cultural Activities

Chellberg Farm is a historic farm where visitors can experience life on an 1880–1930s-era farm by helping slop the hogs and hauling feed for the horses, goats, sheep, chickens, geese, cats, and cow. A cornfield is planted each year at the farm, which is affected by white-tailed deer browsing. No bushels of corn have been taken since 1999 because of deer depredation, which has destroyed the corn crop at the farm (Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

Two festivals are held each year: Maple Sugar Time, based on tapping the trees of the Chellberg sugar bush and interpretation of the "sugaring" process from the Native American through the Chellberg era, and Autumn Harvest, a festive period celebration of a successful harvest (NPS 1995c). Chellberg Farm, part of the Swedish Farming Historic District, is operated as a living-history farm and comprises six restored historic buildings, fields, and sugar bush. National lakeshore staff members provide guided walks, talks, and programs (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 2, 2003).

Of the many annual interpretive activities the national lakeshore conducts for visitors, the Autumn Harvest is the only one that has been affected by deer. As stated previously, this is a festive period celebration of a successful harvest; however, visitors who come to help harvest are disappointed when there is no corn to gather. Deer browsing has resulted in less corn for visitors to harvest by hand (corn harvesting is also part of an interpretive activity with school groups, who are similarly affected) (NPS 1995c; Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006).

Interpretive Programs

The national lakeshore offers a variety of interpretive programs (which vary by season and demand), such as walks along the Little Calumet River to search for wildflowers, including trillium, blue phlox, and anemone. Visitors can also join rangers for hikes along the Tolleston Dune Ridge. During the Oak Savanna Stroll, visitors discover that Miller Woods is home to one of the world's most endangered ecosystems and learn about the complexities of oak savanna habitats. During this tour, visitors look for woodpeckers, hunt for spring wildflowers, and find out about the federally endangered Karner blue butterfly (NPS n.d.c).

Visitor Satisfaction

The Indiana Dunes National Lakeshore identified several visitor experience goals in its 1997 General Management Plan. Two relevant goals include the following:

- Visitors would know about, appreciate, and support resource preservation, management, and restoration programs and goals.
- Visitors would understand and appreciate the fragile and dynamic nature of dunes and other national lakeshore habitat.

Visitor survey cards were distributed to visitors for the years 1998 through 2001. Responses showed that 90 percent or more of visitors to the national lakeshore were "satisfied with park facilities, services, and appropriate recreational opportunities." The target for 2001 was 90 percent; actual responses reached 93 percent, exceeding the target expectations. In addition, 77 percent of visitors in 2001 agreed that they "understand and appreciate the significance of the park." This number also exceeded the national lakeshore expectation, which was 75 percent (NPS 2001b).

VISITOR AND EMPLOYEE HEALTH AND SAFETY

Various health and safety concerns could result from implementation of the alternatives described in this deer management plan. Health and safety applies to national lakeshore visitors, local residents, and national lakeshore employees.

Visitor Health and Safety

Many visitors travel to national parks to see wildlife, especially deer. However, in some parks, deer densities have created problems or have the potential to create problems for visitors, local residents, and employees.

Health

The primary public health concern related to deer management is disease, specifically Lyme disease.

Lyme Disease

Lyme disease is an infection caused by *Borrelia burgdorferi*, a type of bacterium called a spirochete that is carried by deer ticks. This disease organism is transmitted primarily by a hard tick, *Ixodes dammini*, which commonly attacks white-tailed deer. An infected tick can transmit the spirochete to the humans and animals it bites. Untreated, the bacterium travels through the bloodstream, becomes established in various body tissues, and can cause a number of symptoms, some of which are severe. Since Lyme disease was first recognized and reported in Connecticut in 1975, three areas in the United States are now identified where this disease organism is known to be endemic, or occurring naturally. These are areas of the Northeast (in coastal areas from northern Virginia to southern

Maine), the northern Midwest (Minnesota and Wisconsin), and the West (parts of California, Oregon, Utah, and Nevada). Although most cases occur in the northeastern United States, cases of Lyme disease have been reported in at least 25 states, including Indiana (Professional Pest Control Products n.d.; American Lyme Disease Foundation, n.d.).

In 2005, 33 reported cases of Lyme disease in Indiana met the CDC definition of a confirmed case. From 1996 to 2005, the number of reported cases of Lyme disease in Indiana has varied from a low of 19 cases per year to a high of 39, with the average number of reported cases being 27.2 (CDC 2006). Surveys for the tick in Indiana have identified the vector most frequently in the northwestern counties of Indiana. From 1990 to 1999, 5 cases were reported in Lake County, 4 in Porter, and 1 in LaPorte (Indiana State Department of Health 2003).

Conflicting evidence exists to support the link between deer and Lyme disease. According to Fire Island National Seashore, "deer are an incompetent host for the Lyme bacteria. A tick that takes a blood meal from a Lyme-infected deer does not obtain the bacteria from the deer. Most infected ticks get the bacteria from feeding on other animals, such as mice or birds" (NPS 2000b). However, the Maryland Department of Natural Resources cites studies in its deer management plan that "suggest that high deer densities lead to an increase in the incidence of Lyme disease, and that significant tick populations do not occur in the absence of deer" (MDNR 1998).

Symptoms of Lyme disease can include acute headache to more serious nervous system impairment, symptoms resembling rheumatoid arthritis, expanding red rash on or near the tick bite, low-grade fever, abdominal and joint pain, dizziness, and stiff neck. Most cases occur during the summer, when people are outside hiking in infested areas and might receive a bite from an infected tick (Professional Pest Control Products n.d.).

If diagnosed and treated early with antibiotics, Lyme disease is almost always readily cured. In its later stages, Lyme disease can also be treated effectively, but because the rate of disease progression and individual response to treatment varies between patients, some may have symptoms that linger for months or even years following treatment. In rare instances, Lyme disease causes permanent damage (American Lyme Disease Foundation n.d.).

Safety

The national lakeshore's 2001 visitor safety goal is to incur no additional per-capita visitor safety incidents for 1998 to 2003 from the 1992 to 1997 levels (a target of 7.91 safety incidents per 100,000 visitor days). In 2001, this goal was exceeded with 5.99 safety accidents or incidents per 100,000 visitor days (NPS 2001b). Nearly half of all visitor incidents (44 percent) are caused by visitors falling. Visitors experience "numerous cuts and scrapes," which are a "major contributor" to visitor injuries (NPS 1997d). The primary safety issues for visitors and local residents involve injuries that could result from implementation of the proposed deer management alternatives, as described below.

Feeding Deer

Animals that are fed lose their fear of people and may begin to beg for handouts. Without fear, animals become aggressive and may bite, butt, or even trample humans. Feeding wildlife is prohibited by law at Indiana Dunes National Lakeshore (NPS n.d.b). No national lakeshore visitors have been harmed by wildlife to date, even though some occasionally do violate the national lakeshore's rules and feed deer (NPS 2003d).

Deer–Vehicle Collisions

Deer–vehicle collisions are a threat to human safety and are one of the predominant sources of deer mortality. In past studies, the number of deer–vehicle collisions has been correlated to both traffic volume and greater deer abundance. The greatest number of reported animal crashes occur in November, and the second highest in October, which is deer-mating season (Hughes et al. 1996). In addition, deer often travel in family groups, causing more concern for motorists (Upper Thames River Conservation Authority 2001).

According to the Indiana State Police and the IDNR, approximately 10,800 deer–vehicle collisions occur in Indiana each year. The Michigan Deer Crash Coalition reports that the average deer–vehicle collision causes approximately $1,940 in damages (IN Legislative Services Agency 2002). A much larger percentage of vehicle–animal crashes occur on rural rather than urban roads. In urban areas, vehicle–animal crashes compose less than 2 percent of all accidents. The average animal-crash rate for rural roads is 2 to 12 times greater than for urban roads. In addition, animal-crash rates decrease as average daily traffic increases (Hughes et al. 1996).

Animal crashes also occur more frequently at night. Of reported animal crashes, 69 percent to 85 percent occurred at night. The average annual animal-crash frequencies were found to be two to five times higher at night than during the day. The greatest number of animal crashes occurred during the early morning hours (5:00 a.m. to 8:00 a.m.) and night hours (6:00 p.m. to midnight). The influence of vehicle exposure may account for part of this occurrence; however, animal crashes constitute a disproportionate share of all reported accidents during the early morning and night periods (Hughes et al. 1996).

Data from Michigan suggest that approximately 3.16 percent of deer–vehicle collisions result in human injury or death (IN Legislative Services Agency 2002). However, Michigan has an exceptionally high number of deer–vehicle accidents compared to the United States as a whole. Other data show that crashes between animals and vehicles result in substantially lower percentages of fatalities and personal injuries than do other types of motor vehicle accidents nationwide (approximately 0.3 percent of all fatal crashes in the United States) (Hughes et al. 1996).

Lake County had a 15-percent increase in deer–vehicle accidents per billion miles traveled between 2002 and 2003. LaPorte County had a 14.3-percent increase in deer–vehicle accidents per billion miles traveled in the same time period, and Porter County had a 7.4-percent increase. According to the IDNR, the peak white-tailed deer harvest was in 1996, which is also when a high number of deer were involved in collisions. The majority of hunting in the state occurs in November, tapering off into early January. Therefore, deer harvested during the start of a particular season could affect the numbers of the overall deer population the following year (IDNR 2003).

Studies in Indiana have shown positive correlations between the number of deer–vehicle accidents and deer harvest figures. In 1997, Indiana's deer harvest dropped 15 percent from the previous year's harvest. In the same year, the state experienced a 12-percent decline in deer–vehicle collisions (IDNR 1999) (see Tables 32 and 33).

TABLE 32: DEER–VEHICLE ACCIDENTS PER BILLION MILES TRAVELED

County	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Lake	67	49	45	53	52	NA	60	69	NA	NA
LaPorte	180	128	148	163	141	NA	105	120	NA	NA
Porter	190	173	184	183	169	NA	190	204	NA	NA
Total	437	350	377	399	362	NA	355	393	NA	NA

Source: L. Byer, IDNR, pers. comm. July 21, 2006.
NA: Not available.

TABLE 33: NUMBER OF DEER–VEHICLE ACCIDENTS BY COUNTY

County	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Lake	292	226	214	241	242	NA	285	331	NA	NA
LaPorte	245	181	219	251	218	NA	159	177	NA	NA
Porter	288	283	308	302	283	NA	337	368	NA	NA
Total	825	690	741	794	743	NA	781	876	NA	NA

Source: L. Byer, IDNR, pers. comm. July 21, 2006.
NA: Not available.

Although deer are common in all areas of the national lakeshore, they are more prevalent in the East Unit. Highway 12 is a busy road that crosses both the East and West Units and is paralleled by a commuter and a freight train line north of the road. Of the three counties encompassing the national lakeshore, Porter County experiences the highest number of deer–vehicle accidents, as shown in the table above, even though it is the smallest geographically. The majority of the national lakeshore's East Unit, which is larger and contains more rural roads than the other units, is located in Porter County. Table 34 shows the number of deer–vehicle incidents at the national lakeshore between 1983 and 1993.

TABLE 34: DEER–VEHICLE INCIDENTS AT INDIANA DUNES NATIONAL LAKESHORE

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1983	3	0	0	0	0	1	0	0	0	0	3	0	7
1984	1	8	2	1	1	0	0	0	1	1	3	4	22
1985	3	2	1	1	0	0	0	0	1	2	3	3	16
1986	2	1	1	0	0	2	0	0	0	0	1	1	8
1987	0	3	0	0	1	0	0	0	0	5	0	1	10
1988	3	0	2	1	0	1	0	0	1	1	1	0	10
1989	1	1	0	1	1	0	0	0	3	3	1	0	11
1990	3	4	1	4	1	1	0	0	0	3	0	1	18
1991	2	1	0	0	0	0	0	0	0	1	1	1	6
1992	2	2	1	3	0	0	0	0	3	3	3	7	24
1993	5	0	2	3	0	0	0	0	1	1	3	2	17
Total	25	22	10	14	4	5	0	0	10	20	19	20	149
Average	2.3	2.0	0.9	1.3	0.4	0.5	0.0	0.0	0.9	1.8	1.7	1.8	13.5

Source: NPS 2003e.

During the 2003 fall hunting season, a total of eight deer were found within a nine-week period along the roadsides of Beverly Shores as a result of deer–vehicle collisions. Only one was reported as an accident; the remaining seven were not reported (B. Beglin, Beverly Shores resident and member of Environmental Restoration Group, pers. comm. Feb. 3, 2004).

Employee Health and Safety

NPS employees could be susceptible to Lyme disease, as described above for visitors and residents. NPS staff would be exposed to additional potential safety risks if deer management activities are added to their work routine. Currently, the national lakeshore has not met its goal of reducing "loss time injury rate." This goal targets the amount of work time lost due to work-related injuries. The goal set for fiscal years 2001 to 2005 was to reduce this rate to 1.2 injuries per 100 full-time employees.

In 2001, the loss time injury rate improved from 10.5 to 8.7 but did not reach the target of 1.2 injuries per 100 full-time employees. Twenty-one employee injuries were reported in 2001. Eleven resulted in lost work time. Lost time varied from 0.5 to 344 hours, for a total of 1,812 hours. This was a significant increase over 1999. As a result, an implementation team for the Occupational Health and Safety Program was established and several actions were planned to make safety a routine part of each job. The use of a technical board of inquiry was expected to "significantly alter employee attention to personal safety on the job" (NPS 2001b).

National lLakeshore staff reported a total of 16 injuries in 2005. The most common injuries were punctures and bites (3 each). Two people reported insect stings, and two experienced strains from lifting. These 10 injuries were sustained primarily by maintenance and enforcement staff, such as plumbers, laborers, mobile equipment operators, or woodworkers, who often perform manual work. The remaining 6 injuries included stress, falls, or slips or being caught on something and were sustained by volunteers (three) and natural science employees (three). All injuries sustained in 2005 were typically not serious or life-threatening, and no injuries related to deer management activities performed to date have occurred (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Nov. 17, 2006).

SOUNDSCAPES

Some of the alternatives proposed in this plan may affect the soundscape of both the national lakeshore and surrounding entities.

Natural and Human Noise Levels

Natural soundscapes encompass all the natural sounds that occur in parks, including the physical capacity for transmitting those natural sounds and the interrelationships among natural sounds of different frequencies and volumes (NPS 2006b, sec. 4.9). Natural sounds occur within and beyond the range of sounds that humans can perceive, and they can be transmitted through air, water, or solid materials. The NPS works to preserve, to the greatest extent possible, the natural soundscapes of parks. The frequencies, magnitudes, and durations of acceptable levels of unnatural sound will vary throughout a park and are generally greater in developed areas (NPS 2006b, sec. 4.9).

Noise can be defined as an unwanted sound, such as one that is loud, unpleasant, unexpected, or undesired. Sounds are described as noise if they interfere with an activity or disturb the person hearing them. Sound is measured in a logarithmic unit called a decibel (dB). Because the human ear is more sensitive to middle- and high-frequency sounds than to low-frequency sounds, sound levels are weighted to reflect human perceptions more closely. These "A-weighted" sounds are measured using the decibel unit dBA. Table 35 illustrates common sounds and their measured sound levels.

TABLE 35: SOUND-LEVEL COMPARISON CHART

Decibels	Human Perception	Equivalent Sounds	Sound Levels in Indiana Dunes National Lakeshore
180		Rocket-launching pad	
160	Instant perforation of ear drum		
140	Near-permanent damage from short exposure	Large-caliber rifles (e.g., .243, 30-06); jet plane; gunshot blast	Hunting at Indiana Dunes State Park or Dune Acres; air shows at Gary, IN
130	Pain to ears	.22-caliber weapon, riveting steel tank, stock car races, air raid siren, jackhammer	Hunting at Indiana Dunes State Park or Dune Acres
120		Automobile horn, chain saw, pneumatic drill, ambulance siren	Congested traffic on nearby highways and roads, thunder
112		Sandblasting	Construction on nearby highways and roads
100	Very loud	Air compressor at 20 feet, garbage trucks and city buses, snowmobile	Steel-industry trucks traveling on Highways 12 and 20
95	Conversation stops	Power lawnmower, diesel truck at 25 feet, woodworking shop	Homeowners in Ogden Dunes, Dune Acres, and Beverly Shores mowing lawns; diesel trucks traveling on Highways 12 and 20
90	Intolerable for phone use; sustained exposure may result in hearing loss	Steady flow of freeway traffic, 10-HP outboard motors, garbage disposal, subway	Traffic on Highways 12, 20, and 94, particularly during rush hour; motorboats and jet skis traveling along the shoreline on weekends; commuter train to Chicago that parallels Highway 12
80-90		Average factory, food mixer, or processor, garbage disposal	Steel mills and associated businesses between the East and West Units
85		Credit-card verifier, handsaw	
80-85		Noisy restaurant	
75		Busy traffic	Traffic on nearby roads and highways
70		Drilling rig at 200 feet, window air conditioner outside at 2 feet	
66		Conversation	Visitors talking to each other
60	Quiet	Window air conditioner in room, sewing machine	
50	Sleep interference	Average home, bird calls, refrigerator, washing machine, large office	Moderate rainfall
40		Quiet office, library, quiet residential area	
30		Soft whisper	Quiet area in natural environment
20		Quiet house at midnight, whispering at 5 feet	Leaves rustling
10		Normal breathing	

Note: Modified from Final Environmental Impact Statement, Miccosukee 3-1 Exploratory Well, Broward County, Florida (US DOI n.d.; Musani n.d.; Galen Carol Audio n.d.; Dumond 2000; League for the Hard of Hearing 2003).

Nearly all agencies and organizations with authority over noise-producing sources (including the World Health Organization and the National Research Council) use 55 dB as the threshold for defining noise day and night sound levels in urban areas. Many of these organizations recommend a lower threshold for sparsely populated suburban and rural residential areas, and a 10-dB reduction for rural areas (Schomer 2001).

The threshold of perception of the human ear is approximately 3 dB, and a 5-dB change is considered to be clearly noticeable. As shown in Table 36, a 10-dB change would be perceived to be twice as loud (MN Pollution Control Agency 1999). When decibels are doubled, the sound does not become twice as loud. For most people, a 10-dB increase in the measured sound level is perceived as being twice as loud, and a 10-dB decrease is perceived as half as loud (Endpcnoise.com n.d.).

TABLE 36: PERCEPTIONS OF INCREASES IN DECIBEL LEVELS

Amount of Change	Decibel Level
Imperceptible Change	1 dB
Barely Perceptible Change	3 dB
Clearly Noticeable Change	5 dB
About Twice (or Half) as Loud	10 dB
Fourfold Change	20 dB

Source: MN Pollution Control Agency 1999.

Many factors affect how an individual responds to noise. Primary acoustical factors include the sound level, its frequency, and duration. Nonacoustical factors also play a role in how an individual responds to sounds. These factors vary from an individual's past experience and adaptability to the predictability of the occurrence of a noise. The listener's activity also affects how he or she responds to noise (Mestre Greve Associates 1992).

Noise Attenuation

A number of environmental factors mitigate noise emissions in the environment, including absorption of sound by the air and the effect of barriers (structures), hills, and trees on the emitted noise. However, the most important of these factors is likely the distance between the source and the receiver (OPTI 2002).

Distance

Noise levels depend on the distance from the noise source and the attenuation of the surrounding environment. As a sound wave travels through space, the intensity of the sound wave decreases with increasing distance from the source (Henderson n.d.). When the distance from a point source is doubled, the sound level decreases 6 dBA (MN Pollution Control Agency 1999; Komanoff and Shaw 2000; OPTI 2002). For example, if a sound level is 95 dB at 50 feet, it would be 89 dB at 100 feet and 83 dB at 200 feet.

Air Absorption

As sound passes through the atmosphere, it collides with the air molecules, converting some of the energy into heat, which decreases the sound energy. The amount of energy that the atmosphere absorbs varies with the weather conditions and the sound frequency. The atmosphere can reduce sounds by as much as 3 dBA for every 100 feet, depending on weather conditions (OPTI 2002).

Barriers and Hills

Barriers (such as buildings and other structures) and hills can also attenuate sound in the environment. As sound waves bend around obstructions, they lose energy. Therefore, people usually do not hear sounds from sources that are behind hills or buildings. The amount of attenuation provided by an obstruction depends on the how much the sound waves bend. This attenuation is greatest closest to the source but is less effective at greater distances (OPTI 2002).

Trees

Vegetation can help decrease noise, although not as effectively as barriers. Vegetation must be high (taller than the noise source), wide, and dense (so that it cannot be seen through) to be effective (FHWA 2000; OPTI 2002). Many areas at the Indiana Dunes National Lakeshore are heavily vegetated, particularly in the East Unit. Other areas are more open habitats, such as savannas, prairies, and wetlands.

Noise Levels at Indiana Dunes National Lakeshore

Because of the national lakeshore's proximity to human-altered environments, visitors encounter both natural and disturbed conditions (NPS 1993a), as described below.

Natural Sounds

Natural sounds at the national lakeshore include bird calls, wind, and the sound of trickling streams and waves breaking along the shore. Animal movements and insect sounds can also be heard along the trails. The sands of the dunes create an unusual musical sound when visitors walk on them due to a combination of quartz crystals, moisture, pressure, and friction (NPS n.d.j).

Human-Caused Sounds

Since the creation of the national lakeshore, development has increased to the point that most of its boundary now consists of homes, farms, roads, or businesses. The national lakeshore experiences a great deal of noise from sources outside its boundaries. The extreme west end of the national lakeshore borders a large steel-making facility that has been operating since 1906 and continues to operate today (as do all the steel mills in the area). The large industrial complex that bisects the two units includes two steel companies, a Northern Indiana Public Services Company (NIPSCO) coal-burning power plant, and the Port of Indiana (NPS 1997d). Several smaller businesses associated with the steel-making industry are located near the steel mills. Another public service facility exists just east of Mount Baldy, the national lakeshore's only active dune (NPS 2003d).

A commuter train to Chicago and two freight rail lines parallel Highway 12, which crosses the majority of both the East and West Units. AmTrack also uses the rail lines. A utility power line follows the length of the railroad tracks (NPS 2003d).

Highway 20 and Highway 94 run the length of the national lakeshore's boundaries, just a few miles south of the national lakeshore. (Highway 20 actually borders the national lakeshore boundaries in some cases.) A great deal of truck traffic related to the steel mills occurs on Highways 12 and 20, and noise from truck brakes is a frequent sound (NPS 2003d). Several roads enter the national lakeshore, providing access to the three residential communities, state park, and city park that exist within or adjacent to the national lakeshore's boundaries. Truck traffic does not appear to subside in the evenings; in fact, it is possible that truckers drive during later hours to avoid rush hour (NPS 2003d).

Although the national lakeshore provides no boat launches, motorboats and jet skis launch at Burns Landing and Marquette Park, just outside the national lakeshore's boundaries. Motorcraft traversing the shoreline can be heard all day in the national lakeshore on weekends, particularly at Miller Woods in the West Unit. Sometimes lake barges launch fireworks (NPS 2003d).

Small planes frequently fly along the shoreline, and jet noise can be heard from the Gary regional airport and sometimes from Chicago's Midway and O'Hare airports. Each year, Gary holds an air show, which can be heard from the national lakeshore. NIPSCO uses helicopters to check power lines in the area (NPS 2003d).

The Heron Rookery, which is a discontinuous component of the national lakeshore's property, is regarded as the national lakeshore's quietest place. The national lakeshore's noisiest place is the western one-third of the West Unit, which is located just south of steel mills, freight train tracks, and highways. Freight train lines gradually veer southward toward the eastern end of the national lakeshore, taking some of the intermittent train noise with them. However, several nearby highways provide relatively constant noise. The beaches are likely to be quieter than some of the national lakeshore's inland areas, as they are protected by foredunes, vegetation, and distance from noise sources. However, beach visitors are subjected to noise from boats and aircraft (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. May 13, 2004).

No substantial noise sources originate within the national lakeshore, other than occasional grass mowing at Chellberg Farm, repairs to equipment and structures, and staff driving through the national lakeshore. The national lakeshore has performed no studies on ambient sound levels within its boundaries.

Firearm Noise

Gunfire may be categorized as an impulse noise, which has the characteristic of an explosive burst. Firearms produce an intensely loud impulse noise, generating a rapid change in pressure and extremely high sound-pressure levels (Better Hearing 2000). Sounds louder than 140 dB can cause pain, and prolonged exposure to noise of more than 85 to 90 dB can result in permanent hearing loss. The amount of hearing damage an individual would incur depends on his or her distance from the firearm (Musani n.d.).

The following tables show that peak sound levels from rifles and shotguns can range from 152 dB to 170 dB (Musani n.d.).

TABLE 37: SHOTGUN NOISE DATA (DECIBEL AVERAGES)

Type of Shotgun		Decibels
410 Bore	28" barrel	150
	26" barrel	150.25
	18" barrel	156.30
20 Gauge	28" barrel	152.50
	22" barrel	154.75
12 Gauge	28" barrel	151.50
	26" barrel	156.10
	18 " barrel	161.50

Source: Musani n.d.

TABLE 38: CENTERFIRE RIFLE DATA

Type of Rifle	Decibels	Type of Rifle	Decibels
.223, 55GR. Commercial load 18 " barrel	155.5	.308 in 24" barrel	156.2
.243 in 22" barrel	155.9	.30-06 in 24" barrel	158.5
.30-30 in 20" barrel	156.0	.30-06 in 18" barrel	163.2
7mm Magnum in 20" barrel	157.5	.375 18" barrel with muzzle brake	170

Source: Musani n.d.

TABLE 39: CENTERFIRE PISTOL DATA

Type of Pistol	Decibels	Type of Pistol	Decibels
.25 ACP	155.0	.38 Spl	156.3
.32 LONG	152.4	.357 Magnum	164.3
.32 ACP	153.5	.41 Magnum	163.2
.380	157.7	.44 Spl	155.9
9mm	159.8	.45 ACP	157.0
.38 S&W	153.5	.45 COLT	154.7

Source: Musani n.d.

Sound decreases 6 dB per doubling of distance. If an individual started at 50 feet from the source and moved to 100 feet from the source, that person would experience a drop of 6 dBA. If an individual moved from 500 feet to 1,000 feet, he or she would also experience a drop of 6 dBA. The formula to calculate this is: decibels of change = 20 x log(distance 1/distance 2)) (Mc Squared System Design Group, Inc. 2004). See Table 40 for more information.

Firearm Noise Suppressors

Noise suppressors can be used in conjunction with sharpshooting to reduce the impact of sound from a firearm. To fire a bullet from a gun, gunpowder is ignited behind the bullet. The gunpowder creates a high-pressure pulse of hot gas, which forces the bullet down the barrel of the gun. The pressure behind the bullet produces an extremely loud noise when the bullet exits the end of the barrel (*How Stuff Works* 1998).

A silencer screws onto the end of the barrel and has a huge volume compared to the barrel (20 or 30 times greater). The pressurized gas behind the bullet can then expand into a large space, substantially decreasing the pressure of the hot gas. When the bullet exits the silencer, the pressure being released is much lower. Therefore, the sound of the gun firing is considerably softer (*How Stuff Works* 1998).

In a test of suppressors of rifle-caliber firearms, all suppressors reduced the shooter's exposure from approximately 160 dB to less than 140 dB (Suppressor Project n.d.). Commercially available rifle suppressors offer suppression that ranges from 25 to 40 dBA, with most closer to 30 dBA.

Assuming that a person standing 1 foot from a firearm being discharged at 160 dBA moved away at consecutively doubling distances, the decibels would be expected to decrease as shown in Table 40 (based on the information above), with and without use of a suppressor. This table assumes that no attenuating factors, such as hills, structures, or vegetation, are involved. See Table 35 for a comparison of sound-level intensity.

TABLE 40: DECIBELS DECREASE AS DISTANCE IS DOUBLED

Distance from Firearm	Decibels without Suppressor	Decibels with Suppressor
1 foot	160	130
2 feet	154	124
4 feet	148	118
8 feet	142	112
16 feet	136	106
32 feet	130	100
64 feet	124	94
128 feet	118	88
256 feet	112	82
512 feet	106	76
1,024 feet	100	70
2,048 feet	94	64
4,096 feet	88	58
8,192 feet	82	52

Noise Levels and Perceived Annoyance

Annoyance is the measured outcome of a community's response to questions on environmental factors, such as noise exposure. Factors directly affecting annoyance from noise include interference with communication and sleep disturbance. Other less-direct effects are disruption of peace of mind, enjoyment of property, and enjoyment of solitude. The consequences of noise-induced annoyance are privately felt dissatisfaction, publicly expressed complaints to authorities, and potential adverse health effects (Suter 1991).

The relationship between noise and annoyance is commonly described as the day-night average sound level (DNL), based on decibels. "Minimal" exposures to noise have been defined as DNLs below 55 dB, and "moderate" as DNLs between 55 and 65 dB (Suter 1991).

Several factors have been found to influence community reaction to noise. These factors include (Noise Pollution Clearinghouse n.d.):

- duration of intruding noises and frequency of occurrence
- time of year (windows open or closed)
- outdoor noise level in community when intruding noises are not present
- history of prior exposure to the noise source
- attitude toward the noise source
- presence of pure tones or impulses

Certain noises, especially those of an impulsive nature, may cause a startle reflex, even at low levels. The startle occurs primarily to prepare for action appropriate to a possible dangerous situation signaled by the sound. The startle reflex can sometimes be followed by a fright reaction, in which case the effects on the circulatory system become more pronounced (WHO 1980).

The particular time of day or year when the sound occurs is important. A few intrusions late at night, at meal times, or during times of relaxation and leisure may produce more annoyance than a constant flow of intrusive sound when people are fully occupied with other activities (Truax 1999).

Certain sounds arouse a negative response because of unpleasant associations surrounding them and what they represent. In some cases, sound phobias may be traced to actual physical characteristics of the sound, namely, loudness, noisiness, or high pitch. More commonly, sound phobias and taboos reflect social values and personal attitudes toward the sound maker (Truax 1999).

Local Noise Ordinances

Many residential communities exist within or adjacent to the Indiana Dunes National Lakeshore. Michigan City, which is located directly east of the national lakeshore's eastern boundary, has a noise ordinance, as does Portage, which is located south of the eastern end of the West Unit. Michigan City limits noise to 60 dB on any private property (Michigan City Municipal Code n.d.). Portage varies its noise limits based on several factors, but permitted levels never exceed 75 dBA (Portage Municipal Code n.d.). Porter County, which includes the towns of Dune Acres and Beverly Shores, did have a noise ordinance, but it was repealed (Porter County Sheriff's Department, pers, comm. 2003). Dune Acres does not have a noise ordinance (R. Tittle, Dune Acres resident, pers. comm. 2003); no information about Beverly Shores' noise ordinance could be obtained.

SOCIOECONOMICS

The following discussion of socioeconomic resources focuses on the potential for deer-related crop damage or landscape plant damage to neighboring properties. In addition, neighboring land users have implemented deer reduction actions to reduce deer-browse damage, thus incurring related costs. No other actions under the alternatives considered would have more than a negligible effect on local or regional socioeconomic conditions. Therefore, the analysis for socioeconomic resources was limited to deer damage on crops and neighbors' landscape plants, as well as impacts on deer reduction activities conducted by local landowners.

Regional and Socioeconomic Overview

Since the creation of the national lakeshore, outside development has increased to the point that most of its boundary now consists of homes, farms, roads, or businesses. Residential communities, open rural areas, light and heavy industry, and agricultural lands exist within or adjacent to the national lakeshore's boundary. Excessive deer browsing has led local communities and the Indiana Dunes State Park to take action regarding white-tailed deer management on their lands. Local farmers with land adjacent to the national lakeshore have received deer damage control permits to hunt deer on their property. These landowners could be affected by NPS deer management activities, which could affect the size of the local deer herd.

The majority of land in the national lakeshore's vicinity is zoned for cropland and pasture. Areas closer to the lake are zoned for residential purposes and are surrounded primarily by forest, with pockets of wetlands and sand dunes (see Figure 11). Three residential communities are surrounded by the national lakeshore's boundaries: Ogden Dunes in the West Unit and Dune Acres and Beverly Shores in the East Unit. The Indiana Dunes State Park is also located within the East Unit. These four entities, as well as local farmers, are most likely to be affected by the national lakeshore's deer management activities. All these entities, with the exception of Ogden Dunes, have taken action in recent years to remove deer from their lands. Local landowners wishing to remove deer from their property must apply for one of two types of permits from the state DNR.

Deer Management Permits

IDNR's Division of Fish and Wildlife encourages the harvest of white-tailed deer during the legal deer-hunting season as the primary control of overabundant deer. Sharpshooting may be permitted if regular hunting is not feasible. Live trapping and euthanasia are permitted if the method does not render the carcass unsuitable for human consumption (IDNR 2005b).

Landowners apply to the IDNR for a permit to remove deer. These permits contain specific restrictions that dictate when shooting can occur, the type of firearm to be used, the number of deer to be taken, and so on. (IDNR 2005b). No fee is charged for these permits (L. Byer, IDNR, pers. comm. July 27, 2006). Some of the national lakeshore's neighboring landowners have received these permits, which are briefly described below (IDNR 2005b).

Special-Purpose Deer Control Permits

When landowners in urban situations submit a deer damage complaint to the IDNR, the IDNR conducts an investigation, completes a deer damage report, and issues a recommendation. If the situation cannot be resolved through use of nonlethal means or regular hunting seasons, the landowner may apply for a Special-Purpose Deer Control Permit (IDNR 2005b). This has been the case for Beverly Shores and Dune Acres. (Farm owners near the national lakeshore receive Deer Damage Control Permits, described below, which are different than the special-purpose permits.)

Special-Purpose Deer Control Permits are considered unusual because they can occur during the regular hunting season, provide for use of weapons not allowed on a normal permit, and last longer than 30 days, meaning they can cross calendar years (L. Byer, IDNR, pers. comm. Sept. 28, 2005). Special-Purpose Deer Control Permits may be issued at any time during the year (IDNR 2005b).

Residential areas, including resource conservation areas, experience pressures from deer browsing. Deer damage shrubs and landscape vegetation by eating the buds, leaves, flowers, and twigs and rubbing on the bark. In home gardens, deer often eat leaves, flowers, stems, or other edible parts of plants and trample plants. Other less frequent damage includes trampling of plants and damage to trees and shrubs caused by antler rubbing (West Virginia University 1985).

Deer damage to landscape ornamental plants is widespread in the Northeast, but it is not evenly distributed across the landscape. Sayre and Decker (1990) indicated that homeowners with deer impacts reported a median loss of $200 per household in southeastern New York, and about three-fourths of these respondents classified the damage as light to moderate. The average replacement cost for trees and shrubs was nearly $500 for households with deer damage.

Deer Damage Control Permits

Agricultural landowners can receive a Deer Damage Control Permit based on damage to crops. When a Deer Damage Control Permit is requested, the IDNR conducts an investigation and completes a deer damage report. The IDNR may recommend that the permit be used concurrently with alternative control methods, which may include sport hunting, as well as nonlethal methods. The permittee is strongly encouraged to allow deer hunting during all deer seasons, particularly the harvest of does. If sport hunting is not implemented during regular deer-hunting seasons, then future permits would typically not be issued. Sport hunting, if viable, must be used in conjunction with Deer Damage Control Permits (IDNR 2005b).

Deer Damage Control Permits are granted when financial losses of $500 or more occur due to deer damage. No damage control permits may extend past September 15 or be issued during the regular hunting season. Permits are issued only when crops are actively growing and before harvest (IDNR 2005b).

Eighty-six percent of the deer damage complaints received statewide in 2003 involved properties with a previous history of deer damage. Of landowners filing complaints, almost all (approximately 95 percent) allowed some deer hunting on their property. Soybeans were the principal crop damaged in 36 percent of the complaints, followed by corn (30 percent). The percentage of crop most commonly lost ranged from 0 to 5 percent (62 percent of all complaints) (IDNR 2004).

Deciduous woodland was the most common type of cover associated with damage (84 percent), followed by river/stream areas (8 percent). Privately owned parcels adjoining damaged property were implicated as a contributing factor to damage in 52 percent of the cases investigated. Governmental land holdings accounted for 35 percent of parcels adjoining damaged property. In 2003, there was a 56-percent statewide increase in the number of deer authorized to be taken compared to 2002 (IDNR 2004).

Agriculture Profile

The total value of crops in the state of Indiana overall decreased in 2005 by 13 percent compared to 2004. Corn production decreased 13 percent, and soybean production decreased 7 percent in the same timeframe. Farmers in the study area that have received Deer Damage Control Permits own agricultural land in Porter and LaPorte counties (details about specific damage is presented below). Neither of these counties is considered among the state's top 10 corn- or soybean-producing counties (NASS 2006). Table 41 shows changes in pertinent farmland statistics for both counties.

TABLE 41: FARM STATISTICS BY COUNTY

	Porter County			LaPorte County		
	1997	2002	Percent Change	1997	2002	Percent Change
Number of Farms	549	606	10	857	817	-5
Land in Farms	138,970 ac.	145,779 ac.	5	252,171 ac.	243,447 ac.	-3
Average Size of Farm	253 ac.	241 ac.	-5	294 ac.	298 ac.	1
Market Value of Production, Average per Farm	$78,120	$61,579	-21	$113,704	$97,139	-15

Source: NASS 2002.

Porter County

A major natural resource for Porter County is its farmland, which makes up half of the county's area. However, the amount of prime farmland in the county is limited to the east-central portion of Porter County. The county comprises an urban and rural mix of land uses, with an abundance of recreational and natural areas, which are located primarily in the northern part of the county, along the shoreline. More than 80 percent of the county can be described as rural due to the agricultural land and this natural environment (woodlands, wetlands, national parks, and shorelands), which is the largest land use classification for the county (Porter County 2001).

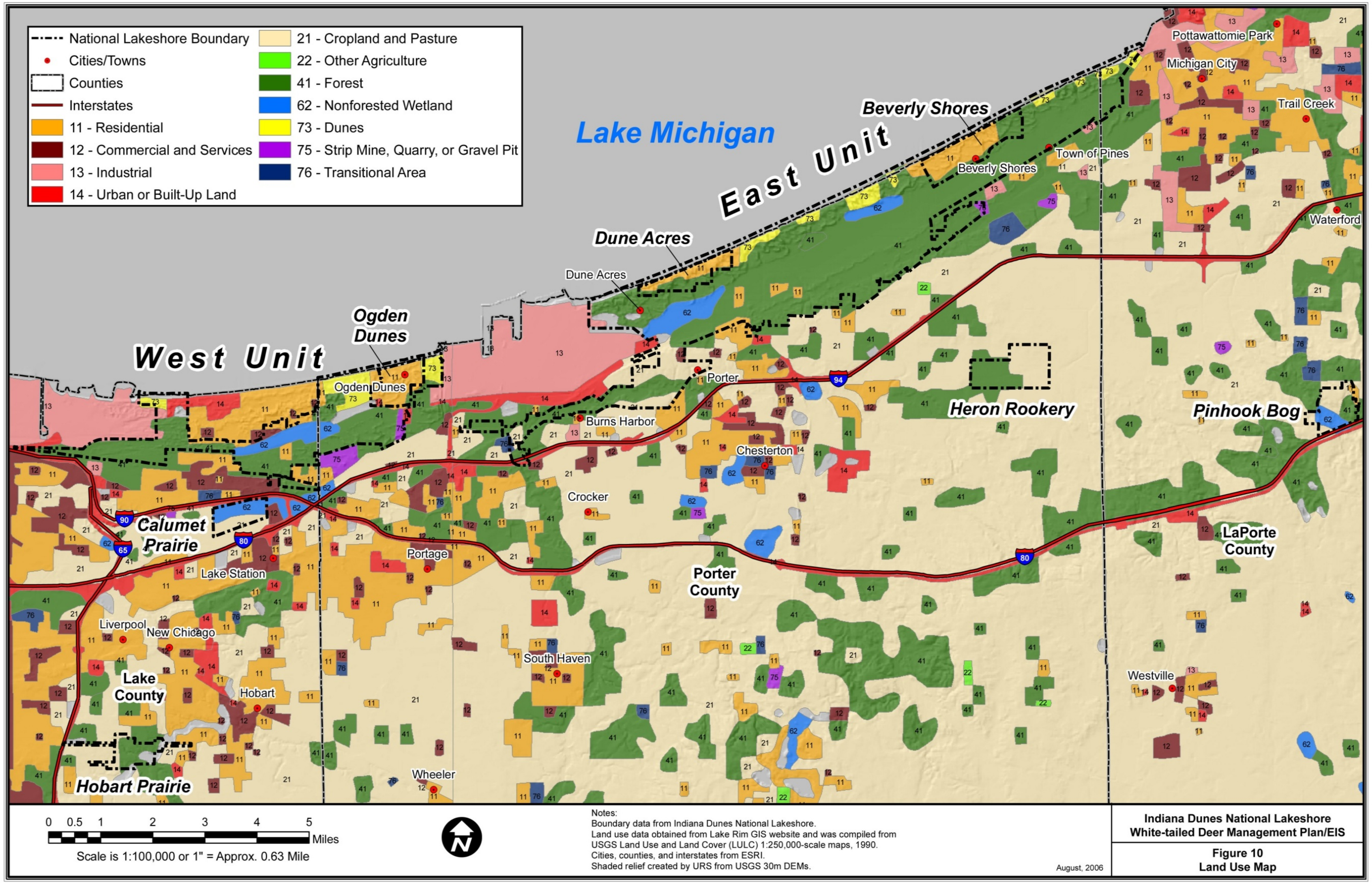
Error! Reference source not found. shows the primary types of crops planted in Porter County. Corn and soybeans, two that received the most deer damage in the study area (66 percent, as indicated above), constitute a large portion of crops planted and harvested in Porter County (Fedstats 2006).

TABLE 42: FIELD CROPS IN 2001, PORTER COUNTY, INDIANA

Crop	Planted (1,000 acres)	Harvested (1,000 acres)	Yield per Harvested Acre (bushels)	Production (1,000 bushels)
Corn	63.2	62.4	139.0	8,674.0
Oats	63.2	62.4	139.0	8,674.0
Soybeans	57.7	57.6	45.9	2,646.4
Wheat, All	2.4	2.4	69.3	166.4
Wheat, Winter	2.4	2.4	69.3	166.4

Source: Fedstats 2006.

FIGURE 11: LAND USE MAP



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LaPorte County

Key trends in agriculture in La Porte County include decreases in the number of farms and total acreage of farms but an increase in the size of individual farms (see Table 41). However, the market value production for both crop and livestock sales decreased $18 million between 1997 and 2002, with the largest decrease seen in crop sales (LaPorte County n.d.). One of the county's objectives is to "protect agricultural lands in areas where agriculture remains economically, ecologically and practically viable" (La Porte County 2006). Table 43 shows that corn and soybeans constitute a large portion of crops planted and harvested in LaPorte County, as in Porter County.

TABLE 43: FIELD CROPS IN 2001, LAPORTE COUNTY, INDIANA

Crop	Planted (1,000 acres)	Harvested (1,000 acres)	Yield per Harvested Acre (bushels)	Production (1,000 bushels)
Corn	114.0	110.3	140.7	15,524.0
Oats	114.0	110.3	140.7	15,524.0
Soybeans	86.5	86.2	47.1	4,059.8
Wheat, All	3.0	2.9	52.6	152.4
Wheat, Winter	3.0	2.9	52.6	152.4

Source: Fedstats 2006.

Deer Management Activities on Neighboring Lands

Neighboring landowners have applied for and received both Special-Purpose Deer Control Permits and Deer Damage Control Permits. Table 44 shows the number of deer taken by the largest landowners in the vicinity of the national lakeshore. The text below describes the history of each landowner's deer management actions in the context of the national lakeshore's individual management units, from west to east.

TABLE 44: REGIONAL WHITE-TAILED DEER REMOVAL NUMBERS FOR ENTITIES SURROUNDING INDIANA DUNES NATIONAL LAKESHORE

	Dune Acres	Indiana Dunes State Park	Beverly Shores
1997-1998	50	0	0
1998-1999	0	201	0
1999-2000	19	117	0
2000-2001	<10*	102	1
2001-2002	25	53	78
2002-2003	25	No hunt	53
2003-2004	30	99	161
2004-2005	50	48	116
Total	~208	620	409

* Permit was for 10 deer.
~ Estimate; exact number not known.
Source: NPS 2003d; L. Byer, IDNR, pers. comm. Sept. 20, 2005, Sept. 13, 2005, July 27, 2006.

West Unit

The national lakeshore's West Unit is primarily surrounded by tracts of residential land, particularly fronting Lake Michigan (including the community of Ogden Dunes). Pockets of cropland and pasture exist southeast of this unit, with residential and commercial services in the remaining areas to the south, as far as Highway 90. Industrial areas occur directly east and west of this unit (see Land Use Map on page 179).

According to NPS staff, the West Unit's deer population is currently not as high as the East Unit's. Deer in the West Unit tend to congregate near the Inland Marsh, where they can feed on neighboring agricultural lands.

Inland Marsh Area

The Inland Marsh is part of national lakeshore property located within the West Unit, south of Highway 12 and north of Highway 94, just east of County Line Road. Deer prefer to bed down in this area during the night and feed during the day on the private agricultural land that exists south of the marsh (and outside national lakeshore boundaries) (NPS 2003d).

In August 2002, the IDNR completed a deer damage report for a farm south of Inland Marsh. The report states that 1 to 5 percent of the total crop was lost to deer browsing, or three-quarters of the yield on 3 acres of soybeans. The national lakeshore provides vegetative cover for the deer, which follow access roads along the farm fields. Losing 1 acre of beans equals $180 to $240 worth of damage. The total estimated damage was $1,000. Figure 12 shows crop damage at this farm from deer browsing (L. Byer, IDNR, pers. comm. Sept. 5, 2003).

The farm owner was permitted to harvest (under a Deer Damage Control Permit) 10 deer during the 2003 regular hunting season and was issued another permit for an additional 10 in 2004. Between January 31, 2004, and February 29, 2004, 3 deer were taken by firearm. In June 2004, the IDNR changed its procedures for issuing agricultural deer damage permits and now issues only agricultural damage permits during the growing season. In July 2004, the farm owner requested and received two additional permits. From July 31 through August 29, 2004, 16 deer were taken, and from September 1 through September 14, 2004, 7 deer were taken (L. Byer, IDNR, pers. comm. Sept. 13, 2005). Ten deer were also taken in 2005 (B. Porch, IDNR, pers. comm. 2006). This landowner owns or farms most of the undeveloped land in this area that is not owned by the national lakeshore (L. Byer, IDNR, pers. comm. Feb. 4, 2004).

FIGURE 12: CROP DAMAGE FROM DEER BROWSING

Ogden Dunes

Ogden Dunes is a community of approximately 1,300 people in the northwestern end of the national lakeshore's West Unit. Like the other communities near the national lakeshore, Ogden Dunes is located north of Highway 12 and abuts Lake Michigan. Unlike the communities in the East Unit, Ogden Dunes has taken no action regarding deer management.

As of February 2004, the IDNR had received no complaints about deer browse from Ogden Dunes or any other business, community, or entity in or near the national lakeshore's West Unit (L. Byer, IDNR, pers. comm. Feb. 4, 2004).

East Unit

Local residents, particularly near the East Unit, have lost an unspecified amount of money due to browsing on ornamental and landscape vegetation in the communities surrounding the national lakeshore.

The East Unit is roughly divided in half by the Indiana Dunes State Park, which fronts Lake Michigan and includes primarily deciduous forest, with pockets of wetlands and dunes. A sliver of national lakeshore land occurs south of this park. National lakeshore land is surrounded primarily by cropland and pasture to the south, with small, primarily residential areas, punctuated with areas of deciduous forest. Smaller parcels of commercial and industrial areas also exist south of the national lakeshore. Two residential communities exist along the lake within the East Unit, one at each end (Dune Acres to the west and Beverly Shores to the east) (see map, page 7).

A 16-member Dunes Region Deer Study Committee was formed in February 1999 to "develop recommendations for the IDNR, other land holding agencies, and communities for managing deer along the Lake Michigan shoreline" (Case and Sang 1999). The areas of specific concern included the Indiana Dunes State Park, the Indiana Dunes National Lakeshore, and the towns of Dune Acres and Beverly Shores—all of which are located in or near the national lakeshore's East Unit. The committee meetings resulted in the recommendation of sharpshooting and controlled hunts (firearms and bow). The community of Dune Acres was the first to implement a deer management program in the area, followed by the Indiana Dunes State Park and the community of Beverly Shores (all of which are located within the national lakeshore's boundaries).

Dune Acres

Dune Acres (with approximately 260 residents) is in the northwestern end of the national lakeshore's East Unit, along the southern shore of Lake Michigan. Dune Acres implemented deer management controls using sharpshooters to decrease deer numbers. This program has been in place since 1997, with 50 deer taken the first year and between 0 and 50 deer taken in following years. A Commission Report from the Deer Committee presented on April 22, 2003, stated that 25 deer had been removed from November 1, 2003, through March 31, 2004, at a cost of $317.47, or $12.70 per deer. The number of deer counted in aerial surveys has consistently ranged from 50 to 60/mi^2 over the past few years (Dune Acres Indiana 2004).

The town works with the IDNR to develop an annual assessment of deer damage to determine the number of deer to remove the following year. The IDNR provides a Special-Purpose Deer Control Permit to allow the use of rifles. Deer must be tagged and used for human consumption (L. Byer, IDNR, pers. comm. Sept. 5, 2003). These efforts, which have been keeping the deer population constant, are expected to continue indefinitely into the future (R. Tittle, Dune Acres resident, pers. comm. Sept. 2, 2003).

The IDNR conducted a deer damage survey of Dune Acres on August 6, 2003. The damage report stated, "there is still extensive browsing occurring on both landscaping plants and native vegetation throughout the area. At each location it was quite easy to see evidence of deer browse, some areas more severe than others." The report recommended that the IDNR "start their permit on November 17, 2003, and allow them [Dune Acres] to take an additional 10 deer so they can take advantage of the influx of deer that may occur from the state park hunt" (L. Byer, IDNR, pers. comm. Sept. 5, 2003). The town also obtained a permit to remove 40 deer between November 1, 2004, and March 31, 2005 (L. Byer, IDNR, pers. comm. Sept. 13, 2005).

Indiana Dunes State Park

Indiana Dunes State Park consists of 2,182 acres located in the north-central part of the national lakeshore's East Unit in Porter County. The Indiana State Legislature passed a law in 1995 directing the IDNR to take action within any or all state parks whenever a given species was causing or was likely to cause ecological damage. The Indiana Dunes State Park began its deer reduction plan (public hunt) in 1998. The state park is now in a deer management "maintenance phase," during which the goal is to keep the deer herd at a level that is compatible with a park's ecosystem (IDNR n.d.a). Reductions in deer removal occur when the previous year's removal exceeds 16 deer/mi^2 of deer habitat or exceeds 0.2 deer remov5d per hunter effort (firearm reductions). Whenever a year's removal falls below these criteria, no removal occurs during the following year, but a removal would be implemented after skipping one year. The hunts at the Indiana Dunes State Park have continued each year through 2001. The yearly hunt was skipped in 2002 because there was no need (Lasorda 2003a). Deer reductions were resumed in 2003 and have continued since (IDNR n.d.a).

The state park employs 10 people who work on managing the deer hunts, which occur over a period of four days each year that a hunt occurs. Each person works four 8-hour days plus overtime during the hunts (with the exception of the park manager, whose overtime work is unpaid), for a total of $9,280. The park also spends approximately $200 for traffic control signs, gas, and other items related to managing the hunt. The total yearly expenditure (when hunts occur) for the state park is approximately $9,500 (B. Baughman, Indiana Dunes State Park, pers. comm. n.d.).

Beverly Shores

Beverly Shores (with approximately 708 residents) is a 2,300-acre municipality in Porter County, Indiana (Beverly Shores Plan Commission 2003). Beverly Shores began working on deer management issues in 1998. Bow hunting by resident invitation to control the deer population began in the 2001–2002 season and has continued since (Beglin and Drake 2001).

The town's goals are to bring the deer number down to 50 or fewer. Beverly Shores would apply for a Special-Purpose Deer Control Permit if the herd totals 75 deer or more. If the herd size reaches 50, the town would no longer apply for a special cull permit but would allow hunting on private property. The town would prefer the herd size to stabilize at 20 deer but believes that this is likely an unrealistic expectation (B. Beglin, Beverly Shores resident and member, Environmental Restoration Group, pers. comm. Feb. 3, 2004).

If hunters conduct the removals, the town incurs minimal costs because hunters dress the animals themselves. The town has spent approximately $200 to $300 per hunt. For removal efforts that are not open to hunting, the town pays for processing the meat, approximately $25 or $75 for an entire deer, depending on the type of process (B. Beglin, Beverly Shores resident and member, Environmental Restoration Group, pers. comm. Feb. 3, 2004).

Pinhook Bog

Farmers adjacent to Pinhook Bog have also received Deer Damage Control Permits. Some of these farms are 0.25 and 0.5 mile from the national lakeshore boundaries. One farmer began receiving Deer Damage Control Permits when the permit process was first implemented. Since 2003, there has been an increase in the number of landowners requesting and receiving permits. The list below shows the total number of deer taken by all farmers in the area since 2003 (L. Byer, IDNR, pers. comm.., Sept. 28, 2005, July 27, 2006).

- 2003: 10 deer taken
- 2004: 7 deer taken
- 2005: 26 deer taken
- mid-2006: 10 deer taken

NATIONAL LAKESHORE MANAGEMENT AND OPERATIONS

The national lakeshore's acreage has continued to grow in the past two decades, increasing by 17 percent, from 12,535 to 15,100 acres. Increased acreage results in greater personnel demands for resource protection and monitoring. The national lakeshore has also experienced dramatic increases in infrastructure, greatly contributing to the overall operating costs (NPS 2001c).

The Indiana Dunes National Lakeshore had 94.76 full-time equivalent (FTE) employees and 21.26 seasonal FTE employees in 2005. Of this number, 14.74 full-time and 6.02 seasonal staff members were employed in resource and visitor protection. An additional 12.31 full-time and 4.7 seasonal staff members were employed in natural and cultural resource management (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Aug. 1, 2006).

The national lakeshore continues to focus operating support toward resource preservation. The Resource Management staff (described in more detail below) is responsible for conducting all deer management operations. Currently, the Wildlife staff (under Resource Management) is limited to two individuals, and no additional Resource Management staff is expected (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. May 13, 2004). Resource Management is fairly well staffed when compared to other NPS units (NPS 2003d).

The national lakeshore also uses volunteers, who could help perform limited and very specific deer management activities, such as fencing (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. May 13, 2004). Volunteer participation increased from 11,600 hours in fiscal year (FY) 1998 to 12,852 hours in 2002, reflecting a 10-percent increase in volunteers during that time period.

Partners also provide support for national lakeshore operations. Ninety percent of cooperating support comes in the form of competitive grants. Grants continue to exceed $100,000 per year and have been used to begin wetland restoration. The national lakeshore also receives assistance in providing environmental education through a partner, the Indiana Dunes Environmental Learning Center (IDELC). The national lakeshore has been funded as one of several servicewide learning centers. These funds provided for two additional employees in 2002 (NPS 2003a).

The Indiana Dunes National Lakeshore is part of the Great Lakes inventory and monitoring network. Individuals in this program inventory taxi and monitor the vital signs of the national lakeshore's ecosystem. Pilot monitoring programs, such as water quality, have started in several of the parks in the program. It is possible that some deer monitoring tasks could be conducted under the inventory and monitoring program. The program is currently identifying which vital signs to monitor. The next step is to determine how to conduct the monitoring. The monitoring program would continue to develop and expand over the next several years (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. May 13, 2004, August 21, 2006).

The West Unit includes some of the most intensively used recreation areas in the national lakeshore. West Beach, which stretches for more than a mile along the shore of Lake Michigan, is a very popular recreation destination. At West Beach, the NPS maintains more than 1 mile of beach and 3 miles of road and parking-area pavements, operates the visitor and information center and associated services and interpretive programs, provides picnic and trail facilities, and manages natural resources (NPS 1993a).

Illegal poaching occurs in the national lakeshore, and the ranger division (approximately 14 rangers in 2002) has a difficult time patrolling the entire national lakeshore. Illegal poaching constitutes a small part of ranger law enforcement; most law enforcement involves visitor service issues (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Aug. 2, 2006).

Interpretation

Interpretive rangers provide educational information to the public and currently include information about deer in their interpretive programs. Interpretation is given through formal interpretive programs, as well as informal, roving interpretation on the beaches and trails; environmental education; and off-site education programs. Rangers work as public information officers and become more actively involved with the public, depending on the level of public interest. They give the public updates on projects and incorporate topics of interest into educational and interpretive programs (NPS 2001c; R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Aug. 2, 2006).

Resource and Visitor Protection

The national lakeshore's visitor safety services include search and rescue, investigations, and patrols of national lakeshore boundaries and high-traffic areas. One such area is Dunewood Campground; the campground has become a persistent source of incidents requiring a law enforcement presence. The visitor protection division also coordinates community programs, such as a Water Safety Exposition and a Drug Awareness and Resistance Education (DARE) program. The challenges facing visitor safety services involve the national lakeshore's uneven and complex boundaries. Boundaries stretch over 15,000 acres, including the 2,182 acres of the Indiana Dunes State Park, managed by the IDNR, and involve co-jurisdictional areas with bordering communities. High levels of trespasses and crimes follow from the high level of visitation (NPS 2001c).

Maintenance

Maintenance activities are designed to protect and prolong the life of national lakeshore assets. These assets include capital improvements through major repairs to equipment, facilities, or structures, as well as construction of new national lakeshore assets. Some of the maintained assets through this program include 215 vehicles, 103 buildings, 45 miles of trails, and 36 parking areas. Maintenance activities at the national lakeshore ensure that all operations meet and comply with U.S. public health codes, the Americans with Disabilities Act, Indiana Department of Transportation and EPA regulations, and any other applicable federal, state, and local regulations. In addition, all activities conform to NPS regulations and director's orders. Such activities include cyclic repairs, restoration of modern and historic structures, and maintenance of water treatment systems throughout the national lakeshore. Maintenance activities fall under three categories: building maintenance, road maintenance, and utility maintenance (NPS 2001c). Maintenance of deer exclosures could affect personnel assigned to building maintenance activities. Changes to the rate of deer–vehicle collisions could affect roadway maintenance, such as possible redesign or other efforts to improve safety in areas of high deer–vehicle collisions.

Building Maintenance

The building maintenance program oversees all major repairs and reconstruction projects for all national lakeshore facilities. Building maintenance activities include major in-house, day-labor projects; contracted rehabilitation work; stabilization of facilities in poor condition; and boarding up and securing of vacant structures waiting for demolition. In addition, overnight facilities must provide safe accommodations and meet public health, sanitation, and life safety code requirements (NPS 2001c).

Road Maintenance

Professional national lakeshore staff, federal highway engineers, and private engineering firms perform major roadway designs and alterations to improve and maintain road safety. Fifty-eight miles of roads and parking areas are located and dispersed through dunes, wetlands, and other types of terrain in the national lakeshore (NPS 2001c).

Management and Administration

The management and administration program provides leadership and support to ensure that the national lakeshore operates as efficiently as possible and according to its mission. Because the national lakeshore is located in a highly developed area, there is a need for extensive communication and partnerships with the public regarding controversial issues, including air and water quality, deer management, and land use. National lakeshore staff and leadership work closely with local, state, and federal agencies and activist groups, including 11 separate municipalities; 3 county governments; regional and state organizations; and federal environmental, transportation, and regulatory offices (NPS 2001c).

Resource Management

Resource management includes management of natural and cultural resources, information integration and analysis, and coordination of these programs. Urban expansion that occurred in the area before the national lakeshore's establishment has led to heavy pressure on national lakeshore resources. The Indiana Dunes National Lakeshore must meet state and federal monitoring requirements, rehabilitate degraded resources, and mitigate future resource damage (NPS 2001c).

Vegetation Management and Restoration


Habitat improvement work

The national lakeshore's mission statement charges it with "the preservation of the national lakeshore's unique flora, fauna, and physiographic conditions and its historic sites and structures." This requires rehabilitation of a variety of ecosystems that have been affected by urbanization of the area. Government lands are increasingly important as refuges for sensitive species, particularly in urban areas; thus, vegetation management at the national lakeshore also includes assessment of rare botanical species and development and implementation of recovery plans (NPS 2001c).

Environmental Monitoring

Vegetation is affected by the quality of the air and water in the area. Because the national lakeshore provides many beaches for visitor enjoyment, environmental monitoring and protection are important activities (NPS 2001c).

Invasive Species Control

Invasive nonnative plant species transplanted into home sites for landscaping and agricultural purposes are rapidly diminishing the quality and stability of the microenvironments that the national lakeshore was established to protect. The problem is so pervasive that no resource management action proceeds without some form of invasive species control as a preliminary step. Control also involves inventory, monitoring, and mapping. Volunteers provide assistance mainly in invasive species control actions and wetland and prairie restoration (NPS 2001c).

Wildlife

The Indiana Dunes National Lakeshore is the only NPS unit to have the Karner blue butterfly—a federally listed endangered species—within its boundaries. Protection of the Karner blue butterfly has thus become an important operation at the national lakeshore. Staff monitors wildlife species to assess their status (NPS 2001c).

Fire Management

Fire management program personnel suppress all wildland fires in and near national lakeshore lands and work with other national lakeshore personnel to replicate the natural role of fire in the management of the national lakeshore's ecosystems. The national lakeshore's fire team is mobile and ready to respond on a local, regional, or national level to assist other areas in their fire suppression operations (NPS 2001c).

Chapter 4
ENVIRONMENTAL CONSEQUENCES

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

This chapter analyzes the likely beneficial and adverse effects of implementing any of the alternatives considered in this *Final White-Tailed Deer Management Plan/Environmental Impact Statement*. This chapter also includes a summary of laws and policies relevant to each impact topic, definitions of impact thresholds (negligible, minor, moderate, and major), methods used to analyze impact, and analysis methods used for determining cumulative effects. As required by the Council on Environmental Quality (CEQ), regulations implementing NEPA and a summary of the environmental consequences for each alternative are provided in Table 14, which can be found in Chapter 2: Alternatives. The resource topics presented in this chapter and the organization of the topics correspond to the resource discussions in Chapter 3: Affected Environment.

INTRODUCTION

Summary of Laws and Policies

Three overarching environmental laws and their implementing policies guide the actions of the NPS in managing parks and their resources: the Organic Act of 1916, NEPA and its implementing regulations, and the National Park Omnibus Management Act. These guiding authorities are briefly described below. For a complete discussion of these and other guiding authorities, refer to the section titled "Related Laws, Policies, Plans, and Constraints" in Chapter 1: Purpose of and Need for Action.

The Organic Act of 1916 (16 USC 1), as amended or supplemented, commits the NPS to making informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations.

NEPA is implemented through regulations of the CEQ (40 CFR 1500–1508). The NPS has, in turn, adopted procedures to comply with these requirements, as found in Director's Order #12 (NPS 2001b) and its accompanying handbook.

The National Park Omnibus Management Act (16 USC 5901 et seq.) underscores the NEPA provisions in that both acts are fundamental to park management decisions. Both acts provide direction for connecting resource management decisions to impact analysis and communicating the effects of those decisions to the public using appropriate technical and scientific information. Both acts also recognize that such data might not be readily available, and they provide options for resource impact analysis if necessary. Section 4.5 of Director's Order #12 adds to this guidance: "When it is not possible to modify alternatives to eliminate an activity with unknown or uncertain potential impact, and such information is essential to making a well-reasoned decision, the National Park Service will follow the provisions of the CEQ regulations (40 CFR 1502.22)."

In summary, the NPS must include in an environmental assessment or impact statement (1) a discussion of whether such information is incomplete or unavailable; (2) the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable, significant adverse impact on the human environment; (3) a summary of existing, credible, scientifically supported adverse impact information that is relevant to evaluating the impact; and (4) an evaluation of such impact based on theoretical approaches or research methods generally accepted in the scientific community. Collectively, these documents provide a framework and a process for evaluating the impact of the alternatives considered in the final EIS.

General Methodology for Establishing Impact Thresholds and Measuring Effects by Resource

The general approach for establishing impact thresholds and measuring the effects of alternatives on each resource category includes the following elements:

- general analysis methods as described in guiding regulations, including the context and duration of environmental effects
- basic assumptions used to formulate the specific methods used in the analysis
- thresholds used to define the level of impact resulting from each alternative
- methods used to evaluate the cumulative effects of each alternative in combination with unrelated factors or actions affecting Indiana Dunes National Lakeshore resources
- methods and thresholds used to determine whether impairment of specific resources would occur under any alternative

These elements are described in the following sections.

General Analysis Methods

The analysis of impact follows CEQ guidelines and Director's Order #12 procedures (NPS 2001b) and is based on the underlying goal of supporting herbaceous plant reproduction and distribution and providing for long-term protection, conservation, and restoration of native species and cultural landscapes at Indiana Dunes National Lakeshore. This analysis incorporates the best available scientific literature applicable to the region and setting, the species being evaluated, and the actions being considered in the alternatives.

As described in Chapter 1: Purpose of and Need for Action, the NPS created an interdisciplinary science team to contribute important information to the impact analysis. For each resource topic addressed in this chapter, the applicable analysis methods are discussed, including assumptions and impact definitions.

Assumptions

Several guiding assumptions provide context for this analysis. These assumptions are described below.

Analysis Period

Goals, objectives, and specific implementation actions for managing deer at Indiana Dunes National Lakeshore are established for the next 15 years; therefore, the analysis period used for assessing impacts is up to 15 years. The impact analysis for each alternative is based on the principles of adaptive management, enabling the NPS to change management actions as information from monitoring the results of management actions and ongoing research emerges throughout the life of this plan.

Geographic Area Evaluated for Impact (Area of Analysis)

The geographic study area (or area of analysis) for this plan includes Indiana Dunes National Lakeshore in its entirety. The area of analysis may extend beyond the national lakeshore's boundaries for some cumulative impact assessments. The specific area of analysis for each impact topic is defined at the beginning of each topic discussion.

Duration and Type of Impact

The following assumptions are used for all impact topics (the terms "impact" and "effect" are used interchangeably throughout this document):

- Short-term impact: Would last from a few days up to 3 years following an action.
- Long-term impact: Would last longer than 3 years up to the life of the plan (15 years).
- Direct impact: Would occur as a direct result of deer management actions.
- Indirect impact: Would occur from deer management actions and would occur later in time or farther in distance from the action.

Future Trends

Visitor use and demand are expected to be similar to the trends noted in recent years. The number of yearly visitors to Indiana Dunes National Lakeshore has fluctuated in the past 15 years. A large increase occurred in 1998 (42.1 percent). Other years show increases ranging from 4.1 percent to 14.7 percent (2002) and decreases ranging from 0.2 percent to 17.1 percent. Visitation was down in 2003 and 2004 but spiked in 2005 with a 17.5-percent increase. A 1.1-percent decrease was expected in 2006, followed by a 2.9-percent increase in 2007, based on forecasts developed by the NPS Public Use Statistics Office (NPS 2006e). In the absence of notable anticipated changes in facilities or access, a 1.5-percent annual increase in visitation is expected over the life of this plan.

Impact Thresholds

Determining impact thresholds is a key component in applying NPS *Management Policies 2006* and Director's Order #12. These thresholds suggest the intensity of a given impact on a specific topic. The impact threshold is determined primarily by comparing the effect to a relevant standard based on regulations, scientific literature and research, or best professional judgment. Because definitions of intensity vary by impact topic, they are provided separately for each topic and cover negligible, minor, moderate, and major impacts. In all cases, the impact thresholds are defined for adverse impact. Beneficial impact is addressed qualitatively.

Cumulative Effects Analysis Method

The CEQ regulations to implement NEPA require assessing cumulative impact in the decisionmaking process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or nonfederal) or person undertakes such other actions (40 CFR 1508.7)." As stated in the CEQ handbook "Considering Cumulative Effects" (CEQ 1997), cumulative effects must be analyzed in terms of the specific resource, ecosystem, and human community being affected, and any analysis should focus on effects that are truly meaningful. Cumulative impacts were evaluated for all alternatives, including alternative A.

Cumulative impact was determined by combining the impact of the alternative being considered with other past, present, and reasonably foreseeable future actions. Therefore, identifying such projects and plans at Indiana Dunes National Lakeshore and, if applicable, the surrounding area was essential. Table 45 summarizes actions that could affect the various resources at the national lakeshore, and the following narrative discusses those requiring additional explanation.

Cumulative effect analysis encompasses four steps:

- Step 1 — Identify resources affected: fully identify resources affected by any of the alternatives.
- Step 2 — Set boundaries: identify an appropriate spatial and temporal boundary for each resource.
- Step 3 — Identify cumulative action scenario: determine which past, present, and reasonably foreseeable future actions to include with each resource.
- Step 4 — Analyze cumulative impact: summarize the effect of these other actions (x) plus the impact of the proposed action (y) to arrive at the total cumulative impact (z).

Cumulative Impact Scenario

Past Actions in and around Indiana Dunes National Lakeshore

Logging changed the species composition of the forest and caused erosion in the dunes of the national lakeshore. Farming resulted in drainage of wetlands, introduction of exotic species, and extirpation of predatory animals. Subsequent residential development accelerated the ditching and drainage of wetlands, modified land use, and added large numbers of structures. Industrial expansion exacerbated these effects and increased air pollution, as well. As development increased, so did efforts to suppress naturally occurring fires. The effects of development have determined the way Indiana Dunes National Lakeshore is managed today. Resource managers are mitigating the damage done in the past (NPS n.d.c).

National lakeshore boundary expansions occurred in 1976, 1980, 1986, and 1992. Crescent Dune was acquired from NIPSCO in 1996 (NPS 1998). The national lakeshore's headquarters area is an old Nike missile base that has been rehabilitated, including demolition of radar towers and fences in 1984 (NPS 1998).

Vegetation

In the early 1900s, the U.S. Steel Company built a steel mill on 9,000 acres, including 7 miles of shoreline. In 1929, Midwest Steel and NIPSCO purchased hundreds of acres in the dunes area for industrial plants. In the early 1960s, Midwest Steel constructed a finishing plant in the area. By the mid-1960s, Bethlehem Steel transferred 20,000 to 25,000 cubic yards of sand a day, leveling hills and filling swamps and marshes, to construct steel-making facilities. NIPSCO began developing its property, constructing two coal-fired generating stations and a substation, a transmission line corridor, and support facilities. These facilities and the Port of Indiana harbor have contributed to deterioration of plant and animal habitats through air and water pollution. Massive landfills have caused alteration of natural drainage patterns. These processes have continued and accelerated. Inadequate disposal of industrial waste products also threatens the entire dunes area (Shirley Heinze Environmental Fund 1997).

Logging and sand mining began in the late 1800s, and hundreds of acres of dunes were denuded and leveled along the Porter County shoreline. Large areas of the Little Calumet marshlands were drained for agriculture after Burns Ditch was constructed from 1924 to 1926. Drainage projects were also implemented along the western end of the Great Marsh; however, the ditches and farmland in this area were abandoned between 1938 and 1951, and it is suspected that drainage might not have been successful there (NPS 1986). Sections of the Great Marsh still exist today, and the marsh is being restored.

The savannah complex near the visitor center has been grazed heavily and long unburned, although recently, the national lakeshore has been burning some of the savannah and prairie areas. The area has been so seriously damaged by logging, farming, and residential development that much of the remnant species reside in disturbed swamps, marshes, ditches, and dry sands, where agricultural weeds are less competitive (Wilhelm 1990).

The area south of U.S. Route 12 has suffered from logging, fire suppression, grading, and water level alterations. In 1980, a fire swept over part of the Tamarak Unit. Dense black-oak scrub land bloomed into black-oak savanna. The NIPSCO substation at the northwest portion of the Hoosier Prairie has been subject to regular mowing and disturbances resulting from maintenance vehicles (Wilhelm 1990).

All of the mesophytic forest in the Heron Rookery has been logged in the past; the south half seems to have been logged at a much earlier time than most of the portion north of the Little Calumet River. The northern portions experienced intense grazing in the past. Most of the 210 acres of recent acquisition to the east are old farmland. This unit is home to 173 native species (Wilhelm 1990).

From 1963 to 1972 in Pinhook Bog, highway salt from a nearby storage bin drained into the southern basin and impacted 5 acres of the 90-acre peatland. Homogeneous stands of cattail have replaced the bog species and are the most prevalent in this area of disturbance. Other species have also invaded this area and are not common elsewhere in the bog. As noted by one researcher "Although the native plant community has shown favorable responses to the declining salt concentrations, there appear to be some limitations to the extent of recovery." The timber on slopes of the mesophytic forest and savanna complex buffers the bog, preventing eroding silts from flowing freely into the bog, carrying excessive quantities of calcium and magnesium bicarbonates (Wilhelm 1990).

Sensitive and Rare Species

Anthropogenic disturbances, such as alterations to natural drainage, interruption of natural fire regimes, agricultural land use, residential and industrial development, and recreational use, have seriously impacted species diversity and habitats in the national lakeshore (NPS 1995c).

The number of plant species now identified as extinct in Indiana Dunes National Lakeshore is 25, whereas in 1986, the number was 16. This alarming increase in loss of plant species implies habitat degradation and may serve as an indicator of an overall decline in the health of the ecosystem (NPS 1995c).

Many larger mammals disappeared as they became too closely associated with people and as their habitat diminished and fragmented. These species include porcupine, gray wolf, black bear, fisher, river otter, mountain lion, lynx (perhaps), bobcat, elk, and bison. Small mammal diversity and numbers may have been reduced by the effects of minerals and chemicals entering the soils from the many factories in the area (Whitaker et al. 1994).

Urban encroachment surrounding the national lakeshore boundary—primarily from residential and commercial development—has fragmented Karner blue butterfly habitat and reduced optimal habitat patch size. Small patches of Karner blue butterfly habitat should be joined by such connection corridors as railroad rights-of-way, open paths, and small patches of suitable habitat that provide an incentive for the butterflies to move through. Maintaining these corridors is essential to the survival of Karner blue butterfly metapopulations (NPS 2003g).

Although the decline of the Karner blue butterfly can be attributed to many factors, lack of fire is a major component. The absence of fire in oak savannas increases the canopy and understory density, restricting growth of lupine and nectar plants, which generally require open canopies. Because the Karner blue butterfly primarily feeds on lupine, the loss of habitat can be directly correlated to the absence of fire (NPS 2003g).

Bald eagle populations began to decline in the early 1800s as a result of shooting for feathers and trophies and of poisoning campaigns against livestock predators. Habitat loss to development contributed to a reduction in bald eagle numbers through the 1940s. Also in the 1940s, the use of dichloro-diphenyl-trichloroethane (DDT) was initiated to control mosquitoes in wetland areas and as a crop-pest insecticide, the use of which resulted in thin eagle eggshells and nesting failure. The EPA banned the use of DDT in the United States in 1972. Following this ban and the passing of the Endangered Species Act in 1973, the bald eagle started to recover and has since met or exceeded the goals established by the recovery plans (NPS 2003g).

Water Quality

A section of the West Unit of the national lakeshore abuts an industrial landfill. This landfill has received millions of tons of steel slag and other industrial waste. In some areas, the landfill along the western edge of the national lakeshore directly affects wetlands that are part of the national lakeshore property. Inadequate data exist to quantify the contaminant levels in sediments or organisms in proximity to this landfill (NPS 1995c).

Industry and agriculture have also influenced ground- and surface-water resources as a result of ditching, the creation of artificial ponds, and the installation of pumping wells. Channelizing streams, including the Little Calumet River, and ditching of wetlands have modified water flow and altered ecosystems (NPS 1995c).

In 1995, the NPS Water Resources Division funded the experimental closure of a portion of Derby Ditch in association with a pilot wetland restoration project. The restoration project included extensive pre-impoundment data on hydrological responses and vegetational changes for the proposed impoundment and surrounding wetland areas. These factors would continue to be tracked and monitored if a water-control structure(s) and subsequent ditch closure were to be built in the designated restoration area. Intensive hydrological monitoring would yield sufficient data to build a predictive computer model of water levels and flow that would help the national lakeshore conduct additional wetland restorations within the Derby Ditch watershed, as well as other disturbed wetland habitats in the national lakeshore (NPS 1995c).

Current Actions in and Adjacent to Indiana Dunes National Lakeshore

Vegetation

The number of plant species thought to be extirpated in the Indiana Dunes National Lakeshore area has risen substantially and may be as many as 90. Research indicates that the single factor most responsible for this extirpation has been and continues to be the destruction or loss of natural habitat (NPS 1986). Most endangered plant species are in a state of decline associated with habitat modification. Additionally, exotic species continue to threaten established populations of endangered and threatened species. Other major threats include interference with such natural disturbance processes as fire; human trampling caused by overuse of an area for commercial, sporting, or educational purposes; beach erosion; and degradation of air quality (NPS 1986).

Trampling by visitors continues, as does illegal collecting of both plants and animals (NPS 1993b). The foredune complex is under "nearly constant abuse" from the foot traffic of visitors who wander off trails. Such activity keeps the sands in a highly exaggerated state (Wilhelm 1990).

About 20 percent of the West Beach unit has been "obliterated" by sand mining, primarily in the area of the national lakeshore formerly known as Long Lake Dunes (Wilhelm 1990). Sand mining also has occurred south of the Inland Marsh parking lot area (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. July 20, 2006).

The national lakeshore is restoring portions of an extensive wetland complex called the Great Marsh south of the primary dunes in its eastern half. Virtually all of what was once known as the Great Marsh had been "obliterated" by drainage, cultivation, and fluctuating water levels (Wilhelm 1990). By plugging ditches, restoring the area's hydrology, removing invasive plants, and planting native species, the national lakeshore is re-creating this diverse ecosystem. Because wetlands naturally filter contaminated water, restoring the Great Marsh will also help to improve the area's water quality (NPS n.d.c).

Threats to plants in the Miller Woods zone come from high amounts of wind-blown sand, resulting from damage caused by off-road vehicles and foot traffic on the nearby dunes. Substantial declines of seaside spurge (*Euphorbia polygonifolia*) have occurred in the beach area. Half of the large westernmost pond, the richest and most stable panne in the national lakeshore, has been "obliterated" by a large slag pile (Wilhelm 1990).

The Little Calumet River carries heavy amounts of silt from eroded and row-cropped uplands in its watershed, resulting in abrasion and deposit of silts during floods. The forests along the bluffs are now confined to steep slopes, the upper edges of which interface with open, highly disturbed, often artificial habitats, which discourage stability in ground-cover vegetation (Wilhelm 1990).

Although manipulation of the national lakeshore has been extensive, development has now stopped for the area under NPS jurisdiction. The area is still used, but the general trend is now toward natural seral stages. Nearly all of the old structures are being razed (about 700 by 2010), and some roads are being restored to former habitats. Much of the farmland is returning to its natural state and is in various seral stages, such as grassland, shrubland, or young forest (Whitaker et al. 1994).

White-Tailed Deer

CWD) has been detected in deer in Rockford, IL, approximately 80 miles from the national lakeshore. IDNR biologists do not believe that any animal in Indiana is infected with CWD but cannot guarantee that any individual deer is free of disease (Indiana Government n.d.).

The state of Indiana has tested approximately 6,000 deer to date, and no occurrences of CWD have been discovered. The state used two sampling/testing methods (brain sample and lymph node sample) and found the lymph node sample method to be more effective and accurate.

Wildlife, Sensitive and Rare Species

In 1984 and 1985, the Morton Arboretum surveyed the sensitive and rare plant species in the national lakeshore. Surveys focused on areas where disturbances to rare plant species were most likely to occur, such as the eroding Lake Michigan shoreline, wetlands affected by low water tables, and high inland dunes. The studies indicated that many of these species are in a state of decline (Bowles 1988), a situation that persists today.

The national lakeshore is working with fire and mechanical means to improve Karner blue butterfly habitat. During the summer of 2006, national lakeshore staff released some Karner blue butterflies into a section of the East Unit, restoring them to an area from which they had been extirpated (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. July 20, 2006).

The national lakeshore's 2005 *Fire Management Plan* focuses on three main goals related to preserving the Karner blue butterfly habitat (NPS 2003g):

1. Manage and improve habitats in the West Unit supporting the Miller Woods and Inland Marsh complex metapopulations.
2. Establish and improve new suitable habitats in the East Unit capable of supporting a Karner blue butterfly metapopulation and restore the Karner blue butterfly to them.

3. Create and improve dispersal corridors within each metapopulation to improve its viability.

Work is slowly progressing on all of the tasks listed above (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. July 20, 2006). These goals reflect those established and mandated by the Fish and Wildlife Service's *Karner Blue Butterfly Recovery Plan* (USFWS 2003). This plan suggests that Indiana Dunes National Lakeshore should support at least two minimum viable metapopulations, each consisting of at least 3,000 adult butterflies (NPS 2003g). Nectar source plants, especially those preferred by the Karner blue butterfly, and lupine would be transplanted along dispersal corridors to encourage Karner blue butterfly into the corridors. Populations of Karner blue butterfly require connection corridors to maintain genetic exchange and allow for repopulation of areas following fire or other events that cause a reduction in numbers. Dirt roads and power line and railroad rights-of-way can serve as managed dispersal corridors (NPS 2003g), a tactic that involves planting nectar plants and lupine, killing the brush, keeping vehicles off the natural sections of rights-of-way, and not spraying when lupine would be killed (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. July 20, 2006). Indiana Dunes National Lakeshore will also cooperate with agencies that own adjacent properties and rights-of-way that provide Karner blue butterfly habitat to encourage dispersal (NPS 2003g).

In July 2007, the bald eagle was removed from the threatened species list. Because of increasing population trends, the availability of preferred nesting and wintering habitat is not considered a limiting factor or threat to the continued survival of the species. The bald eagle is still protected under the Bald and Golden Eagle Protection Act of 1962, the Migratory Bird Treaty Act of 1918, the Lacey Act Amendments of 1981, and the Convention on International Trade in Endangered Species (CITES). Dichloro-diphenyl-dichloroethylene (DDE, a component of DDT) concentrations and residues of polychlorinated biphenyls (PCBs) along the Great Lakes remain a concern. Lower reproduction among bald eagles nesting along the shores of the Great Lakes, compared to those nesting inland, is documented. New chemicals may enter the environment, and their breakdown products may be poorly understood. High concentrations of mercury may cause neurological problems in bald eagles and may also reduce egg-hatching rates. Lead poisoning caused by the consumption of waterfowl wounded with lead shot may also be a concern, but this possibility has been greatly reduced since the 1991 requirement to use nontoxic shot for waterfowl hunting. West Nile virus is documented from birds in the national lakeshore and has been known to cause fatality in raptors, including bald eagles (NPS 2003g).

Habitat loss and fragmentation are the primary threats to existing metapopulations of Pitcher's thistle. Development, sand mining, beach and dune stabilization projects, and some types of recreational activity have destroyed or modified approximately 10 percent of the known habitat (USFWS 2002, as cited in NPS 2003g).

Residential and commercial construction and road maintenance directly affect populations of Pitcher's thistle by reducing and eliminating existing and potential habitat and by fragmenting metapopulations. Construction on portions of the dune system where Pitcher's thistle is absent would further fragment the dune system and reduce the amount of available habitat for recolonization. Planting to stabilize dunes alters dune-building processes and may decrease available habitat for Pitcher's thistle and reduce the potential for new habitat to be created. Occurrences of Pitcher's thistle in Wisconsin and Indiana are not now affected by sand mining, and the effect of sand-mining operations in Michigan has yet to be determined (USFWS 2002, as cited in NPS 2003g).

Off-road vehicle use and trampling by beach and dune visitors in high-use areas threaten Pitcher's thistle and its habitat. Direct human trampling, usually occurring during the growing season, results from people hiking and climbing and is particularly detrimental in certain areas where beach and dune zones are narrow (USFWS 2002, as cited in NPS 2003g).

Prescribed burning is limited in the Pitcher's thistle habitat. Pitcher's thistle may be negatively affected by human activity and off-road vehicle use when prescribed burning or wildfire suppression occurs during the growing season. These effects may include trampling and damage to dune habitat from sand deposition and erosion where plants have become established (NPS 2003g).

Human persecution and collection appear to remain substantial factors in the decline of the eastern massasauga. Mowing or plowing fields during the active season may also result in direct mortality. Because of the movement patterns exhibited by the eastern massasauga, roadkill may represent another important factor in the decline of the species (USFWS 2002, as cited in NPS 2003g).

The eastern massasauga is also threatened by habitat loss and fragmentation. Early successional habitat has a canopy cover of 25 percent to 50 percent and provides open areas for thermoregulation. Succession to a closed canopy represents a substantial threat by severely limiting the amount of habitat available. Fluctuation of water levels may affect the eastern massasauga by causing direct mortality during hibernation and by reducing the amount of available habitat supporting hibernation sites. Fragmentation of suitable habitat threatens the eastern massasauga by limiting the potential for movement between seasonally preferred habitat patches (USFWS 2002, as cited in NPS 2003g).

Direct mortality has been documented from fire, usually associated with fires occurring after emergence from hibernation. Prescribed burning reduces unwanted and invasive vegetation and helps to increase the open-canopy habitat preferred by the eastern massasauga. Prescribed burning also stimulates the growth of prairie plants and provides an enhanced food source for the herbivorous rodents that constitute the main prey base (USFWS 2002, as cited in NPS 2003g).

Piping plover population decline is primarily due to habitat loss and alteration following the industrial and commercial development of the southern lakeshores of the lower Great Lakes. Shoreline development continues to threaten the Great Lakes population of piping plovers by further reducing the amount of available habitat and compromising the quality of the existing habitat. Although residential development has not deterred nesting at some sites in Michigan, piping plovers using these areas tend to exhibit lower reproductive success, which may be attributable to higher levels of human disturbance (USFWS 2002, as cited in NPS 2003g).

Recreational activities, including beach walking, kite flying, fireworks, bonfires, horseback riding, and use of motorized vehicles, represent substantial threats through disturbance of piping plovers and may deter or disrupt nesting. Pedestrians may repeatedly flush nesting piping plovers and expose eggs to temperature extremes and predators. Dogs present a particularly dangerous threat by chasing adults from nests and separating chicks from adults. Disturbance reduces the amount of time that piping plovers may spend foraging and has been implicated as a factor in the general decline of fitness for migrating shorebirds in breeding areas (USFWS 2002, as cited in NPS 2003g).

Environmental contamination and pollution may also affect the Great Lakes population of piping plovers. Concentrated levels of PCBs detected in piping plover eggs from Michigan have the potential to lower reproductive success. The exact source of this concentration is unknown and may result from contamination along migration routes or at the wintering grounds (USFWS 2002, as cited in NPS 2003g).

Prescribed burning within designated critical habitat may reduce the cover provided by marram grass and alter the quality of the habitat, but this effect is expected to be temporary.

Visitor and Employee Health and Safety

The NPS has proposed methods to address traffic issues at the national lakeshore, including planned improvements to roads and pedestrian crossings that could affect vehicular safety. The 1997 East Unit General Management Plan amendment states, "the National Park Service will work to enhance safety by improving intersections and other actions." Such improvements include repairing the County Line Road Bridge, redesigning roads to facilitate traffic flow, and constructing new roads. In addition, other highway-related projects occurring outside the national lakeshore, such as widening IN 51 between I-94 and US 20 and extending 15th Street in Lake Station, could affect safety (NPS 1997d).

The national lakeshore has completed construction and opened the new West Beach access road and County Line Road Bridge. This project improved visitor access and circulation by providing a semi-cloverleaf, one-way entrance road; a new bridge; and a new exit (NPS 1998). Michigan City and the South Shore Heritage Foundation are considering implementing the Trolley to the Dunes project, which would include shuttle services to help reduce traffic congestion and could also affect the number of traffic accidents.

Hunting will likely continue on neighboring lands, including the towns of Dune Acres and Beverly Shores and Indiana Dunes State Park (see the "Socioeconomics" section of chapter 3 for more information).

Visitor Use and Experience

The national lakeshore is actively closing roads as it acquires rights-of-way. It is possible that some may be converted to hiking/biking trails, as called for in the national lakeshore's general management plans. Some of these roads may be closed and restored to natural conditions. A new section of trail and bridge has been added to the West Beach trail in the West Unit; it is possible that the separate trails in this unit may eventually be connected. The trails provide hiking, interpretive uses, and cross-country skiing throughout the West Unit. Bike trails are confined to access roads (NPS 1993a).

Beverly Shores, Dune Acres, and Indiana Dunes State Park (which all border the national lakeshore's East Unit) have taken actions to reduce the size of the local deer herd. Such activities are planned to continue indefinitely into the future until a specific deer herd size is reached or can be maintained.

Off-road vehicle use is not permitted within the national lakeshore, but such use has happened in the past and continues to occur. Ranger patrols and the use of wire cables and fencing have proven successful at preventing illegal off-road vehicle use. Most of the cabling exists along roads and has not been a deterrent to deer movement (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. Sept. 11, 2003).

Cultural Resources

Archeological Resources

Ground disturbance, whether related to erosion, weather, visitor activities, or national lakeshore projects and routine work, has impacted previously unknown archeological resources. Threats to archeological resources include collection by visitors; disturbance from construction, maintenance, and animal husbandry and other farm activities; disturbance from visitor activities (erosion from foot traffic); and deterioration from environmental causes (weather, erosion) (NPS 1995c).

Cultural Landscapes

The *Bailly-Chellberg Interpretive Prospectus* of 1983 identified interpretive waysides for the area and recommended burying overhead power lines, a project that was completed in 1985. Because Chellberg Farm is managed as a cultural resource, plants and animals that damage or reduce the cultural resource quality are controlled. During the 1900s, farmers hunted and trapped pest animals. Deer, mice, woodchucks, raccoons, wasps, and nonnative plants are currently damaging the existing cultural resource (NPS 2000d).

Neighboring Lands

Dune Acres, Indiana Dunes State Park, and Beverly Shores have all implemented some form of deer management in the past several years to reduce the deer population. Each entity is now in a deer population maintenance phase and plans to continue implementing deer management policies indefinitely to keep the deer population constant. Although the community of Ogden Dunes has taken no action to manage deer populations in the national lakeshore's West Unit, the farm owner near the Inland Marsh continues to apply for and receive cull permits (see the "Socioeconomics" section of chapter 3 for more information).

Soundscapes

Beverly Shores, Dune Acres, and Indiana Dunes State Park have taken actions to reduce the size of the local deer herd, which will continue indefinitely. Beverly Shores plans to conduct bow hunts; Dune Acres allows sharpshooters; and the state park permits hunting with firearms only (B. Weber, IDNR, pers. comm. May 11, 2004). The owner of a farm near the national lakeshore's West Unit and farmers near Pinhook Bog have also conducted culls and continue to receive permits from the IDNR for shooting deer. However, culls occur only on specific days for a short time and do not occur year-round (see the "Socioeconomics" section of chapter 3 for more information).

Noise generated from highways, trains, boats, planes, and nearby industry would continue to impact the national lakeshore's natural soundscape.

Water Quality

The potential for water quality contamination is exceptionally high because of the proximity of heavy industry and agricultural lands. Potential industrial sources of water pollution include two steel mills, can-coating operations, and a coal-fired power plant (NPS 1995c). Of special concern are discharges of toxicants and pollutants from local industry, waste treatment and industrial effluent, leaching from industrial landfills and settling ponds, road salt runoff, heavy contamination from industrial sources, and pesticide and herbicide runoff from adjacent agricultural lands. Also of concern are nonchemical water quality contaminants, such as turbidity from local destruction of riparian zones, causing sediment to clog streams and potentially disrupt endemic flora and fauna (NPS 1995c).

Potential sources of water pollution from transportation include two federal highways, two interstate highways, and several railroad lines. Runoff of road salt into ditches and streams that eventually flow into the national lakeshore's waters is also a threat. There is a potential for spillage of hazardous chemicals along highways and railroads whose drainage ditches flow into national lakeshore waters (NPS 1995c).

Much effort has been spent on reducing conventional point sources of water pollution, including constructing municipal and industrial wastewater treatment plants. Continuing adverse effects of wastewater treatment plants and other sources of pollution on water quality include decreased organism diversity and increased numbers and biomass of pollution tolerant. However, improvements have been made in controlling these sources, and the national trend appears to be toward generally improving water quality. Very few data exist on contaminant levels and their effects on organisms at the national lakeshore (NPS 1995c).

External development affects ground- and surface-water hydrology around the entire periphery of the national lakeshore. Industrial activities, road construction and maintenance, and residential development have affected the national lakeshore in the past and continue to have an impact on ground- and surface-water quantity and quality. A January 1994 General Accounting Office (GAO) report (GAO/RCED-94-59) states that damage has already resulted from external threats, and additional damage will occur if actions are not taken to detect and mitigate it. Areas of particular concern include the Inland Marsh (potential residential development), West Beach pannes, Cowles Bog (industrial effects), and Long Lake. Any alteration of dunes (removal, breaching) can affect the abundance and distribution of sensitive plant communities located down the hydrologic gradient between the dunes and inland wetland areas. Marshes, such as Little Lake and Howe's Prairie, are highly dependent on this water-level gradient, and any disturbances would have negative impact on rare plant communities found in these areas (NPS 1995c).

Residential and industrial withdrawal of groundwater has the potential to lower or cause unnatural fluctuation in water-table levels on which plant communities depend. Partly as a consequence of development, many wetlands at the national lakeshore are being invaded by exotic or invasive species, including purple loosestrife, reeds (*phragmites*), and cattail. These plants have the potential to alter evapotranspiration rates to the extent that water tables could be lowered in localized areas, but no data currently exist to prove this theory (NPS 1995c; D. Mason, Indiana Dunes National Lakeshore, pers. comm. 2007).

Approximately 22 miles of the Little Calumet River are being developed under the multiagency Little Calumet River Project, which would provide for recreational navigation from the mouth of Burns Waterway to the Indiana–Illinois border. A recreational area greater than 2,500 acres in size could be provided by this corridor (NPS 1995c).

At least one beach in the national lakeshore is occasionally closed to swimming because of high levels of *E. coli*. Soils in the Dunes Creek watershed, which drains into Lake Michigan, have been found to harbor *E. coli* year-round. High *E. coli* counts in Dunes Creek may be due to sediment-borne bacteria eroding into the water, as no significant human fecal input was present (Byappanahalli et al. 2003). *E. coli* have also been found year-round in the shore sand, making the sand a nonpoint source of *E. coli* contamination to the beach water when waves strike the beach. Although visitor contact with contaminated sand may be more common if beach water is closed to swimming, the health effects of *E. coli* presence in sand are unknown (Smith et al. 2006).

National Lakeshore Management and Operations

The health of the national lakeshore's vegetation has been and continues to be adversely affected by pests and disease, including invasive exotic plants and gypsy moths. Details on the effects of these pests on the national lakeshore can be found in the "Other Ecosystem Management Issues" section of Chapter 1: Purpose of and Need for Action.

Foreseeable Future Actions in and Adjacent to Indiana Dunes National Lakeshore

Wildlife and Sensitive and Rare Species

Habitat management in the national lakeshore is expected to affect wildlife populations. The greatest effect would be in the early seral stages of current agricultural and residential areas. Vegetation in open areas would ultimately be replaced by woodland species in much of these areas. There would be less open habitat as succession spreads toward the climax communities that once existed. However, species of open areas should be able to hold their own on the natural wet and dry grasslands in the national lakeshore, and more land would be acquired and would add to habitat diversity (Whitaker et al. 1994).

Prescribed fire would be the main method for improving and maintaining Karner blue butterfly habitat at the national lakeshore. Establishing, maintaining, and improving habitats for Karner blue butterfly would require several management techniques. When prescribed burning is not feasible because of declines in Karner blue butterfly numbers, burn regulations, or extremely degraded habitat, the habitat would be maintained or restored through mechanical measures; these may include manually cutting and treating unwanted vegetation with herbicide. Mowing may be implemented in small Karner blue butterfly areas for establishing short-term dispersal corridors and habitat patches and may be combined with other treatments (NPS 2003g).

Most prescribed burns occur in the spring and fall, when the Indiana bat has not yet migrated to or from the southern Indiana hibernation shelters. It is unknown how Indiana bats react to fire or whether they can elude death from heat and smoke. It is also unknown how fire affects the structural integrity of preferred roosting and maternity trees and whether prescribed burning could lead the bats to abandon these sites. Large dead or dying trees with exfoliating bark or cavities located in the open or forest edges are preferred roosting sites and may also be used by maternity colonies. Actions to save particularly good trees would be taken and could include protecting them from the fire by removing accumulated fuels or establishing a line to prevent them from burning (NPS 2003g).

Water Quality

Accidental discharge, either through malfunction of industrial equipment or spillage due to truck or railroad mishap, could threaten the area's water resources (NPS 1995c).

Compilation of Foreseeable Future Actions

Most of the actions currently underway are expected to continue into the future, such as conversion of national lakeshore roads to hiking trails, restoration of wetlands, prescribed burning, and deer management activities at the state park and in local communities. These actions are listed in Table 45.

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TABLE 45: CUMULATIVE ACTIONS

Impact Topic	Past Actions	Current Actions	Future Actions (20 years)
Vegetation	Steel industry, commercial development Restoration of 400 residential home sites to natural conditions Visitor trampling Illegal plant collecting National lakeshore boundary extensions Nike site rehabilitation Timbering and sand mining Marshlands drained for agriculture Farming, resulting in introduction of exotic species Ditch construction Ditches and farmlands abandoned, 1938–1951 Spread of exotic species Increase in native species extinction High amounts of wind-blown sand from off-road vehicles and foot traffic on dunes Disturbed and artificial habitat (discouraged ground-cover vegetation growth) Fire suppression in Savannah complex Restoration of fire (prescribed fire) in Savannah complex and most fire-dependent systems Logging, farming, residential development in Savannah complex Logging changed the species composition of the forest and caused erosion in the dunes Drainage, cultivation, fluctuating water levels in Keiser Unit Fire through Tamarak Unit in 1980, resulting in dense black oak scrub Logging in Heron Rookery Intense grazing in Heron Rookery Farming on approximately 210 acres of Heron Rookery Regular mowing and disturbances from maintenance vehicles at NIPSCO substation in Hoosier Prairie Drainage of highway salt from storage bin into 5 acres of 90-acre peatland from 1963 to 1972 in Pinhook Bog Unit; homogenous stands of cattail replaced bog species in this area Karner blue butterfly habitat restoration Experimental closure of a portion of Derby Ditch in association with pilot wetland restoration project Ditching of wetlands Farming, resulting in drainage of wetlands	National lakeshore boundary continues to be developed with new houses and businesses Continuation of home-site restoration in the national lakeshore Closing of roads, restoring some to natural conditions Reduction in illegal off-road vehicle use Restoration of the Great Marsh Trampling, illegal collecting, spread of exotics, prescribed fire, etc., continue to occur Restoration of some wetlands and old home sites Karner blue butterfly habitat restoration is continuing	Continued development around NPS boundaries expected Conversion of roads to hiking trails or restoration to natural conditions Trampling, illegal collecting, spread of exotics, prescribed fire are expected to continue into the future Restoration of some wetlands and old home sites would continue Karner blue butterfly habitat restoration would continue
Soils and Water Quality	Slag pile added to western pond in Miller Unit Discharge of toxicants and pollutants from heavy industry Industrial landfill along western boundary of the national lakeshore Pesticide/herbicide runoff from agricultural lands Waste treatment and industrial effluent Leeching from industrial landfills and settling ponds Road salt runoff Heavy contamination from industrial sources Increased turbidity Destruction of riparian zones Reduction of conventional point sources of water pollution Construction of municipal and industrial wastewater treatment plants Experimental closure of a portion of Derby Ditch in association with pilot wetland restoration project Creation of ditches and artificial ponds Pumping of wells Ditching of wetlands Channelized streams, including Little Calumet River Increased impervious surfaces (two federal and two interstate highways, several railroad lines) Local and residential development (withdrawal of groundwater and impact on surface water hydrology) Road construction and maintenance	Most actions from the past are continuing, plus: Industrial landfill along western boundary of the national lakeshore currently impacting wetlands on NPS property In the Little Calumet River Project, 22 miles of the Little Calumet River are being developed to provide recreational navigation Restoration of some wetlands	Most actions from the past and present are expected to continue
White-Tailed Deer and Deer Habitat	Deer management in state park and local communities Exclosures established in several areas throughout the national lakeshore for monitoring purposes Annual spotlight and several aerial infrared surveys of deer populations within the national lakeshore and adjacent communities Prescribed burning of woodland understory Farming, resulting in extirpation of predatory animals	Deer management in state park and local communities Continuation of prescribed burns CWD detected in deer in Rockford, IL, 60–80 miles from the national lakeshore	Deer management in state park and local communities Continuation of prescribed burns Potential for CWD to infect the national lakeshore's herd
Other Wildlife and Wildlife Habitat	Habitat restoration by NPS Prescribed burns Habitat loss and fragmentation Industrial development Residential and commercial construction and road maintenance Sand mining Beach and dune stabilization projects Direct mortality from fire Environmental contamination and pollution	Prescribed burning (all species) Restoration of national lakeshore roads to natural conditions (all species) Dogs Recreational activities Environmental contamination and pollution	Prescribed burning (all species) Restoration of roads to natural conditions (all species)

Impact Topic	Past Actions	Current Actions	Future Actions (20 years)
Sensitive and Rare Species	Decline in native plant species Karner blue butterfly: Habitat restoration by NPS Prescribed burns Urban encroachment (fragmented habitat) 1992 – Midwest Steel Co. transferred habitat to construct landfill Bald eagle: Shooting for feathers, poisoning Use of DDT on agricultural lands Establishment of Endangered Species Act (ESA) in 1973 Protection under ESA as a threatened species Lead poisoning Reduction in amount of lead poisoning since 1991 due to requirement to use nontoxic shot for waterfowl hunting Bald and Golden Eagle Protection Act Migratory Bird Treaty Act Lacey Act Amendments Convention on International Trade in Endangered Species DDE concentrations and residues of PCBs along Great Lakes Pitcher's thistle: Habitat loss and fragmentation Residential and commercial construction and road maintenance Sand mining Beach and dune stabilization projects Eastern Massasauga: Persecution Collection Roadkill Habitat loss and fragmentation Fluctuation of water levels Direct mortality from fire Piping plover: Industrial and commercial development Habitat loss Recreational activities Environmental contamination and pollution	Prescribed burning (all species) Restoration of roads to natural conditions (all species) Karner blue butterfly: Burning and continued habitat restoration Indiana bat: Ongoing monitoring Bald eagle: DDE concentrations and residues of PCBs along Great Lakes Eastern massasauga: Wetland restorations may help stabilize water levels in some sections of habitat Piping plover Dogs Recreational activities Environmental contamination and pollution Concentrated levels of PCBs in eggs	Prescribed burning (all species) Restoration of roads to natural conditions (all species) Karner blue butterfly: Burning and continued habitat restoration Indiana bat: Ongoing monitoring Bald eagle: Potential delisting as a federally threatened species; DDE concentrations and residues of PCBs along Great Lakes Piping plover: Ongoing monitoring Pitcher's thistle: Ongoing monitoring Eastern massasauga: Potential succession to closed-canopy forest; burning to keep habitat open; and monitoring
Archeological Resources	Ground disturbance (erosion, weather, etc.) has exposed sites Collecting by visitors Construction disturbance Maintenance activities Animal husbandry and other farm activities Erosion from visitor foot traffic Deterioration from environmental causes (weather, erosion)	All actions from the past currently occurring today	All actions from the past currently occurring today that are expected to continue in the future Development outside the national lakeshore
Cultural Landscapes	Burial of overhead power lines in 1985 Erosion from heavy foot traffic near Chellberg Farm Visual impact from adjacent land uses	Erosion from heavy foot traffic near Chellberg Farm Visual impact from adjacent land uses	Erosion from heavy foot traffic near Chellberg Farm Visual impact from adjacent land uses
Visitor Use and Experience	Deer management actions on adjacent lands (use of firearms) Illegal off-road vehicle use Restoration of 400 residential home sites to natural conditions within the national lakeshore National lakeshore boundary extensions	Deer management actions on adjacent lands (use of firearms) Continuation of home-site restoration in the national lakeshore Road closures; restoration of some to natural conditions Reduction in illegal off-road vehicle use	Conversion of roads to hiking trails or restoration to natural conditions
Visitor and Employee Health and Safety	Deer management actions on adjacent lands (use of firearms) New West Beach access road and bridge	Deer management actions on adjacent lands (use of firearms)	Deer management actions on adjacent lands (use of firearms) Road and pedestrian crossing improvements Roadway improvements may reduce number of deer–vehicle collisions Potential spread of Lyme disease
Soundscapes	Deer management in state park and local communities (firearms) Increased noise from highways, trains, boats, planes, nearby industry	Maintenance phase of deer management in state park and local communities (firearms) Continued noise from highways, trains, boats, planes, nearby industry More homes, businesses, and traffic	Maintenance phase of deer management in state park and local communities (firearms) Continued noise from highways, trains, boats, planes, nearby industry Continuing noise from more homes, businesses, and traffic
Socioeconomics	Population increase from 1990–2003 Population decrease in 2004 Previous deer management by neighboring landowners LaPorte County experienced its largest decrease in crop sales between 1997 and 2002	Continued deer management by neighboring landowners Costs for ongoing deer removal efforts Hunters provide socioeconomic benefits to local community/businesses	Deer management by neighboring landowners expected to continue
National Lakeshore Mgmt and Operations	Deer management actions on adjacent lands	Deer management actions on adjacent lands	Deer management actions on adjacent lands Town of Porter may annex land within the national lakeshore

VEGETATION

Guiding Regulations and Policies

The NPS Organic Act of 1916 and the NPS *Management Policies 2006* (NPS 2006b) direct parks to provide for the protection of park resources. NPS *Management Policies 2006* states, "the Service will not attempt to solely preserve individual species (except threatened or endangered species) or individual natural processes; rather, it will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological ecosystems" (NPS 2006b, sec. 4.1). The policies further state, "The Service will not intervene in natural biological or physical processes, except to restore natural ecosystem functioning that has been disrupted by past or ongoing human activities, or when a park has identified the intervention as necessary to protect other park resources or facilities."

With regard to the restoration of natural systems, the NPS "will re-establish natural functions and processes in human-disturbed components of natural systems in parks," and it "will seek to return human-disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated" (NPS 2006b, sec. 4.1.5).

Indiana Dunes National Lakeshore's management goals include ensuring that deer browsing does not preclude conserving vegetation and sensitive plant populations and that deer-browsing effects do not lead to the decline or extirpation of rare plant species. The national lakeshore will also strive to maintain natural abundance, biodiversity, and ecological integrity of its wildlife and plant populations. The national lakeshore's vegetation plays a direct role in ensuring natural abundance, biodiversity, and the ecological integrity of wildlife by providing habitat, particularly lower-canopy and ground-nesting bird habitat and habitat of sensitive and rare species.

Assumptions, Methodology, and Impact Definitions

Maps illustrating vegetation cover within Indiana Dunes National Lakeshore and communications with NPS staff were used to identify baseline conditions in the study area. All available information on known vegetation in the national lakeshore was compiled, including nonnative species. The impact definitions for vegetation were defined qualitatively, as described below:

Negligible:	A reduction in the abundance and diversity of native vegetation may occur, but any change would be so small that it would not be measurable.
Minor:	A reduction in the abundance and diversity of native vegetation would occur and would be measurable but would be limited and of little consequence to the viability of the native plant community.
Moderate:	Some measurable reduction in the abundance and diversity of native vegetation would occur, but it would result in a small-scale consequence to the viability of the native plant community in the national lakeshore.
Major:	A noticeable reduction in the abundance and diversity of native vegetation would occur. The change would be measurable and of widespread consequence to the viability of the native plant community in the national lakeshore.

Area of Analysis

The area of analysis for assessing impact on vegetation is all of Indiana Dunes National Lakeshore. The area of analysis for cumulative impact is the national lakeshore and the areas within one-third of a mile of the national lakeshore boundary, based on the average home range of deer in the national lakeshore.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under alternative A, national lakeshore staff would continue current deer management actions, including limited fencing and maintenance of the large-area exclosure, limited use of repellents, and inventorying and monitoring efforts. No new deer management actions would be taken.

As described in Chapter 3: Affected Environment, the national lakeshore has been monitoring vegetation growth using paired plots since 1997. Although the plots have shown an increase in the density of woody-stemmed plants and an increase in percentage cover, they did not account for enough data to indicate that cover types were changing (increasing or decreasing) more rapidly in these areas versus the control areas (NPS 1999b). However, “moderate” or greater impact from browsing can cause changes to the species composition of plant communities (G. Parker, Purdue University, pers. comm. 2004). For example, sweet cicely (*Osmorhiza* spp.) is the first plant to be affected in plant communities that support this species, as well as white baneberry (*Actaea pachypoda*) and jack-in-the-pulpit (*Arisaema triphyllum*); sweet cicely is also usually among the first to disappear from a site. Results from national lakeshore monitoring data suggest that all three species show signs of deer-browsing impact; given that stem heights for jack-in-the-pulpit have decreased, it can be assumed that deer have browsed preferred forage in some areas of the national lakeshore to the point that they have begun to fall back on secondary preferred species. As a result, alternative A would have long-term, major, adverse impact on woody vegetation because of the amount of current and future deer browsing expected, resulting in a decrease in native plant abundance and, eventually, a loss in native plant diversity.

These data are supported by research on other species in the national lakeshore. Monitoring data in the national lakeshore have shown that trillium species have had lower than 5-inch (13-centimenter) basal stem heights. Research by Augustine and Frelich 1998 and Anderson 1994 indicate that trillium with basal stem heights of less than 5 inches do not recover to reproduce. Once the plant community’s reproduction levels are below 50 percent, the community starts to degrade and does not recover (R. Anderson, Illinois State University, pers. comm. 1994).

The national lakeshore has previously fenced small areas containing rare plants and habitat to protect them from deer browsing. These fenced areas would continue to be maintained. New fencing and exclosures would be used on a limited basis, as they are today, for any newly identified rare species or for habitats sensitive to deer browsing, such as the northern white cedar (*Thuja occidentalis*) in Cowles Bog. This action would have long-term, beneficial impact on the plants or fenced areas by precluding deer browsing. However, the impact on the unfenced majority of national lakeshore vegetation would continue to be adverse, long term, and major because no measures would be taken to limit or control the deer population size or growth under this alternative.

National lakeshore staff would use commercial repellents in limited areas. These repellents do not have known adverse effects on vegetation. Under this alternative, repellent use in the national lakeshore would continue to be minimal and would be used for new restoration plantings (plugs) to allow the new plants a chance to become established without stress from deer browsing. The effectiveness of repellents generally decreases as deer density increases and/or other food availability decreases. Therefore, this action would have short-term, beneficial impact on plants treated with repellents, but as the deer numbers remained high or increased or the food availability in the national lakeshore decreased, the effectiveness of repellents could be expected to decline. The impact on the untreated majority of vegetation in the national lakeshore would continue to be adverse, long term, and major.

Although monitoring vegetation plots and maintaining fenced areas would result in trampling of vegetation as staff traveled to and around the fenced areas, the impact would be temporary, as these activities typically take only a few days per year and are not likely to restrict reproductive success of the plant community. The amount of vegetation affected by these actions would be less than 1 percent, as they would occur in only a few areas of the national lakeshore. Therefore, the impact of these activities would be short term, adverse, and negligible.

Cumulative Impact

Increased impact on national lakeshore vegetation is expected from increased outside development and more visitor trampling. In addition to deer browsing, past actions within and adjacent to the national lakeshore, such as steel mill development and wetland draining or filling, have adversely affected the dune and forest resources. Fire suppression has altered the natural structure and composition of national lakeshore plant communities, and off-road vehicle damage that has been observed along the dunes has also had adverse affects. The national lakeshore's efforts to control invasive exotic species, gypsy moths, exotic plant species, and other pests would continue to benefit its resources and their ability to regenerate naturally. The national lakeshore plans to implement limited prescribed burning in the future, which would also benefit its prairies, oak savanna, and other fire-dependent habitats. The national lakeshore plans on continuing to restore previously disturbed areas (razed home sites, closed roads) and the Karner blue butterfly habitat. All of these activities—combined with continued pressure on national lakeshore vegetation and the limited native plant reproduction expected under alternative A because of continued deer browsing—would result in both adverse and beneficial effects on vegetation. Overall, cumulative impact would be adverse, long term, and major because deer would continue to restrict the abundance and diversity of the native vegetation within the national lakeshore.

Conclusion

The deer population would remain in excess of the recommended density for sustaining natural reproduction of native national lakeshore vegetation under alternative A and would likely remain high or increase over time, adversely impacting native plant abundance and diversity. As long as the deer population remains high or increases, overall impact would include decreased ability of plants to naturally reproduce, which in turn would lead to decreased native plant diversity, increased opportunity for exotic plants, and decreased abundance of native plants. Some benefits would be gained from management actions, such as maintaining small fenced areas and applying repellents in selected areas; however, the benefits would not protect or affect the majority of the national lakeshore. Benefits could also be gained after periodic declines in deer population resulting from disease or lack of available food; however, such population declines would not last long enough for native plant communities to fully recover. The impact of large numbers of deer browsing on a very large percentage of the national lakeshore's native vegetation and the consequent limiting of natural plant reproduction would be adverse, long term, and major. Past, present, and future actions, combined with the continued pressure on plant reproduction expected under this alternative, would result in both adverse and beneficial impact, with adverse, long-term, major cumulative effects.

Alternative B: Combined Nonlethal Actions–Fencing, Repellents, and Reproductive Control

Under alternative B, a combination of nonlethal actions would be implemented, in addition to the actions described under alternative A, to protect plant species and biodiversity and to manage deer numbers in the national lakeshore. The additional actions would include construction of additional small-area protection fencing and large-area exclosures, more extensive use of repellents in areas where fencing and exclosures would not be appropriate or feasible, and measures to control doe reproduction.

The repellents and fencing described under alternative A would continue to be used and monitored under alternative B. Additional fencing and exclosures would be constructed under alternative B to protect plant species and biodiversity within localized areas of the national lakeshore. Approximately 15 small protection fences would be constructed per year, and 303 large exclosures of 20 square meters or greater would be constructed throughout the national lakeshore. This action would eliminate deer browsing in the exclosures, thus protecting an estimated 936 acres, or about 7 percent of the national lakeshore. Protecting these areas from deer browsing would allow native plant species to reproduce, providing isolated opportunities for maintaining plant abundance and diversity. However, the effect of browsing on vegetation in the remaining unprotected areas of the national lakeshore would be similar to alternative A. It is expected that monitoring over the life of the plan would continue to show that the average plant heights in the unprotected areas are below the indicator thresholds, resulting in an adverse, long-term, major impact to native vegetation abundance and diversity.

Constructing, maintaining, and monitoring the 303 large exclosures would have some impact to vegetation in the national lakeshore because of the trampling and removal of existing vegetation. Even though fences would be located to avoid tree removal, some trees would have to be removed during construction. Additionally, tree branches within 5 feet of either side of the fence would be removed to prevent branches from hitting the fence in high winds or dead branches falling on the fence, thus minimizing future maintenance requirements. The area affected during construction would be about 60 acres (0.004 percent) of the national lakeshore (262,514 linear feet by 10-foot-wide cleared area = 2,625,140 square feet, or 60.26 acres). Given the small size of the affected area in relation to the size of the national lakeshore and the limited nature of the action, the impact of exclosure construction and maintenance would be adverse, long-term, and negligible. Trampling of vegetation during fence construction and monitoring, as well as removal of deer from within exclosures, would have adverse, short-term, negligible impact because construction and monitoring would average only a few days per year.

Additional repellents may be used in areas where installing a fence is undesirable—around historical resources, for example, where a fence would disrupt the historical integrity of the site or in areas with scenic viewsheds. Under current conditions, the efficiency of applying repellents would be low. Additionally, repellents need to be applied frequently to cover new growth on treated plants. Therefore, repellents would be used only in areas around historic structures to protect the historic landscape, around the national lakeshore nursery stock, and for habitat restoration projects. The size of these areas is estimated at a few acres. Given the small amount of vegetation that would be protected by repellents, the impact would be beneficial and short term. Over time, this benefit would decrease as the deer population increased, deer adapted to the repellents, preferred species abundance decreased, or other available food decreased. Assuming that the repellents were effective, the effect of repellent use on untreated vegetation would be adverse and long term because deer-browsing pressure on other available vegetation would likely increase; however, the impact would be negligible given the small area of vegetation protected from deer browsing.

Implementing reproductive control, as described in Chapter 2: Alternatives, would have several effects. Given the large number of does to be treated, bait piles would be used to concentrate deer in certain locations so that the darting could be done as efficiently as possible. As many deer as possible would be treated daily (estimated 10 deer treated per day over 60 days) until 90 percent of the does had been treated. Impact on vegetation in the areas around the bait piles would be adverse, short term (from a few hours to a few days in any location), localized, and negligible.

The effect of reproductive control on the deer population and, thus, deer browsing could be beneficial. However, several years could be required for the population to be reduced; researchers disagree on the amount of time needed to reduce a population size using reproductive controls (Hobbs et al. 2000; Nielsen et al. 1997; Rudolph et al. 2000). The actual amount of time needed to observe a decrease would depend on a number of factors, such as the type of treatment, its effectiveness in stopping reproduction, the size of the population at the time of initial treatment, the actual mortality rate, and the percentage of the population that was treated. Other factors, such as untreated deer moving into the national lakeshore and treated deer leaving the national lakeshore, would also influence the time required to achieve reduced numbers. The benefit of this action would be in proportion to the amount of population reduction, with the greatest benefit achieved when the deer population was lowered to the point where plant reproduction could sustain native vegetation abundance and diversity. Hobbs et al. (2000) described a model wherein, if 90 percent of the breeding does in the national lakeshore were effectively treated annually, mortality would have to exceed the number of surviving offspring from the 10 percent of untreated does to achieve a population reduction. An average mortality rate in urban/suburban deer populations is 10 percent (Hobbs et al. 2000). Based on these factors, it is expected that reproductive control could theoretically stop population growth if a 90-percent treatment rate could be achieved and sustained, but the national lakeshore would not be able to reach its initial deer-density goal within the life of this plan using current technology. Therefore, sustaining plant abundance and diversity would not be expected outside the large exclosures during the life of this plan. A significantly longer time frame would be needed to see results from current reproductive control technology.

Cumulative Impact

The same past, present, and future actions described under alternative A would also occur under alternative B. Management actions identified in alternative B, where approximately 7 percent of the national lakeshore's vegetation would be protected from browsing, combined with reproductive control, could reduce deer density after more than 15 years of implementation and would provide some beneficial impact over the long term but not immediately. Large-area exclosures would give some patches of native vegetation the opportunity to successfully reproduce, and reproductive control of deer would eventually help reduce the size of the deer herd, resulting in beneficial impact that would combine with the beneficial effects of prescribed burning for habitat restoration, restoration of previously disturbed areas (razed home sites, closed roads), and disease and pest control. However, adverse effects from increased development around the national lakeshore and other cumulative adverse actions, in conjunction with continued deer-browsing pressure on the majority of the vegetation and delayed reduction in the deer population, would not be offset by the beneficial effects of proposed actions. Therefore, cumulative impact on native vegetation under this alternative would be adverse, long term, and moderate to major.

Conclusion

Under alternative B, overall, approximately 7 percent of the national lakeshore's native vegetation would benefit from constructing exclosures over the life of this plan, and doubling the use of repellents would help protect small areas. Remaining vegetation would continue to be adversely affected by deer browsing over the long term until reproductive controls became effective and the deer population decreased. However, because the benefits of reproductive control would not be fully realized within the life of this plan, overall impact on vegetation would be adverse, long term, and major, as native vegetation decreased in abundance and diversity in the majority of the national lakeshore. Past, present, and future activities, combined with the continued pressure on native vegetation expected under this alternative, would result in both adverse and beneficial impact. Over the long term, cumulative impact would be adverse and moderate to major.

Alternative C: Lethal Action—Sharpshooting

Alternative C would continue the actions described under the no-action alternative, with the addition of sharpshooting for controlling deer herd numbers. Qualified federal employees and authorized agents[5] would carry out sharpshooting to reduce the deer population.

The repellents and fencing described under alternative A would continue to be used and monitored under alternative C. No additional fencing, exclosures, or repellent use would occur under this alternative. Immediately reducing the deer population would allow increased opportunity for native plant reproduction, which would sustain native plant diversity and abundance. However, it is possible that some small rare plant populations would decline or become extirpated before deer densities were reduced to target levels with the current levels of fencing and repellents.

Under this alternative, it is estimated that up to 581 deer (approximately half of the current population) would be removed during the first year of sharpshooting. Roughly 50 percent of the population would be removed in subsequent years until the initial density goal (15 deer/mi^2) was achieved. It is expected that rapidly reduced pressure from deer browsing (dropping from 70 deer/mi^2 and 35 deer/mi^2, respectively, in East and West Unit management zones to closer to 15 deer/mi^2) would allow the preferred browse species to increase and survive to maturity, providing the necessary growth for natural reproduction. The closer the deer density came to 15 deer/mi^2, the higher the chance of achieving plant reproduction (Bowersox et al. 2002; Horsley et al. 2003; Stout 1999; Marquis et al. 1992).

This conclusion is supported by comparison of open-plot data with exclosure data in the national lakeshore. As described under alternative A, the national lakeshore has been monitoring its vegetation growth since 1997, using paired plots. Results from the exclosure data suggest that deer have browsed preferred forage in some areas of the national lakeshore to the point that they are falling back on secondary preferred species.

Rapid deer herd reduction and control would result in beneficial long-term impact on vegetation, allowing the abundance and diversity of vegetation throughout the national lakeshore to recover. It is expected that after approximately 10 years, monitoring would show that the majority of the paired plots have plant heights reaching or exceeding the minimum heights required for successful plant reproduction. Therefore, implementation of alternative C would result in short-term, moderate impact that would decrease over time to long-term, minor impact as deer browsing was reduced by actions taken under alternative C. Reduced deer browsing under alternative C would result in increased plant reproduction and a resulting increase in plant abundance and diversity, though some small rare plant populations might be extirpated before deer densities were reduced to target levels.

A number of other actions would occur as part of sharpshooting, as described in more detail in Chapter 2: Alternatives, which would further affect vegetation in limited areas. These actions include setting up bait stations, occupying shooting areas, and dragging deer to locations for processing and transport. Baited areas would be small, the bait would not remain long, and any uneaten bait would

[55] Authorized agents can include, but are not limited to, other agency and tribal personnel and contractors. In addition to other federal contracting requirements, for the purposes of this plan, a contractor is a fully insured business entity, nonprofit group, or other government agency engaged in wildlife management activities that include lethal removal through sharpshooting. The authorized agent must possess all necessary permits.

be removed after annual sharpshooting efforts had been completed. Furthermore, baiting would occur in winter, after most vegetation has died back or is covered by snow, so impact on vegetation would be minimal. Sharpshooting might take place from elevated positions, which would require portable tree stands to be temporarily hung in trees. Such portable stands do not damage the tree (no nails or screws would be used) and would not have an adverse impact on woody vegetation. Removing deer carcasses from the kill site could require dragging them over vegetation, which would temporarily trample some vegetation. All of these actions (establishing bait and shooting stations and dragging deer) would result in some trampling of woody vegetation; however, the area of impact would be small (less than 1 percent of national lakeshore vegetation). As plant reproduction increased, more vegetation might be affected by each action; however, the overall amount of vegetation affected would still be small, and the impact would be short term and negligible. In addition, the sharpshooting effort would decrease over time, as fewer deer would be removed each year.

If the carcasses cannot be donated or used, the waste and/or carcasses of the removed deer would be disposed of either by burying them onsite or leaving them on the surface for natural decomposition. Whenever several deer were processed in any given location, the waste and/or carcasses would be collected and buried. In cases where carcasses could not be donated, they would be buried. Disposal pits would be in previously disturbed sites and approximately 8 feet wide, 8 feet long, and 4 feet deep. They would be dug before sharpshooting began and covered and fenced to prevent entry. Soil removed from the pits would remain onsite and be covered to prevent erosion. Creating these disposal sites could result in the removal of some vegetation. Sites would be selected in areas outside historic districts and in previously disturbed areas free of sensitive vegetation. Therefore, the impact on vegetation would be adverse, short term, and negligible.

Cumulative Impact

The same past, present, and future activities described under alternative A would occur under alternative C. Quickly reducing the national lakeshore's deer population would provide beneficial long-term effects, with adverse impact being reduced to negligible or minor levels over time. These effects, combined with the beneficial effects of prescribed burning for habitat restoration, restoration of previously disturbed sites (razed home sites, closed roads), and disease and pest control, would result in primarily beneficial cumulative impact. This beneficial impact would somewhat offset the adverse effects from increased development around the national lakeshore and other cumulative adverse actions. Therefore, cumulative impact on vegetation under this alternative would be mostly beneficial and long term.

Conclusion

Enhancing native plant reproduction by quickly reducing deer-browsing pressure under alternative C and by maintaining a smaller deer population through sharpshooting would result in beneficial long-term impact because native vegetation throughout the national lakeshore could recover. In the short term, implementing alternative C would result in moderate impact on vegetation, as a quick reduction in deer numbers would support an increase in plant reproduction. Although a smaller deer herd would reduce the amount of browsing that could lead to extirpation of rare plant species, some rare plant species may continue to decline without additional fencing and repellents, increasing the potential for extirpation of some species. As deer numbers are further reduced over the long term, native plant diversity and abundance would increase, resulting in a reduction of adverse impact to minor levels. Under alternative C, less than 1 percent of the national lakeshore's vegetation would be affected by trampling at bait stations, shooting sites, or disposal sites; placement of these sites would be in previously disturbed areas free of sensitive vegetation. Therefore, adverse impact of these actions would be short term and negligible. Past, present, and future activities, combined with the reduced browsing stress on native vegetation and subsequent increase in plant diversity and abundance, would result in beneficial, long-term cumulative impact.

Alternative D: Combined Lethal and Nonlethal Actions

Alternative D would include all actions described under alternative A, plus a combination of certain additional lethal and nonlethal actions from alternatives B and C to reduce deer herd numbers. The lethal action would include sharpshooting, which would be done initially to reduce deer herd numbers quickly. Reproductive control of does would be implemented as a maintenance tool to keep deer numbers at an acceptable level when a federally approved fertility control agent that provides three to five years' efficacy becomes available for application to free-ranging populations.

The repellents and fencing described under alternative A would continue to be used and monitored under alternative D, but no additional fencing, exclosures, or repellent use would occur. As described for alternative C, up to 581 deer (approximately half) would be removed during the first year of sharpshooting. Roughly 50 percent of the population would be removed in subsequent years until the target density goal was achieved. It is expected that rapidly reduced deer-browsing pressure (dropping from more than 70 deer/mi^2 and 35 deer/mi^2, respectively, in East Unit and West Unit management zones to closer to 15 deer/mi^2) would allow the preferred browse species to increase and survive to maturity, providing the necessary growth for natural reproduction. The closer the deer density came to 15 deer/mi^2, the higher the chance of achieving successful regeneration (Bowersox et al. 2002; Horsley et al. 2003; Stout 1999; Marquis et al. 1992).

Immediate reduction and control of the deer population would result in beneficial long-term impact on vegetation because deer browsing would be substantially reduced and the abundance and diversity of vegetation throughout the national lakeshore could recover. As described for alternative C, it is expected that after approximately 10 years, monitoring would show that the majority of the paired plots would have plant heights reaching or exceeding the minimum heights required for successful plant reproduction. Therefore, implementing alternative D would result in short-term, moderate impact that would decrease over time to long-term, minor impact as deer browsing was reduced by actions taken under alternative D. Reduced deer browsing under alternative D would result in increased plant reproduction and an ensuing increase in plant abundance and diversity.

As described for alternative C, a number of other actions would occur as part of implementing sharpshooting, such as setting up bait stations, occupying shooting areas, and dragging deer carcasses to locations for processing and transport. Although all of these actions would result in some trampling of vegetation, the area of impact would be small (less than 1 percent of vegetation), and the impact would be adverse, short term, and negligible, given the small size of the affected area and the short duration of the impact. As plant reproduction increased, more vegetation might be affected by each action; however, the overall amount of vegetation affected would still be small, and the impact would be short term and negligible. In addition, the level of effort required may increase over time, as removing deer from a smaller population may become more difficult.

During sharpshooting, the waste and/or carcasses of removed deer would have to be disposed of, which could result in the removal of some vegetation. However, sites selected for disposal would be in previously disturbed areas and free of sensitive vegetation. Therefore, the impact on vegetation would be adverse, short term, and negligible.

Reproductive controls would be implemented to maintain the desired deer population level after direct reduction efforts had initially reduced the population size. However, the success of implementing reproductive controls on a deer population that has undergone several years of direct reduction efforts would depend on technological advances, the sensitivity of deer to humans, methods used by the sharpshooters, changes in immigration with reduced deer density, and general deer movement behavior (Porter et al. 2004; Naugle et al. 2002). It should be expected that getting close enough to administer remote injections would become increasingly difficult after sharpshooting efforts because of deer behavior changes in response to previous human interaction (B. Underwood, USGS, pers. comm. 2005). If reproductive control could be successfully implemented, deer numbers could be kept low and impact on vegetation would be adverse, long term, and minor.

Assuming a deer population density of 15 deer/mi^2 when reproductive controls were initiated, there would be a maximum of 414 deer in the national lakeshore (approximately 20.7/mi^2). This number would exceed the maximum size suggested for application of reproductive controls in free-ranging deer populations. Assuming that the sex ratio composition of the reduced deer population would be approximately 50 to 50, there would be 207 does in the population. The majority of the does (90 percent, or 186 does) would have to be treated so that they could be identified for re-treatment in successive years. It is estimated that up to 5 deer per day could be treated (taking a minimum of 37 days), given the increased effort to locate deer. The deer population would continue to be monitored for growth. If the deer population increased during the reproductive control application under this alternative, periodic sharpshooting would be initiated to maintain the population density at the identified goal.

Some of the actions involved in implementing reproductive control could result in trampling of vegetation (similar to implementing construction of fences and sharpshooting); however, these actions would last only a few hours to a few days in any location, and the adverse effect on vegetation would be short term and negligible.

Assuming that reproductive controls could be used throughout the national lakeshore to maintain the deer population size, impact on vegetation would be beneficial and long term because a substantial reduction in deer browsing would allow the abundance and diversity of vegetation throughout the national lakeshore to recover.

Cumulative Impact

The same past, present, and future activities described under alternative A would also occur under alternative D. Rapidly reducing the deer population would relieve deer-browsing stress on the majority of the national lakeshore's vegetation, providing long-term, beneficial impact and reducing adverse impact to minor levels. Rapid deer-density reduction would give the national lakeshore's habitat the opportunity to regenerate, resulting in beneficial impact that would combine with the beneficial effects of prescribed burning for habitat restoration, restoration of previously disturbed sites (razed home sites, closed roads), and disease and pest control, resulting in cumulative impact that would be primarily beneficial. These beneficial impacts would somewhat offset the adverse effects from increased development around the national lakeshore and other cumulative adverse actions. Therefore, cumulative impact on vegetation under this alternative would be mostly beneficial and long term.

Conclusion

Enhancing native vegetation reproduction by quickly reducing deer-browsing pressure under alternative D and by maintaining a smaller deer population through the use of reproductive control and sharpshooting would result in beneficial long-term impact because native vegetation could recover throughout the national lakeshore. In the short term, implementation of alternative D would result in moderate impact on vegetation, as a quick reduction in deer numbers would support an increase in plant reproduction. As deer numbers were further reduced over the long term, native plant diversity and abundance would increase, resulting in a reduction of adverse impact to minor levels. Under alternative D, less than 1 percent of the national lakeshore's vegetation would be affected by trampling at shooting, treatment, or disposal sites. Therefore, adverse impact of these actions would be short term and negligible. Past, present, and future activities, combined with the reduced browsing stress on native vegetation and subsequent increase in plant diversity and abundance, would result in beneficial, long-term cumulative impact.

SOILS AND WATER QUALITY

Guiding Regulations and Policies

The Clean Water Act (33 USC 1251 et seq.), by establishing water quality standards at the national level, creates the framework to protect and restore the quality of natural waters. Under EPA regulations, the states are responsible for administering the provisions of the Clean Water Act by establishing water quality standards and managing water quality. According to EPA regulations, water quality standards must

1. designate uses to be made of the water
2. set minimum narrative or numeric criteria sufficient to protect the uses
3. prevent degradation of water quality through anti-degradation provisions

In administering the Clean Water Act, Indiana designated all streams, rivers, lakes, and other waters within the Great Lakes drainage basin, including those within the national lakeshore, for warm-water aquatic-life use, full-body (primary) contact recreational use, and industrial and agricultural uses. In addition, all waters in Indiana Dunes National Lakeshore have been designated as Outstanding State Resource Waters by virtue of being located within the national lakeshore boundaries (327 Indiana Administrative Code [IAC] 2-1.5-18(b)(2)(D)). As mandated by the antidegradation standard found at 327 IAC 2-1.5-4(c), such waters shall be maintained and protected in their present high quality without degradation. Also, the East Branch of the Little Calumet River and a portion of Burns Ditch (from its confluence with the East Branch of the Little Calumet River to the mouth), a portion of Salt Creek (above the confluence with the Little Calumet River), Kintzele Ditch (from Beverly Drive downstream to Lake Michigan), and the open waters of Lake Michigan are designated as salmonid waters (327 IAC 2-1.5-5(a)(3)(C)). This designation requires that where natural temperatures permit, these surface waters will be capable of supporting put-and-take trout fishing and salmonid fisheries and maintaining the natural reproduction of trout (327 IAC 2-1.5-5(a)(3)).

In supporting federal and state regulations, NPS *Management Policies 2006* states that the NPS will "take all necessary actions to maintain or restore the quality of surface waters and groundwaters within the parks consistent with the Clean Water Act and all other applicable Federal, State, and local laws and regulations" (NPS 2006b, sec. 4.6.3). The policies also instruct park units to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil or its contamination of other resources (NPS 2006b, sec. 4.8.2.4).

The Indiana Dunes National Lakeshore purpose statement includes provisions for preserving, maintaining, and restoring the integrity and character of its natural resources and processes. To achieve this purpose, management goals have been established to protect, restore, and maintain natural resources in good condition and to manage these resources within their broader ecosystem context (NPS 1997d).

Assumptions, Methodology, and Impact Definitions

Soils would be affected primarily by erosion resulting from loss of vegetative ground cover because of deer browsing, while water quality would be affected primarily by the associated sedimentation, as well as increases in *E. coli* levels from higher deer density.

Soils

Vegetative cover is just one of several factors that determine how much and how quickly rainfall or snowmelt reaches surface waters. Other factors include soil type, climate, topography, and the amount of time between precipitation events. There is very little storage of water that flows over a forest floor where deer spend the majority of their time. Although obstacles on the ground, such as leaf litter and woody debris, help slow surface runoff, other factors, such as loss of vegetative cover, topography, soil compaction, impervious surfaces, and cut slopes of roads, can increase the amount and velocity of surface runoff (EPA 2005). Soils in the national lakeshore classified as moderate or severe erosion hazards are found on slopes of up to 40 percent in uplands, small knolls, wooded breaks along major streams, narrow ridges, escarpments, outwash plains, moraines, lake plains, sand dunes, and beach ridges and along drainage ways and streams.

Turbidity is a measurement of water clarity, and soil erosion contributes to and affects turbidity. Turbid water may consist of stirred up or suspended sediment or foreign particles, making the water muddy or clouded. Therefore, turbidity indicates degrees of soil erosion (high levels of turbidity result in part from high levels of soil erosion), as well as impact on water quality (high levels of turbidity degrade water quality). For these reasons, turbidity levels have been incorporated into impact thresholds for both soils and water quality.

Impact definitions for soils were derived from available soils information, national lakeshore staff observations of the effects on soils from loss of vegetation, and water quality data available at the national lakeshore. The thresholds for the intensity of a soils impact are defined as follows:

Negligible: Impact on soils (including erosion) would not be measurable. Turbidity and sedimentation levels would be within historical or baseline conditions.

Minor: Impact on soils would be measurable and occur within a small area. Resulting changes in soil erosion rates and stormwater flows would cause localized alterations to turbidity and sedimentation levels that are within historical or baseline conditions and flows.

Moderate: Impact on soils would be measurable and occur over a relatively wide area. Resulting changes in soil erosion rates and stormwater flows would cause widespread but intermittent alterations to turbidity and sedimentation levels that would result in occasional deviations from historical or baseline conditions and flows.

Major: Impact on soils would be apparent and regional, affecting a large area in and outside the national lakeshore. Resulting changes in soil erosion rates and stormwater flows would cause frequent alterations to turbidity and sedimentation levels, which would alter baseline conditions and flows over an extensive area and could result in modifications to the natural stream channel and instream flow characteristics.

Water Quality

The potential for water contamination is exceptionally high at the national lakeshore because of the proximity of heavy industry, transportation corridors, and agricultural lands. Water quality and quantity would be affected by the amount of ground cover in the national lakeshore. As noted, a reduction of ground cover by deer browsing could lower water quality because of increased turbidity from increased surface water runoff; turbidity is an indirect measure of sediment in surface waters.

E. coli are bacteria whose presence indicates that water may be contaminated with human or animal wastes. Frequent and extremely high densities of *E. coli* associated with discharges from Derby Ditch and other human-made drainages within the Great Marsh system are of particular concern to the national lakeshore. These high *E. coli* levels are responsible for most of these waters being listed as "impaired" under Section 303(d) of the Clean Water Act. Beach closures and advisories are issued when the state standard for *E. coli* is exceeded or preemptively, when an odor is detected or a combined sewer overflow occurs. Between 1998 and 2005, 183 such beach closures occurred. Deer feces loading in receiving streams is one source of *E. coli* contamination. However, *E. coli* are found in both point and nonpoint sources of pollution, including sewer overflow; discharges from municipal and industrial wastewater treatment plants; illicit discharges; stormwater runoff; failing residential septic systems; contaminated sediment; and the intestinal tracts of warm-blooded animals, such as humans, livestock, domestic pets, and wildlife, including deer (IDEM 2004a, 2004c, 2004e). In the case of the Little Calumet–Portage Burns Waterway and Lake Michigan shoreline TMDLs, nonpoint sources (including deer and other wildlife) are considered the dominant sources of *E. coli* (IDEM 2004e). The contribution of deer to an area's overall *E. coli* level is difficult to quantify; fecal loading from deer alone cannot be attributed to increases in *E. coli* levels.

The NPS *Management Policies 2006* states that the NPS will determine the quality of park surface and groundwater resources and avoid, whenever possible, the pollution of park waters by human activities occurring within and outside of parks (NPS 2006b). Management steps to achieve this goal include the following:

- Work with appropriate governmental bodies to obtain the highest possible standards available under the Clean Water Act for the protection of park waters.
- Take all necessary actions to maintain or restore the quality of surface waters and groundwaters within the parks consistent with the Clean Water Act and all other applicable federal, state, and local laws and regulations.
- Enter into agreements with other agencies and governing bodies, as appropriate, to secure their cooperation in maintaining or restoring the quality of park water resources.

Historically, national lakeshore staff has monitored open water, streams, and wells for a variety of water quality issues. Information on historic turbidity levels, used to monitor sediment at the national lakeshore, is limited to a partial dataset from samples taken in 1999 and to samples taken in the surrounding watershed. Currently, surface waters, including the swimming beaches in the national lakeshore, are monitored for *E. coli* from April 1 through October 31. These data and available information on water resources in the national lakeshore (from such sources as the Indiana Department of Environmental Management [IDEM] and the USGS, as well as the *E. Coli* Task Force, which comprises several local, state, and federal agencies in Indiana) were reviewed for analysis. The potential impact of each alternative on water resources was evaluated for turbidity and *E. coli* by (1) estimating the potential for changes in erosion and sedimentation, assuming that loss of vegetation could result in increased soil erosion and stream flows as a result of greater stormwater flows; and (2) estimating the potential for changes in bacteria (*E. coli*) loads in the national lakeshore's water resources from changes in the number of deer in the study area, assuming that greater deer densities could increase *E. coli* levels. The thresholds for the intensity of a water quality impact are defined as follows:

Negligible: Changes to turbidity levels would not be measurable. *E. coli* levels would be within the historical or baseline levels for a localized area.

Minor: Measurable and localized changes to turbidity would be within historical or baseline levels. *E. coli* levels would be measurable and within the historical or baseline range for a localized area.

Moderate: Measurable and localized changes to turbidity would deviate from baseline levels. Changes in *E. coli* levels would be clearly detectable during monitoring and would deviate from historical or baseline levels in a localized area.

Major: Frequent alterations to baseline turbidity levels would occur over a widespread area. Changes in *E. coli* levels would be clearly detectable during monitoring and would alter baseline levels on a regional or watershed scale.

Area of Analysis

The area of analysis for assessment of impact, including cumulative impact, of the various alternatives is the 536-square-mile portion of the Little Calumet–Galien watershed in Indiana, including the Lake Michigan shoreline.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

The expected increase in the deer population and browsing associated with alternative A is also expected to accelerate the loss of vegetative ground cover. Soils with vegetative cover hold water longer, and plants naturally filter contaminants from water. Loss of vegetation would result in increased soil erosion and sedimentation into national lakeshore streams and increased localized turbidity in watershed streams. National lakeshore staff would continue activities to protect native plants, such as creating and monitoring small fenced areas; however, there are currently only two small-area fences (typically less than 43 square feet, or 4 square meters) and one large-area exclosure. These areas would do little to protect against soil erosion or water contamination. The expected continued loss of vegetative ground cover from increased deer browsing could eventually result in adverse, long-term, negligible impact on the soils and water quality at the national lakeshore.

The contribution of fecal loading from deer to levels of *E. coli* would be difficult to quantify. However, the increase in the deer population would decrease the abundance of small mammals; thus, less fecal loading from small mammals would occur, which could negate the increase in deer fecal loading.

Cumulative Impact

The surface waters of the national lakeshore are within the 536-square-mile Little Calumet–Galien watershed (Hydrologic Unit Code 04040001) that includes the Lake Michigan coastline of Indiana (EPA 2006; IDNR 2001b). This watershed is part of the Great Lakes system that drains the northern quarter of Indiana (IDEM 2004a, 2004b). Cumulative impact on soils and water quality would not only arise from activities in the national lakeshore but also would be heavily influenced by past, present, and future activities in the adjacent areas.

Increased soil erosion from loss of ground cover resulting from deer browsing will also have an adverse impact on soils and water quality. Weather events, such as thunderstorms, could adversely impact soils in the watershed. Pesticide/herbicide runoff from adjacent agricultural lands also contributes to current water quality conditions at Indiana Dunes National Lakeshore and adversely affects water quality within the watershed. Industrial sources of water pollution in the vicinity of Indiana Dunes National Lakeshore include two steel mills, can-coating operations, and a coal-fired power plant. Pollution from these sources includes the discharge of toxicants, heavy metals, and other pollutants from local industry into nearby surface waters; waste treatment and industrial effluent; and leaching from industrial landfills and settling ponds. Potential sources of water pollution from transportation include two federal highways, two interstate highways, and several railroad lines (NPS 1999a). Road salt runoff and hazardous chemical spills along the highways and railroads whose drainage ditches flow into national lakeshore waters are pollutants of special concern from these sources. All of these activities (which have occurred in the past and are expected to continue), combined with the continued and increasing deer-browsing pressure and fecal loading under alternative A, would result in adverse, short- and long-term, and minor to moderate impact on soil and water quality.

Conclusion

Adverse, long-term, negligible impact on soil and water quality could result from soil erosion and sedimentation because of loss of vegetation from increased deer browsing, assuming continued growth of the deer population under alternative A. The potential for adverse, long-term, negligible impact on water quality could result from increased fecal loading from the deer population. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Past, present, and future activities both inside and outside the national lakeshore, combined with the continued pressure from deer browsing expected under this alternative, would result in adverse, short- and long-term, and minor to moderate impact on soil and water quality.

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

Several nonlethal actions under alternative B would be implemented in combination to protect the national lakeshore's resources and reduce the deer population. Actions include the use of small-area protection fencing, large-area exclosures, increased use of repellents in limited areas, and reproductive control of does.

Under alternative B, at least 303 exclosures, totaling more than 930 acres (approximately 7 percent of the total national lakeshore), would be used throughout the national lakeshore to exclude deer from those areas. The use of large-area exclosures could have both beneficial and adverse effects on soils and water quality. Potential tree removal and the installation of fence posts would disturb surficial soils and remove vegetative cover, thus temporarily increasing erosion potential. Although regeneration of vegetation within the exclosures would help minimize the potential for soil erosion, such large-area exclosures would concentrate the deer population in the remaining unexclosed areas and into adjacent residential communities and open rural and industrial areas. The overall deer-browsing pressure in the national lakeshore and adjacent areas would not be reduced, and the benefits of the exclosures might initially be offset by adverse impact in other areas as a result of increased loss of vegetative ground cover. This would then result in increased soil erosion and sedimentation into streams and increased localized turbidity in watershed streams. Adverse impact would be long term and negligible, gradually shifting to beneficial as more of the vegetation regenerated as a result of protection afforded by the exclosures.

Continued use of small-area protection fencing and repellents would have little impact in mitigating soil erosion and might cause deer to concentrate browsing elsewhere, resulting in increased loss of vegetation in those areas.

The use of reproductive control could reduce the deer population to a limited extent if it were successfully implemented. Even if all does targeted were treated, reproductive control would require several years to take effect, with a best-case scenario of a 5-percent reduction in population over several years after 90 percent of the does were treated (Hobbs et al. 2000). Furthermore, the use of bait piles would concentrate the deer population, resulting in trampling and loss of vegetative cover in these localized areas. This would result in increased soil erosion and sedimentation into streams and increased localized turbidity in watershed streams. Adverse impact from bait stations would be long term and negligible, but any reduction in the deer population would help decrease the overall loss of vegetation due to deer browsing, decrease erosion and turbidity in stream waters, and be beneficial in the long term.

Cumulative Impact

The cumulative impact under alternative B would be similar to that under alternative A because the same past, present, and future activities are expected under both alternatives. The beneficial long-term impact on soil and water quality of alternative B would slightly offset some of the adverse cumulative impact; however, the majority of adverse impact on soils and water quality occurs from sources outside the national lakeshore, where impact might or might not be mitigated. Therefore, actions under alternative B would offset only a very small part of the overall cumulative effects, which would continue to be adverse, short and long term, and minor to moderate.

Conclusion

Adverse, long-term, and minor impact on soils and water quality could occur if deer displaced by the small-area protection fencing and large-area exclosures concentrated in other areas of the national lakeshore and neighboring areas, resulting in increased loss of vegetation in those areas and a potential increase in soil erosion. This impact would gradually shift to beneficial in the long term as revegetation occurred in the large exclosures, potentially reducing soil erosion. Beneficial long-term impact would also result from decreased loss of vegetation, as reproductive control of the deer population would gradually reduce deer numbers over time. Cumulative effects would be adverse, short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. Beneficial long-term impact occurring inside the national lakeshore would offset cumulative impact only slightly.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, sharpshooting would be used to rapidly reduce the number of deer in the national lakeshore and to maintain a sustainable deer population of 15 deer/mi^2 after the third year of implementation. A smaller deer herd would allow revegetation to occur more quickly throughout the national lakeshore because deer-browsing pressure would be decreased. Regrowth of vegetative ground cover would reduce the potential for soil erosion and sedimentation of streams, resulting in beneficial long-term impact on soils and water quality. A smaller deer herd would produce less fecal loading into surface waters, resulting in lower *E. coli* levels and a beneficial long-term impact on water quality.

The use of animal disposal pits would result in the potential for long-term adverse impact on groundwater quality. In cases where the meat from deer is unsuitable for donation to charity or for surface or landfill disposal, the carcasses and/or internal organs would be buried onsite. Disposal pits measuring 8 feet x 8 feet x 4 feet would be dug at previously disturbed sites throughout the national lakeshore. Soil removed from the pits would remain onsite and would be covered to prevent erosion. Carcasses would be transported to the pit(s) within 12 hours of sharpshooting. After each addition of carcasses, the pit would be covered with approximately 1 foot of soil. When the pit had reached capacity, it would be covered with approximately 3 feet of soil. The soil would be covered with straw or woodchip mulch to prevent erosion, and when the weather and season were appropriate, the soil would be seeded with an NPS-approved seed mix and mulched.

Dead animals take a long time to decompose in a disposal pit because of limited aeration. Because of a high potential for groundwater contamination, adequate distance from drinking water supplies is necessary. The USDA Natural Resources Conservation Services (USDA-NRCS) Conservation Practice Standards (Code 316, Animal Mortality Facility) states that disposal pits shall not be located on highly permeable soils or over fractured or cavernous bedrock within 2 feet of the bottom of the pit unless an approved liner is used (USDA 2005). In addition, disposal pits shall not be located on sites where a seasonal high water table is less than 2 feet from the bottom of the pit unless artificial drainage is installed to maintain water-level depth more than 2 feet below burial depth of waste. No minimum depth is required, but the selected depth shall accommodate 30 inches of cover over the carcass. Furthermore, multiple pits shall be separated by a minimum of 3 feet of undisturbed or compacted soil (USDA 2005). In order to mitigate adverse, minor, and long-term effects from groundwater contamination, qualified NPS staff would select locations for disposal pits that do not conflict with USDA guidance. The potential for long-term adverse impact on groundwater quality would be mitigated with proper site selection, as described above. Trenching required for the disposal pits (with proposed mitigation measures) would result in an adverse, short-term, negligible impact on soils.

Continued use of fences and repellents would likely have little impact in mitigating soil erosion. Because of the initial deer reduction via sharpshooting, damage from deer concentrating browsing elsewhere and localized fecal loading to water would be mitigated. Therefore, overall impact under alternative C would be beneficial and long term.

Cumulative Impact

The cumulative impact from sharpshooting would be similar to those for alternatives A and B, with a slightly greater beneficial effect from the immediate reduction of deer numbers and the maintenance of a smaller sustainable deer population (15 deer/mi^2) after the third year of implementation. However, animal disposal pits would carry a potential for long-term adverse impact on groundwater quality. This potential would be mitigated with proper disposal pit site selection. Any beneficial long-term impact on soil and water quality from alternative C would only slightly offset the adverse cumulative impact. The adverse long-term impact on groundwater could add to cumulative adverse impact contributed from outside the national lakeshore, where impact might or might not be mitigated. Therefore, the combined actions of alternative C with other past, present, and future activities would result in adverse, short- and long-term, minor impact on soil and water quality.

Conclusion

Beneficial long-term impact on soils and water quality would result from rapidly reducing the number of deer in the national lakeshore and maintaining a sustainable population of 15 deer/mi^2 after the third year of implementation. Vegetative ground cover would be able to reestablish, helping reduce soil erosion and sediment loading in the national lakeshore's creeks. Fecal loading in surface waters from the deer population would be reduced. Adverse, long-term, and minor impact on groundwater quality could result from animal disposal pits placed in areas of unknown soil and bedrock types and water-table level. Cumulative effects would be adverse, short and long term, and minor because of the industrial and agricultural influences surrounding the national lakeshore. Any beneficial impact occurring inside the national lakeshore would not offset adverse cumulative impact.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, sharpshooting would be used to initially reduce the number of deer in the national lakeshore, with reproductive control of does used to maintain a sustainable population of approximately 15 deer/mi^2 after the third year of implementation. Disposal methods described under alternative C would apply. A smaller deer herd would reduce fecal loading into surface waters, resulting in lower *E. coli* levels and providing a beneficial long-term impact on water quality. The reduction and long-term maintenance of a small herd would allow vegetative ground cover to reestablish throughout the national lakeshore and potentially reduce soil erosion, providing beneficial long-term impact on the soils and water quality of the national lakeshore. As with alternative C, the use of animal disposal pits presents a potential for minor, long-term, adverse impact on groundwater quality. This impact would be mitigated with proper disposal pit site selection.

The small-area protection fencing would be similar to that described under alternative A but with only five small fenced areas for plant protection. This alternative would also include construction of one large-area exclosure (2 to 5 acres) every other year for plant protection. Continued use of fences, exclosures, and repellents would likely have little mitigating effect on soil erosion. The initial deer reduction via sharpshooting would mitigate damage from deer concentrating browsing elsewhere and localized fecal loading. Therefore, overall impact under alternative D would be beneficial and long term.

Cumulative Impact

Cumulative impact on soils and water quality under alternative D would be very similar to that described for alternative C, with beneficial long-term effects on soils and water quality resulting from the relatively rapid reduction of deer numbers and the long-term maintenance of a smaller deer herd over the life of the plan. However, as with alternative C, disposal pits carry a potential for long-term adverse impact on groundwater quality, although this would be mitigated with proper disposal pit site selection. Any beneficial long-term impact on soils and water quality under alternative D would not offset the adverse cumulative impact. Cumulative effects would be adverse, both short and long term, and minor to moderate because of the industrial and agricultural influences surrounding the national lakeshore. The adverse long-term impact on groundwater could add to that contributed from outside the national lakeshore, where impact might or might not be mitigated. Therefore, the actions of alternative D, combined with other past, present, and future activities, would result in adverse, short- and long-term, minor impact on soil and water quality.

Conclusion

Impact on soil and water quality would be beneficial and long term as a result of rapidly reducing the number of deer in the national lakeshore and maintaining a population of 15 deer/mi^2 after the third year of implementation. Vegetative ground cover would be able to reestablish, helping reduce soil erosion and sediment loading in the national lakeshore's creeks. Fecal loading in surface waters from the deer population would be reduced. Adverse, long-term, and minor impact on groundwater quality could result from animal disposal pits. Cumulative effects would be adverse, both short and long term, and minor because of the industrial and agricultural influences surrounding the national lakeshore. Any beneficial impact occurring inside the national lakeshore would not offset adverse cumulative impact.

WHITE-TAILED DEER AND DEER HABITAT

Guiding Regulations and Policies

The NPS Organic Act, which directs NPS units to conserve wildlife unimpaired for future generations, is interpreted by the agency to mean that native animal life should be protected and perpetuated as part of the national lakeshore's natural ecosystem. NPS relies on natural processes to control populations of native species to the greatest extent possible; otherwise, they are protected from harvest, harassment, or harm by human activities. According to the NPS *Management Policies 2006*, the restoration of native species is a high priority (NPS 2006b, sec. 4.1). Management goals for wildlife include maintaining components and processes of naturally evolving ecosystems, including natural abundance, diversity, and the ecological integrity of plants and animals.

Assumptions, Methodology, and Impact Definitions

The evaluation of deer and deer habitat was based on a qualitative assessment of how expected management actions would affect the national lakeshore's deer herd and its habitat. The national lakeshore's deer herd is directly affected by the natural abundance, biodiversity, and ecological integrity of the vegetation that its habitat comprises.

Available information on the national lakeshore's deer herd and habitat was compiled and analyzed in relation to the management actions. The impact definitions are as follows:

Negligible: There would be no observable or measurable impact on the deer population, its habitat, or the natural processes sustaining it. Impact would be well within natural fluctuations.

Minor: Impact would be detectable but not outside the natural range of variability. Small changes to deer population numbers, population structure, genetic variability, and other demographic factors might occur. Occasional responses to disturbance by some individuals could be expected but without interference to factors affecting population levels. Sufficient habitat would remain functional to maintain viability of the deer population. Impact would be outside critical reproduction periods.

Moderate: Impact on the deer population, its habitat, or the natural processes sustaining it would be detectable and could be outside the natural range of variability. Changes to population numbers, population structure, genetic variability, and other demographic factors would occur, but the deer population would remain stable and viable. Frequent responses to disturbance by some individuals could be expected, with some negative impact on factors affecting population levels. Sufficient habitat would remain functional to maintain the viability of the deer population. Some impact might occur during critical periods of reproduction or in key habitat.

Major: Impact on the deer population, its habitat, or the natural processes sustaining it would be detectable, expected to be outside the natural range of variability, and extensive. Population numbers and structure, genetic variability, and other demographic factors might experience large declines, resulting in decreased viability or stability. Frequent responses to disturbance by some individuals would be expected, with negative impact on factors resulting in a decrease in population levels. Loss of habitat would affect the viability of the deer population.

Area of Analysis

The area of analysis for assessment of impact is Indiana Dunes National Lakeshore. The area of analysis for cumulative impact is the national lakeshore and the area within one-third of a mile of the NPS boundary, which is based on the estimated average home range of deer in the national lakeshore.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under alternative A, national lakeshore staff would continue monitoring the deer population and use controls to protect important resources, none of which would reduce the size of the deer population in the national lakeshore. The actions under this alternative would be very limited and reflect what is occurring today. With no control on the deer population, the population would continue to vary depending on conditions; however, the general trend toward increased numbers would continue. In addition, the national lakeshore would continue to conduct activities to protect sensitive plant species. As additional rare understory plant species were found within the national lakeshore, they would be protected with additional fencing, which would further limit potential food sources for national lakeshore deer.

Under alternative A, the deer population would continue to degrade the ground/shrub habitat that is important to them. As detailed in the “Vegetation” section, the deer population would remain higher than the recommended density for successful native plant reproduction and would likely increase over time, adversely affecting native vegetation abundance and diversity.

Starvation and poor reproduction, as demonstrated by deer in overpopulated herds, are not evidence that the herd is regulating itself. Starvation and disease are not acute mortality factors, like predation, but rather, provide only chronic control over a population (Eve 1981, as cited in Warren 1991). Under overpopulation conditions, deer herds can remain at high levels for many years until starvation, disease, or severe winter weather cause a temporary reduction in population size, typically lasting two to five years. By this time, adverse ecological effects (habitat degradation) have already occurred. Such reductions in the deer herd as a result of natural die-offs would not likely allow recovery of the natural community (Warren 1991).

It is expected that alternative A would continue to result in major, adverse, and long-term impact on deer habitat and, in turn, the deer population.

Cumulative Impact

Increased adverse impact on the deer population is expected from continued habitat fragmentation and degradation within and surrounding the national lakeshore. In addition to deer browsing, past actions within and near the national lakeshore, such as logging and fire suppression, have adversely affected deer habitat. The national lakeshore’s past and proposed future increase in efforts to control invasive exotic species, along with efforts to control gypsy moths and other pests, offer beneficial effects for deer habitat and, therefore, impact the overall herd. The national lakeshore’s plans to implement limited prescribed burning in the future also would be expected to beneficially impact vegetation and deer habitat. All of these activities, combined with pressure from continued deer browsing on vegetation and degradation of deer habitat expected under alternative A, would result in adverse cumulative impact on deer. Adverse cumulative impact would be major and long term because the deer population would continue to exceed carrying capacity, and potential habitats and food sources would continue to be restricted.

Conclusion

Under alternative A, lack of control on the growth of the deer population would result in continued adverse, long-term, major impact on deer and their habitat from excessive deer browsing and the continued high density of the population. Past, present, and future activities, combined with the continued pressure on vegetation resources and deer habitat expected under this alternative, would result in adverse, long-term, major cumulative impact. Because alternative A would not reverse the expected long-term increase in the deer population, adverse habitat impact would likely continue or worsen in Indiana Dunes National Lakeshore and would occur over the long term.

Alternative B: Combined Nonlethal Actions–Fencing, Repellents, and Reproductive Control

Several nonlethal actions would be implemented under alternative B to protect deer habitat and reduce deer numbers in the national lakeshore. Actions include the use of exclosures, increased use of repellents in limited areas, and reproductive control of does. Fencing and repellents would be implemented as described under alternative A.

Use of exclosures and repellents would protect specific vegetation or habitat but would exclude deer from potential food sources in approximately 7 percent of the national lakeshore. Areas outside the exclosures would continue to be affected by heavy deer browsing. Impact on deer would be similar to that discussed under alternative A, resulting in adverse, long-term, major impact.

If successfully implemented, reproductive control would help reduce the impact on deer by allowing habitat to improve. However, researchers disagree on the amount of time needed to reduce a population size using reproductive controls, and several years could be required to see results (Hobbs et al. 2000; Nielsen et al. 1997; Rudolph et al. 2000). The actual amount of time needed to observe a decrease would depend on a number of factors, such as the type of treatment used, its effectiveness in stopping reproduction, the size of the population at the time of initial treatment, the actual mortality rate, and the percentage of the population treated. Other factors, such as untreated deer moving into the national lakeshore and treated deer leaving the national lakeshore, would also affect the amount of time required to reduce herd numbers. The benefit of this action would be proportional to the amount of population reduction that it provided; therefore, a benefit could not be established until an improvement in vegetation was observed. Hobbs et al. (2000) described a model wherein, if 90 percent of the breeding does in the national lakeshore were effectively treated annually, mortality would have to exceed the number of surviving offspring from the 10 percent of untreated does in order to achieve a population reduction. An average mortality rate in urban/suburban deer populations is 10 percent (Hobbs et al. 2000). Based on these factors, it is expected that reproductive controls could stop population growth, but the national lakeshore would not be able to reach its initial deer-density goal within the life of this plan using current technology. Therefore, the impact on deer would continue to be adverse, long term, and major.

The physiological, biological, and behavioral effects of applying reproductive controls to deer are summarized in appendix F. The long-term effect of implementing reproductive control on a free-ranging deer herd is difficult to predict, given the many variables. The effect on individual deer may be majorly adverse as a result of handling stress and possible physiological or behavioral changes induced by the agent used. However, it is expected that the long-term adverse effect on the population would be minor to moderate, as the adverse impact over time would be offset by the beneficial effect of population reduction.

Cumulative Impact

The same past, present, and future activities described under alternative A would also occur under alternative B. Implementing the management actions identified in alternative B, which would protect approximately 7 percent of the national lakeshore's vegetation from browsing, plus reproductive control, could reduce the deer density after more than 15 years. This reduction would offer benefits over the long term but not immediately. Combined with all other actions affecting deer, the pressure on vegetation resources and deer habitat from continued browsing expected under alternative B would result in adverse, long-term, moderate to major cumulative impact on deer.

Conclusion

Impact on deer under alternative B would be adverse, long term, and major. Such actions as the use of fencing and exclosures and increased use of repellents would help maintain plant diversity in only very limited areas, and because the effect of reproductive control on the deer population would not be seen for many years, the overall long-term effect of alternative B would be expected to remain at major adverse levels for the life of this plan. Past, present, and future activities, combined with continued pressure on vegetation resources and deer habitat expected under this alternative, would result in adverse, long-term, moderate to major impact.

Alternative C: Lethal Action—Sharpshooting

Sharpshooting would be used under alternative C to reduce the size of the deer herd, thereby reducing deer density to allow native vegetation and deer habitat to recover from browsing pressure. Fencing and repellents would be used, as under alternative A.

Research indicates that when habitat is stressed, it cannot support healthy deer over the long term (Eve 1981). When deer density is high, signs of nutritional stress (such as low body and internal organ mass, low fecal nitrogen levels, and high prevalence of parasitic infections) typically occur. When deer density is reduced to the nutritional carrying capacity, all these indicators show improvement (Sams et al. 1998).

Reducing deer-density levels and maintaining them would allow vegetation to recover, providing better foraging habitat for the national lakeshore deer population. With increased vegetation and improved foraging habitat, this alternative would have beneficial long-term effects, and the current adverse impact on deer habitat would be reduced to negligible or minor over the long term as the deer population decreased. Adverse impact would still range from minor to moderate during the short term while habitat recovered.

This alternative would result in an impact to the deer population size, reducing the population from 70 or more deer/mi^2 to 15 deer/mi^2 (as described in Chapter 2: Alternatives), which is more closely aligned with levels that are in balance with other components of the ecosystem. Therefore, reducing the population to 15 deer/mi^2 would have a beneficial effect on the long-term viability of the deer population in the national lakeshore.

Cumulative Impact

The same past, present, and future activities described under alternative A would occur under alternative C. Relieving deer-browsing pressure through rapid reduction in the deer population would allow the majority of the national lakeshore's habitat to recover, resulting in beneficial effects and reducing adverse impact over the long term to negligible or minor levels.

Enabling the habitat to recover improves it for the national lakeshore deer population and would result in adverse, long-term, negligible to minor impact that would combine with the beneficial effects of prescribed burning and disease and pest control to yield a cumulative impact that would be primarily beneficial. This beneficial impact would offset the adverse effects from habitat fragmentation and degradation from other cumulative adverse actions. Therefore, cumulative impact on deer under this alternative would be mostly beneficial and long term.

Conclusion

The relatively rapid reduction of the deer herd and the resulting regeneration of forage under alternative C would result in beneficial effects on deer habitat and would reduce adverse impact to negligible or minor levels over the long term as the deer population decreased. Adverse impact would still range from minor to moderate while habitat recovered. Past, present, and future activities, combined with the reduced browsing pressure expected under this alternative, would result in long-term, beneficial cumulative impact on deer.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, sharpshooting of deer would be used to reduce the size of the deer herd, and reproductive control and sharpshooting would be used to maintain the deer population at the reduced size. Fencing and repellents would be implemented, as under alternative A.

The intent of this alternative would be to reduce deer density rapidly to allow native vegetation to recover from deer-browsing pressure. As vegetation regenerated, better foraging habitat would be provided for the national lakeshore deer population. With increased vegetation and improved foraging habitat, this alternative would have beneficial, long-term, minor to moderate effects. Adverse impact would still range in the minor to moderate level during the short term while habitat recovered.

Once implemented, the effect of reproductive control on the deer population would reduce the impact on deer. The actual amount of time needed to observe a decrease would depend on the type of treatment used, its effectiveness in stopping reproduction, the size of the population at the time of the initial treatment, and the percentage of the population treated. In combination with sharpshooting, beneficial impact from a reduction in herd size would range from negligible to minor.

Cumulative Impact

The same past, present, and future activities described under alternative A would occur under alternative D. Relieving deer-browsing pressure through rapid reduction in the deer population would allow the majority of the national lakeshore's habitat to regenerate, resulting in beneficial effects and reducing current adverse impact over the long term to negligible or minor levels.

Reducing deer-density levels and maintaining these levels under alternative D would allow vegetation to recover, providing better foraging habitat for the national lakeshore deer population. This would result in beneficial, long-term, minor to moderate impact that would combine with the beneficial effects of prescribed burning and disease and pest control to yield a cumulative impact that would be primarily beneficial. This beneficial impact would offset the adverse effects from increased development and other cumulative adverse actions. Therefore, cumulative impact on deer under this alternative would be mostly beneficial and long term.

Conclusion

Implementing long-term deer population reduction and management through the use of sharpshooting and reproductive control under alternative D would have long-term and beneficial effects; in addition, adverse impact on deer habitat would be reduced to negligible or minor levels over the long term as the deer population decreased. Past, present, and future activities, combined with the reduced pressure on deer habitat expected under this alternative, would result in beneficial, long-term cumulative impact on deer.

OTHER WILDLIFE AND WILDLIFE HABITAT

Guiding Regulations and Policies

The NPS Organic Act of 1916, NPS *Management Policies 2006* (NPS 2006b), and NPS *Reference Manual 77: Natural Resource Management Guideline* (NPS 1991) direct NPS managers to provide for the protection of park resources. The Organic Act requires that wildlife be conserved unimpaired for future generations, a requirement that has been interpreted to mean that native animal life is to be protected and perpetuated as part of a park unit's natural ecosystem. Parks rely on natural processes to control populations of native species to the greatest extent possible; otherwise, they are protected from harvest, harassment, or harm by human activities. The NPS *Management Policies 2006* makes restoration of native species a high priority. Management goals for wildlife include maintaining components and processes of naturally evolving park ecosystems, including natural abundance, diversity, and ecological integrity of plants and animals (NPS 2006b, sec. 4.1). Policies in the NPS *Natural Resource Management Guideline* state, "the National Park Service will seek to perpetuate the native animal life as part of the natural ecosystem of parks" and "native animal populations will be protected against… destruction… or harm through human actions."

Assumptions, Methodology, and Impact Definitions

The evaluation of other wildlife was based on a qualitative assessment of how management actions would affect other wildlife and their habitat. The national lakeshore's wildlife species are directly affected by the natural abundance, biodiversity, and ecological integrity of the vegetation that comprises their habitat.

Available information on known wildlife, including unique or important wildlife or wildlife habitat, was compiled and analyzed in relation to the management actions. The impact definitions are as follows:

Negligible: There would be no observable or measurable impact on native species, their habitats, or the natural processes sustaining them. Impact would be well within natural fluctuations.

Minor: Impact would be detectable but not outside the natural range of variability. Small changes to population numbers, population structure, genetic variability, and other demographic factors might occur. Occasional responses to disturbance by some individuals could be expected but without interference to factors affecting population levels. Sufficient habitat would remain functional to maintain viability of all species. Impact would be outside critical reproduction periods for sensitive native species.

Moderate: Impact on native species, their habitats, or the natural processes sustaining them would be detectable and could be outside the natural range of variability. Changes to population numbers, population structure, genetic variability, and other demographic factors would occur, but species would remain stable and viable. Frequent responses to disturbance by some individuals could be expected, with some negative impact on factors affecting population levels. Sufficient habitat would remain functional to maintain the viability of all native species. Some impact might occur during critical periods of reproduction or in key habitat.

Major: Impact on native species, their habitats, or the natural processes sustaining them would be detectable, outside the natural range of variability, and extensive. Population numbers and structure, genetic variability, and other demographic factors might experience large declines. Frequent responses to disturbance by some individuals would be expected, with negative impact on factors resulting in decreasing population levels. Loss of habitat might affect the viability of at least some native species.

Area of Analysis

The study area for this analysis (including cumulative impact) is primarily Indiana Dunes National Lakeshore and the adjacent habitat surrounding the national lakeshore, including Indiana Dunes State Park and agricultural and neighboring community lands.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under alternative A, national lakeshore staff would continue monitoring the deer population and conduct activities to protect native plants, such as creating and monitoring small protective fences and applying repellents in restoration areas (such use is currently minimal). Maintaining protective fencing or applying repellents to protect individual plants or groups of plants from deer browsing could restrict other wildlife from using these plants. However, these actions would have little effect on other wildlife because of the small scale of the actions, and their impact would not be measurable. Therefore, the impact of fencing and repellent use under this alternative would be adverse, short term, and negligible.

The vegetation/habitat conditions described in Chapter 3: Affected Environment indicate that deer have already affected vegetation (reduced abundance and diversity) and, thus, habitat for other wildlife species within the national lakeshore. The ground and shrub layers of the national lakeshore habitat have been heavily browsed by deer, suggesting that the abundance and diversity of other wildlife using this habitat is currently less than what it would be if deer-browsing pressure were lower. With no control on deer population growth, vegetation used as food and cover would become less abundant for other wildlife.

The coyote is the only predator species in the national lakeshore that uses deer as a food source and could benefit from high deer density or open understory conditions. Other animals, such as box turtles, vultures, crows, and chickadees, may also feed on deer carcasses. Small predators, such as foxes, hawks, owls, skunks, and raccoons, may decline as prey, as have mice, rabbits, and ground-nesting birds.

DeCalesta (1994) documented that a number of intermediate-canopy–nesting songbirds are affected by deer browsing. His research was less conclusive on the impact to ground- and upper-canopy–nesting species. The study concluded that several intermediate-canopy–nesting songbirds were absent at deer populations greater than 20 deer/mi^2 (eastern wood pewee [*Contopus virens*], indigo bunting [*Passerina cyanea*], least flycatcher [*Empidonax minimus*], yellow-billed cuckoo [*Coccyzus americanus*], and cerulean warbler [*Dendroica cerulea*]). The eastern phoebe (*Sayornis phoebe*) and American robin (*Turdus migratorius*) were absent at deer densities of 65 deer/mi^2.

Each of these species, with the exception of the least flycatcher, is known to nest in the national lakeshore. In 1981, the American robin and indigo bunting were listed as abundant in the national lakeshore, while the eastern wood pewee, yellow-billed cuckoo, and cerulean warbler were listed as common. The least flycatcher was listed as uncommon and the eastern phoebe was listed as rare (Krekeler 1981). The 2003 national lakeshore list had the eastern wood pewee and cerulean warbler maintaining their common listing, while the yellow-billed cuckoo had declined to uncommon. The least flycatcher and eastern phoebe had increased to common (NPS 2003h). As of 2005, the American robin was still listed as abundant, while the indigo bunting had declined to common (Lind et al. 2005).

Heavy deer browsing also results in lack of cover for small mammals, as well as snakes, frogs, and small ground-nesting or -feeding birds, making the habitat less suitable for small mammals.

Species that depend primarily on other habitats (such as wetlands) may also be affected by high deer numbers. Areas of greater herbaceous cover support more amphibians than areas with less cover; however, forest structure is an important factor in amphibian abundance only when suitable hydrology is present (Nuzzo and Mierzwa 2000). Some frogs, snakes, salamanders, and turtles (e.g., bullfrogs, snapping turtles) live close to water during much of their lives and are, therefore, less affected by deer; however, high-quality herbaceous cover would benefit these species (Nuzzo and Mierzwa 2000). Other aquatic species (e.g., box turtles, hognose snakes, American toads, and gray tree frogs) also depend on vegetation, fruits, and insects found in the ground/shrub habitat, and their habitat is similarly affected by high deer numbers. Heavy deer browsing may not directly affect fish habitat, but increased vegetative cover would enhance aquatic habitats along stream banks.

Such animals as box turtles, rabbits, mice, and ground- and intermediate-nesting birds, which require ground- and intermediate-canopy vegetation to maintain viable populations, would be adversely affected by high deer densities (greater than 20 deer/mi^2) because available food and cover would be greatly reduced by browsing. As browsing impact increased, more and more wildlife species would be adversely affected by these changes. For example, during winter, when food is less abundant, a number of species depend on acorns, nuts, seeds, and fruits. When deer compete for or reduce the availability of these food sources by preventing plants from reproducing, other wildlife species could eventually decline and even cease to exist in the national lakeshore because of the lack of available food.

For the reasons listed above, the impact of alternative A to other wildlife would be adverse, long term, and negligible to major, depending on the species. Species that depend on ground and shrub habitat for food or cover could be severely reduced or eliminated from the national lakeshore, while impact on species that are less dependent on ground/shrub habitats for food and cover would be negligible to minor.

Cumulative Impact

Actions resulting in cumulative impact on wildlife would be similar to those described for vegetation because vegetation constitutes the habitat that affects wildlife species to a great extent. Adverse impact on national lakeshore vegetation and wildlife is expected to continue from pollution, habitat fragmentation, and off-road vehicle use. In addition to deer browsing, past actions in or near the national lakeshore, such as steel mill development and wetland draining/filling, have adversely affected the wetland, dune, and forest habitats near the national lakeshore. Fire suppression has also altered the natural structure and composition of the national lakeshore habitat. Wildlife diseases (e.g., rabies and West Nile virus) have affected some species.

The national lakeshore's efforts to control invasive exotic plant species, gypsy moths, and other pests would have beneficial impact on wildlife habitat. The national lakeshore has implemented limited prescribed burning since the 1980s, which benefits the national lakeshore's prairie, oak savanna, and other fire-dependent habitats. The national lakeshore plans on continuing to restore previously disturbed sites (razed home sites, closed roads) and Karner blue butterfly habitat. All of these activities, combined with the continued pressure on national lakeshore habitat expected under alternative A because of continued deer browsing, would result in both adverse and beneficial impact on other wildlife. Overall, cumulative impact would be adverse, long term, and major because high densities of deer would continue to restrict habitat conditions for many wildlife species.

Conclusion

Under alternative A, habitat for wildlife species other than white-tailed deer would continue to be adversely affected by a large deer population and related browsing, resulting in a loss of ground/shrub habitat, decreased habitat diversity, and increased abundance of nonnative plants. A few predator species would benefit from a large deer population and a more open understory and ground cover, enabling them to better see and catch prey. However, the impact of large numbers of deer browsing on vegetation would adversely affect a large percentage of habitats for other wildlife (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles), resulting in adverse, long-term, and potentially major impact, depending on the species. Past, present, and future activities, combined with the continued pressure on ground/shrub habitat expected under this alternative, would result in both adverse and beneficial impact, with adverse, long-term, major cumulative effects.

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

Under alternative B, a combination of nonlethal actions would be implemented, in addition to the actions described under alternative A, to protect biodiversity and wildlife habitat and to manage deer numbers in the national lakeshore. These actions would include constructing additional fencing and exclosures, using repellents more extensively in areas where fencing and exclosures would not be appropriate or feasible, and controlling doe reproduction.

Fencing and exclosures would be constructed to protect specific species or habitat in the national lakeshore to maintain plant diversity. As explained under "Vegetation," approximately 7 percent of the national lakeshore would be protected from deer browsing in this manner during the life of the plan. The size of the openings in the fences (4 inches square) would allow small birds and mammals (e.g., songbirds, rabbits, raccoons) to pass in and out of these exclosures. The presence of fence posts and fencing would also provide perches for some birds, including hawks and owls. The fence could be an obstacle to other birds (e.g., birds hitting the fence). This action would make more ground-/shrub-layer habitat available to other wildlife than alternative A. However, because only 7 percent of the national lakeshore would be fenced off from browsing deer and because deer density outside the protected areas would remain high, the beneficial impact to other wildlife would be limited. As under alternative A, a continued high degree of deer browsing throughout a majority of the national lakeshore would reduce the availability of food and cover for species that depend on ground-/shrub-layer vegetation for survival. These species would decline and could cease to exist in the national lakeshore, resulting in an adverse, long-term, major impact on these species. Other species that have a more diverse diet or are less dependent on ground/shrub habitat would be less affected by high or increased deer density. The overall impact to wildlife throughout the national lakeshore would continue to be adverse, long term, and negligible to potentially major, depending on the species.

The use of repellents to protect individual plants or groups of plants from deer would have little effect on other wildlife, as this use would be implemented at such a small scale that the impact would not be measurable. Therefore, the use of repellents would have adverse, short-term, negligible impact.

The use of reproductive controls could help reduce the impact on other wildlife. However, researchers disagree on the amount of time needed to reduce a population size using reproductive controls, and several years could be required to see results (Hobbs et al. 2000; Nielsen et al. 1997; Rudolph et al. 2000). The actual amount of time needed to observe a decrease would depend on a number of factors, such as the type of treatment used, its effectiveness in stopping reproduction, the size of the population at the time of initial treatment, the actual mortality rate, and the percentage of the population treated. Other factors, such as untreated deer moving into the national lakeshore and treated deer leaving, would also affect the time required to reduce herd numbers. The benefit of this action would be proportional to the amount of population reduction that it achieved and a corresponding improvement to understory habitat. Hobbs et al. (2000) described a model wherein, if 90 percent of the breeding does in an area were effectively treated annually, mortality would need to exceed the number of surviving offspring from the 10 percent of untreated does in order to achieve a population reduction. An average mortality rate in urban/suburban deer populations is 10 percent (Hobbs et al. 2000). Based on these factors, it is expected that reproductive controls could stop population growth, but it would not be possible to achieve a meaningful population reduction within the national lakeshore during the life of this plan.

As with alternative A, a continued high degree of deer browsing throughout the majority of the national lakeshore would reduce the availability of food and cover for species that depend on ground-/shrub-layer vegetation for survival (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles). These species would decline and could be eliminated from the national lakeshore. This would be an adverse, long-term, major impact on these species. Other species that are less dependent on ground/shrub habitat (e.g., snapping turtles, spotted salamanders, barred owls, cedar waxwings) would be less affected by high or increased deer density. The overall impact to wildlife throughout the national lakeshore would continue to be adverse, long term, and negligible to potentially major, depending on the species.

Human presence associated with the installation of fencing and exclosures or the application of repellents and reproductive control techniques could adversely affect wildlife while the actions were being carried out. However, such small areas of the national lakeshore would be affected for such a short period that the adverse impact would be short term and negligible.

Cumulative Impact

The same past, present, and future actions described under alternative A would also occur under alternative B. Under alternative B, approximately 7 percent of the national lakeshore's vegetation would be protected from deer browsing, and the use of reproductive control could reduce deer density and related browsing impact after more than 15 years. Combined with the effects of prescribed burning for habitat restoration, restoration of previously disturbed sites, and disease and pest control, this alternative would provide some beneficial long-term impact. However, these beneficial effects would not be large enough to offset the adverse effects from pollution, habitat fragmentation, and other cumulative adverse actions, in conjunction with the continued deer-browsing pressure on the majority of the ground/shrub vegetation in the national lakeshore. Therefore, overall cumulative impact on wildlife habitat and, thus, to other wildlife species under this alternative would be adverse, long term, and moderate to major.

Conclusion

Under alternative B, approximately 7 percent of the national lakeshore vegetation would benefit from fencing and exclosures and increased use of repellents over the life of the plan. The remaining habitat, however, would continue to be subject to a high degree of deer browsing, adversely affecting both ground- and shrub-layer habitat for many other species of wildlife until reproductive controls took effect and reduced the deer population (more than 15 years). Overall, impact on other wildlife would be adverse, long term, and negligible (e.g., snapping turtles, spotted salamanders) to potentially major (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles), depending on the species. Past, present, and future activities, combined with the continued pressure on wildlife habitat expected under this alternative, would result in both adverse and beneficial impact, with adverse, long-term, moderate to major cumulative effects on other wildlife.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, sharpshooting would be used to reduce the deer herd size. The intent of this alternative would be to reduce deer density rapidly to enable ground/shrub habitat to recover from deer-browsing pressure. Fencing and repellents would also be implemented, as described under alternative A.

Reducing the degree of deer browsing throughout the majority of the national lakeshore would increase the availability of food and cover for species that depend on ground-/shrub-layer vegetation for survival (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles). These species would be able to maintain viable populations in the national lakeshore. As the vegetation became more diverse and abundant with reduced browsing pressure, the number of wildlife species that would benefit from these changes would also increase. This would be a beneficial long-term impact on these species. Other species that have a more diverse diet or are less dependent on ground/shrub habitat (e.g., snapping turtles, spotted salamanders, barred owls, cedar waxwings) would be less affected by a reduced deer density.

Predators that use deer as a food source, such as coyotes, would be adversely affected by a lower deer density or more abundant ground/shrub vegetation and denser understory conditions. Other animals that feed on deer carcasses, such as box turtles, vultures, crows, and chickadees, would also be adversely affected by fewer deer. However, none of these species depends solely on deer as a food source, so the adverse impact on these species would be long term and minor. Any carcasses left behind after sharpshooting would counter this impact. Such predators as foxes, hawks, owls, skunks, and raccoons would find a denser understory more difficult for hunting small prey than open understory conditions. However, better habitat conditions and an increase in the abundance of prey species would also benefit these predators.

Wildlife other than deer would be temporarily disturbed by the presence of humans placing bait stations, shooting deer, and observing deer behavior. Bait could provide a beneficial food source to other wildlife during the time that reduction activities were conducted; however, the small quantity and short time periods that bait would be available would have a negligible impact on any species. The surface disposal of deer waste and/or carcasses would provide a beneficial food source to such animals as coyotes, chickadees, and box turtles; however, under this alternative, it is expected that the majority of carcasses would be buried. The small number of carcasses left for natural decomposition would not be substantially different from what occurs through natural mortality and accidents (e.g., disease, old age, car collisions). These human disturbances would be adverse but temporary (less than 30 days per year) and negligible, as they would not cause any measurable change to the habitat or population levels of other wildlife species.

Long-term reduction and controls on deer population growth would enable vegetation used as food and cover by other wildlife to become more abundant. Therefore, the impact of alternative C to other wildlife would be mostly beneficial and long term, depending on the species. Species that depend on ground/shrub habitat for food or cover would benefit the most (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles), while there would be little or no benefit to species that depend primarily on other habitats (e.g., snapping turtles, spotted salamanders, barred owls, cedar waxwings).

With increased habitat available to wildlife for food and cover, this alternative would result in beneficial long-term effects, and existing adverse impact on other wildlife would be reduced to negligible or minor levels.

Cumulative Impact

The same past, present, and future actions described under alternative A would also occur under alternative C. Management actions identified in alternative C, which would drastically reduce deer-browsing pressure through a rapid reduction of the deer population, would produce beneficial long-term effects on other wildlife (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles). Some adverse impact on habitat would result from trampling during placement of bait stations, occupying shooting locations, and removing deer carcasses. However, such impacts would be temporary and isolated, causing little interference with other species activities, resulting in adverse, short-term, negligible impact.

Rapid deer-density reduction would allow the national lakeshore's ground/shrub habitat to recover, improving habitat for other wildlife and resulting in beneficial impact that would combine with the beneficial effects of prescribed burning for habitat restoration, restoration of previously disturbed sites (e.g., razed home sites), and disease and pest control. This beneficial impact would offset adverse effects from pollution, habitat fragmentation, and other cumulative adverse actions. Therefore, cumulative impact on wildlife habitat and other wildlife species under this alternative would be mostly beneficial and long term.

Conclusion

Under alternative C, impact on other wildlife species and habitat would be beneficial and long term as a result of rapid reductions in deer numbers in the national lakeshore, thereby reducing deer-browsing pressure on vegetation and allowing increased abundance and diversity of other wildlife that depend on ground/shrub habitat, such as ovenbirds, wood frogs, eastern hognose snakes, and box turtles. Adverse long-term impact would be reduced to negligible or minor levels over time. Human disturbances from trampling at bait stations, shooting from designated sites, or disposing of deer carcasses would be temporary and isolated. Therefore, adverse impact of these actions on other wildlife species would be short term and negligible. Past, present, and future activities, combined with the reduced browsing pressure on ground/shrub habitat expected under this alternative, would result in long-term, beneficial cumulative impact on other wildlife.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, the size of the deer herd would be directly reduced through sharpshooting, and reproductive control or sharpshooting would be used to maintain the population at the desired level. Fencing and repellents would be implemented, as described under alternative A.

The impact of each reduction method (sharpshooting or reproductive control) on other wildlife would be similar, as long as habitat was improved by reducing deer-browsing pressure. Potential differences in impact would relate to the time required for implementation and the resulting deer population size.

A reduced degree of deer browsing throughout the majority of the national lakeshore would increase the availability of food and cover for species that depend on ground-/shrub-layer vegetation for survival (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles). These species would be able to maintain viable populations within the national lakeshore. As the vegetation became more diverse and abundant with reduced browsing pressure, the number of wildlife species that would receive a long-term benefit from these changes would increase. Other species that have a more diverse diet or that depend more on other habitats (e.g., snapping turtles, spotted salamanders, barred owls, cedar waxwings) would be less affected by reduced deer density.

As described for alternative C, a few species that use deer as a food source, such as coyotes, might be adversely affected by fewer deer or denser understory conditions. However, coyotes do not depend solely on deer as a food source, so the adverse impact would be minor. Such predators as foxes, hawks, owls, skunks, and raccoons would find a denser understory more difficult to hunt in than open conditions. However, better habitat conditions and resulting increases in the abundance of prey species would also benefit these predators.

Wildlife other than deer would be temporarily disturbed by the presence of humans placing bait stations, shooting deer, implementing reproductive control techniques, and observing deer behavior, similar to alternatives B and C. Bait could provide a beneficial food source to other wildlife during the time that reduction activities were conducted; however, the small quantity and short time periods that bait would be available would have a negligible impact on any species. Surface disposal of deer waste and/or carcasses would provide a beneficial food source to such animals as coyotes, chickadees, and box turtles; however, under this alternative, it is expected that the majority of carcasses would be disposed of through burial. The small number of carcasses left for natural decomposition would not be substantially different than what currently occurs through natural mortality and accidents (e.g., disease, old age, car collisions). These human disturbances would be adverse but temporary (less than 30 days per year) and negligible, as they would not cause any measurable change to the habitat or population levels of other wildlife species.

Long-term reduction and controls on deer population growth would allow vegetation used as food and cover by other wildlife to become more abundant. Therefore, the impact of alternative D to other wildlife would be mostly beneficial and long term, depending on the species. Species that depend on ground/shrub habitat for food or cover would benefit the most (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles), while there would be little or no benefit to species that depend primarily on other habitats (e.g., snapping turtles, spotted salamanders, barred owls, cedar waxwings).

With increased vegetation available to wildlife for food and cover, this alternative would result in beneficial long-term effects, and existing adverse impact would be reduced to negligible or minor levels.

Cumulative Impact

The same past, present, and future actions described under alternative A would also occur under alternative D. Rapidly reducing the deer population and alleviating browsing pressure on the majority of the national lakeshore habitat under alternative D would provide long-term beneficial impact on other wildlife species (e.g., ovenbirds, wood frogs, eastern hognose snakes, and box turtles).

Some adverse impact on other wildlife would result from trampling by humans setting bait stations, occupying shooting locations, and removing deer carcasses. However, such impact would be temporary and isolated, causing little interference with other species' activities, resulting in adverse, short-term, negligible impact.

Rapid deer-density reduction would give the national lakeshore's habitats the opportunity to recover, improving habitat for other wildlife and resulting in beneficial impact that would combine with the beneficial effects of prescribed burning for habitat restoration, restoration of previously disturbed sites (e.g., razed home sites), and disease and pest control, resulting in primarily beneficial cumulative impact. This beneficial impact would offset the adverse effects from pollution, habitat fragmentation, and other cumulative adverse actions. Therefore, cumulative impact on wildlife under this alternative would be mostly beneficial and long term.

Conclusion

Under alternative D, impact on other wildlife would be long term and beneficial because of rapidly reduced deer numbers in the national lakeshore, resulting in decreased browsing pressure on habitat and allowing increased abundance and diversity of other wildlife that depend on ground/shrub habitat, such as ovenbirds, wood frogs, eastern hognose snakes, and box turtles. Long-term management of the deer population would be implemented through the use of sharpshooting or reproductive control, resulting in continued long-term beneficial impact by maintaining the population at desired levels. Over time, current adverse impact would be reduced to negligible or minor levels. Other wildlife would be temporarily affected by trampling at bait stations and shooting sites, during application of reproductive control techniques, or during disposal of deer carcasses. The adverse impact of these isolated actions on other wildlife would be short term and negligible. When combined with the reduced pressure on habitat expected under this alternative, past, present, and future activities would result in beneficial, long-term cumulative impact on other wildlife.

SENSITIVE AND RARE SPECIES

Guiding Regulations and Policies

The Endangered Species Act (16 USC 1531 et seq.) mandates that all federal agencies consider the potential effects of their actions on species listed as threatened or endangered. If the NPS determines that an action may affect a federally listed species, consultation with the USFWS is required to ensure that the action would not jeopardize the species' continued existence or result in the destruction or adverse modification of critical habitat. One of Indiana Dunes National Lakeshore's objectives is to protect habitat of sensitive and rare species from unacceptable adverse impact related to deer browsing.

NPS *Management Policies 2006* states that potential effects of agency actions would also be considered for state- or locally listed species. The NPS is required to control access to important habitat for such species and to perpetuate the natural distribution and abundance of these species and the ecosystems upon which they depend. Therefore, an analysis of the potential impact on state-listed species is also included in this section (NPS 2006b).

Indiana Dunes National Lakeshore has two federally endangered species, the Karner blue butterfly and the Indiana bat. Three additional species are listed as endangered but are thought to have been extirpated from the national lakeshore (American burying beetle, Hine's emerald dragonfly, and Mitchell's satyr). Two threatened species also occur at the national lakeshore, the bald eagle and the Pitcher's thistle. Indiana Dunes National Lakeshore has one candidate species, the eastern massasauga. The national lakeshore also has critical habitat for one endangered species, the piping plover. Several state-listed species (23 invertebrates, 28 birds, 2 fish, 8 reptiles, 4 amphibians, 4 mammals, and 123 plants) are also included in this analysis.

Assumptions, Methodology, and Impact Definitions

To assess impact on listed species and sensitive habitat, the following process was used to identify

- which species are in areas likely to be affected by management actions described in the alternatives
- habitat loss or alteration caused by the alternatives

- disturbance potential of the actions and the species' potential to be affected by the actions

The information in this analysis was obtained through the best professional judgment of the national lakeshore staff and experts in the field (as cited in the text) and by conducting a literature review.

Federally Listed Species

The USFWS and National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service guidance (USFWS &NMFS, 1998) for implementing section 7 consultation under the Endangered Species Act defines the terminology used to assess impact on listed species as follows:

Take: From Section 3(18) of the Federal Endangered Species Act: "The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Any take of a Federally-listed species that could result from deer management at the national lakeshore would be considered

Incidental take: Take that results from, but is not the purpose of, carrying out an otherwise lawful activity.

No effect: The appropriate conclusion when the action agency determines its proposed action will not affect a listed species or designated critical habitat.

May affect, is not likely to adversely affect: The appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not (1) be able to meaningfully measure, detect or evaluate insignificant effects; or (2) expect discountable effects to occur.

May affect, likely to adversely affect: The appropriate finding in a biological assessment (or conclusion during informal consultation) if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant, or beneficial (see definition of "is not likely to adversely affect"). If the overall effect of the proposed action is beneficial to the listed species but is also likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species. If incidental take is anticipated to occur as a result of the proposed action, an "is likely to adversely affect" determination should be made. An "is likely to adversely affect" determination requires the initiation of formal section 7 consultation.

The following impact categories can be used to determine the magnitude of effects on federally listed special status species and their associated habitat (including designated critical habitat) that would result from implementation of any of the alternatives. The Endangered Species determinations pursuant to section 7 of the act are included.

Adverse

Negligible: There would be no observable or measurable impact on federally listed species, their habitats, or the natural processes sustaining them in the proposed project area. This impact intensity would equate to a determination of "no effect" under section 7 of the Endangered Species Act.

Minor: Individuals may temporarily avoid areas. Impact would not affect critical periods (e.g., breeding, nesting, denning, feeding, resting) or habitat. This impact intensity would equate to a determination of "not likely to adversely affect" under section 7 of the Endangered Species Act.

Moderate: Individuals may be impacted by disturbances that interfere with critical periods (e.g., breeding, nesting, denning, feeding, resting) or habitat; however, the level of impact would not result in a physical injury, mortality, or extirpation from the national lakeshore. This impact intensity would equate to a determination of "likely to adversely affect" under section 7 of the Endangered Species Act.

Major: Individuals may suffer physical injury or mortality or populations may be extirpated from the national lakeshore. This impact intensity would equate to a determination of "likely to adversely affect" under section 7 of the Endangered Species Act.

State-Listed and Special Status Species

For wildlife species listed by the state of Indiana (but not under the Endangered Species Act) and species protected under the Migratory Bird Treaty Act that the national lakeshore has identified as needing special management consideration, assessment uses the same thresholds as those for impact on wildlife, as follows:

Negligible: There would be no observable or measurable impact on native species, their habitats, or the natural processes sustaining them. Impact would be well within natural fluctuations.

Minor: Impact on native species, their habitats, or the natural processes sustaining them would be detectable but not outside the natural range of variability. Occasional responses to disturbance by some individuals could be expected but without interference to feeding, reproduction, resting, or other factors affecting population levels. Small changes to local population numbers and structure and other demographic factors might occur. Some impact might occur during critical reproduction periods for a protected species, but this would not result in injury or mortality. Sufficient habitat national lakeshorewould remain functional to maintain the viability of the species in the national lakeshore.

Moderate: Impact on native species, their habitats, or the natural processes sustaining them would be detectable and could be outside the natural range of variability. Frequent responses to disturbance by some individuals could be expected, with some negative impact on feeding, reproduction, resting, or other factors affecting local population levels. Some impact might occur during critical periods of reproduction or in key habitats and result in harassment, injury, or mortality to one or more individuals. However, sufficient population numbers or habitat national lakeshorewould remain functional to maintain the viability of the species in the national lakeshore.

Major: Impact on native species, their habitats, or the natural processes sustaining them would be detectable, expected to be outside the natural range of variability, and permanent. Frequent responses to disturbance by some individuals would be expected, with negative impact on feeding, reproduction, or other factors, resulting in a decrease in national lakeshore population levels. Impact during critical periods of reproduction or in key habitats in the national lakeshore would result in direct mortality or loss of habitat that might affect the viability of a sensitive species. Local population numbers and structure and other demographic factors might show large declines.

Area of Analysis

The study area for this analysis (including cumulative impact) is primarily Indiana Dunes National Lakeshore and the adjacent habitat surrounding it, including Indiana Dunes State Park and agricultural and neighboring community lands.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Correspondence with the USFWS confirms that 6 wildlife species (3 of which are extirpated) and 1 plant species in the national lakeshore are federally listed (see Table 25). Correspondence with the IDNR Division of Nature Preserves and input from its staff confirm that 69 wildlife species and 123 plant species in the national lakeshore are currently listed by the state as endangered, threatened, of special concern, or rare (see Tables 26 through 30).

Under alternative A, the impact on federally and state listed species and sensitive habitats would be similar to what was described for vegetation. The primary impact to these species would be the result of not taking action to control deer numbers. Observations and research in the national lakeshore indicate that deer browsing has already caused noticeable changes to the vegetation, including eliminating or reducing numbers of certain plant species, decreasing plant diversity, increasing nonnative plants, and decreasing native plant abundance (NPS 1999b, n.d.f).

Invertebrates. Three butterflies and a beetle are federally listed as endangered for this area. The American burying beetle, Mitchell's satyr, and Hine's emerald dragonfly are thought to have died out in the national lakeshore based on its records. The Karner blue butterfly is locally abundant and is being managed through reintroduction efforts and a habitat restoration program. Wild lupine, the sole food source for Karner blue larvae, is thought to be a palatable species to deer. Deer have been observed eating wild lupine flowers, which could affect lupine reproduction and its long-term survival, thereby having direct effects on the viability of the Karner blue butterfly. The impact of continued deer-browsing pressure would be adverse, long term, and major as deer decrease lupine availability to the Karner blue butterfly.

The state lists 23 invertebrate species, including the 4 federally listed species described above. Little data on most of these species are available; 5 are primarily dependent on aquatic habitat and are not expected to be affected by deer density to a great extent (long-term, adverse, and negligible impact). The other 14 species are found in various habitats in the national lakeshore; most depend on ground-or shrub-layer vegetation for part of their life cycle. These species could be directly affected by deer-browsing pressure and would sustain an adverse, long-term, minor to major impact, depending on their dependence on browsed vegetation. Representatives of this group for discussion in this section include the bunchgrass skipper and the Kansas prairie leafhopper.

Birds. The national lakeshore includes 1 federally endangered species (piping plover). Plover habitat consists primarily of unvegetated sand dunes and beaches, neither of which would be adversely affected by deer browsing (negligible long-term impact).

The state lists 28 bird species as endangered or of special concern, 14 of which are migratory and do not nest in the national lakeshore (including the bald eagle and piping plover). Of the 14 species that may nest in the national lakeshore, 6 are primarily aquatic or wetland-dependent and would sustain negligible, long-term, adverse impact from continued or increased deer browsing (king rail, marsh wren, least bittern, sedge wren, Virginia rail, black tern). The remaining 8 species depend to some degree on ground- and shrub-layer vegetation (e.g., black-and-white warbler, hooded warbler) for nesting or hunting (e.g., barn owl, red-shouldered hawk). These species would experience minor to moderate, long-term, adverse impact from continued or increased deer browsing.

Fish, Reptiles, and Amphibians. The national lakeshore includes 1 federal candidate species, the eastern massasauga. This species uses a variety of habitats, including seasonal wetlands, open grasslands, and forest edges. Continued or increased deer browsing would have minor, long-term, adverse impact on this species.

The state lists 2 fish, 1 as extirpated from the national lakeshore and 1 as endangered. Neither species would be affected by deer browsing. The state list includes 8 reptiles (7 endangered and 1 of special concern) and 4 amphibians (1 endangered and 3 of special concern). A number of these species are water dependent (e.g., mudpuppy, western ribbon snake, spotted turtle, Blanding's turtle) and would not be adversely affected by changes in deer browsing (negligible long-term impact). Other species with some degree of dependence on ground- and shrub-layer vegetation would experience adverse, long-term, and minor to major impact from continued or increased deer browsing under this alternative (e.g., smooth green snake, Butler's garter snake, northern leopard frog).

Mammals. The national lakeshore includes 1 federally listed endangered species, the Indiana bat. This species roosts in mature trees and forages on flying insects. Continued or increased deer browsing would have negligible, adverse, long-term impact on this species. The state list also includes Franklin's ground squirrel (endangered), least weasel, and star-nosed mole (both of special concern). Franklin's ground squirrel prefers habitats with dense, tall cover dominated by mixed grasses and tall forbs. High deer densities may alter the Franklin's ground squirrel habitat so that it is no longer suitable to support the species. Least weasels prey on small mammals and sometimes eat grass stems and mast. If deer reduce the herbaceous cover and resulting food source for small mammals, the prey base for least weasels would be reduced. Star-nosed moles often forage aboveground for terrestrial insects. Less herbaceous cover as a result of deer browsing would result in fewer food resources for star-nosed moles and increase exposure to predators, such as owls, foxes, weasels, and skunks. Therefore, these state-listed species would experience minor to moderate, long-term, adverse impact as a result of continued or increased deer browsing.

Plants. The national lakeshore has only 1 federally listed plant (threatened), the Pitcher's thistle. The primary habitat for this species is the sand dunes. Herbivory of the leaves by white-tailed deer has been found to be a limiting factor in growth, survival, and dynamics of Pitcher's thistle (COSEWIC 2000). Continued or increased deer browsing is expected to have an adverse effect (moderate to major, long term) on this species.

The state list includes an additional 122 species, ranging from rare to endangered. Table 30 lists each species, its state designation, habitat, natural history, and projected palatability to deer. Given the number of species listed, each species is not evaluated individually for this plan; rather, groups of species with similar expected responses to deer browsing are presented. Reviews of national lakeshore information on the effects of deer on these species (NPS n.d.f) and additional available local information on plant resistance or palatability indicate that representative listed plants identified as palatable or frequently browsed by deer include bluebead, lesser purple fringed orchid, whip-poor-will flower, and rare clubmoss. Species in this group (65 percent of the state-listed species) would be directly affected by deer browsing, resulting in long-term adverse impact ranging from minor to major. Listed plants considered resistant to deer browsing include Canada spikesedge and longbeak beaksedge. Species in this group (21 percent of listed species) would be less affected by continued deer browsing; therefore, impact would be adverse, negligible, and long term. No information on deer palatability was found for many other listed species, including American bluehearts, globe beaksedge, prairie fameflower, and wild basil. Species in this group (14 percent) would experience adverse impact ranging from negligible to major, depending on their palatability to deer.

Ignoring the growth of the deer population would result in adverse, long-term, moderate to major impact on the listed plant species not currently protected. Browsing impact on sensitive species that are palatable or preferred by deer could result in a reduction of sensitive species in the plant community, either as a result of mortality directly from browsing or from impact on overall plant health and the ability of plants to produce seed stock or otherwise spread. Continual browsing of preferred plants over time could result in the loss of sensitive species from the national lakeshore. Similar impact on sensitive species considered to be less palatable to deer would also be expected if food resources were limited because of deer population growth, seasonal or climate variations (e.g., drought), or reductions in plant abundance resulting from disease or insect impact.

Under alternative A, the national lakeshore would continue to conduct limited activities to protect sensitive plant species. The national lakeshore currently fences known locations of the state-listed trillium. As additional rare understory plant species were found in the national lakeshore, they would also be evaluated for the need for protection by additional fencing.

Cumulative Impact

In addition to deer browsing, past actions, such as plant collection, logging, and fire suppression, have adversely affected sensitive and rare plant species in and around the national lakeshore. The national lakeshore's past and current efforts to control invasive exotic species, along with efforts to control gypsy moths and other pests, would result in beneficial impact on sensitive resources. Plans to implement limited prescribed burning in the future would also benefit native plant communities over the long term. Natural conditions, such as drought, have affected and can affect the viability of sensitive species. All these activities, when combined with the continued pressure on sensitive resources expected from continuing deer browsing under alternative A, would result in both adverse and beneficial cumulative impact on federally and state-listed sensitive and rare species. Adverse cumulative impact would be moderate and long term, because deer would continue to affect ground and shrub habitat.

Conclusion

Impact on federally and state-listed wildlife and plant species would be both beneficial and adverse under alternative A. Beneficial impact would result from maintaining fencing around known individual plants and rare plant communities and from establishing fencing around newly discovered rare plants in the national lakeshore. Overall, adverse, long-term, moderate to major impact on listed plant and wildlife species would be expected from excessive deer browsing and the resulting suppression of new, viable populations in the national lakeshore. Past, present, and future activities, combined with the continued pressure on federally and state-listed plant and wildlife species expected under this alternative, would result in both adverse and beneficial impact. Adverse cumulative impact would be long term and moderate to major.

Alternative B: Combined Nonlethal Actions–Fencing, Repellents, and Reproductive Control

Several nonlethal actions would be implemented under alternative B to protect national lakeshore resources and reduce deer numbers there. Actions include additional fencing, exclosures, increased use of repellents in limited areas, and reproductive control of does.

The use of exclosures and fencing to protect selected plants and the use of repellents in selected areas will protect some plant populations or individual federally and state-listed plant species. The natural reestablishment of native vegetation in the exclosures could promote the growth of sensitive species if suitable habitat characteristics and seed stock were present, resulting in a beneficial long-term impact to the plants, as well as listed wildlife. However, exclosures would provide protection for only about 7 percent of the national lakeshore's plant species. Areas outside the exclosures would continue to be affected by heavy deer browsing, and impact on federally and state-listed species would be similar to that discussed under alternative A.

Implementing reproductive controls would, over an extended period, reduce the deer population and browsing pressure on native plant communities throughout the national lakeshore, enabling natural communities to reestablish themselves and increase their extent. This result would potentially promote reestablishment of listed plant and wildlife species in suitable areas and reduce adverse long-term impact on listed plant and wildlife species to minor to moderate.

Cumulative Impact

The same past, present, and reasonably foreseeable actions described under alternative A would occur under alternative B. All of these actions, combined with extended use of large-scale exclosures and a long-term reduction in deer-browsing pressure resulting from the use of reproductive controls, would result in both beneficial and adverse cumulative impact on federally and state-listed species. Adverse cumulative impact would be long term and minor.

Conclusion

Impact on federally and state-listed plant and wildlife species under alternative B would be adverse, long term, and moderate to major until reproductive controls on the national lakeshore deer herd proved effective. Placing and maintaining exclosures would protect sensitive vegetation in about 7 percent of the national lakeshore over the life of the plan. These areas would include sensitive and rare plants, resulting in beneficial long-term impact. However, adverse, long-term, minor to moderate impact from deer browsing would continue outside the exclosures. Past, present, and future activities, combined with the continued pressure on listed plant and wildlife species expected under this alternative, would result in both beneficial and adverse impact. Adverse cumulative impact would be long term and minor to moderate.

Alternative C: Lethal Action—Sharpshooting

Use of sharpshooting would reduce deer density and browsing pressure on listed plant and wildlife habitats and promote growth and recovery of sensitive species if suitable habitat characteristics and seed stock were present. Some browsing of palatable listed plant species occurring outside fencing would be expected to occur, even with reduced deer herd density (15 deer/mi^2). A smaller deer herd density would reduce browsing pressure on rare plants over time, enabling them to reestablish themselves and increase the extent of natural communities. Increased areas of native vegetation would be expected to promote reestablishment of listed species. Reducing deer herd density would decrease the potential for deer-browsing impact on sensitive species, resulting in beneficial long-term impact. Some deer browsing would continue, however, even with herd density maintained at target levels. Potential impact on palatable, sensitive plant species occurring outside fencing would be adverse, long term, and minor.

Cumulative Impact

The same past, present, and reasonably foreseeable actions described under alternative A would also occur under alternative C. All of these actions, combined with an immediate reduction in deer-browsing pressure, would result in both beneficial and adverse cumulative impact on federally and state-listed species. Adverse cumulative impact would be long term and minor.

Conclusion

Impact on listed species under alternative C would be both beneficial and adverse. Beneficial impact would be expected as a result of a relatively rapid reduction in deer density and browsing pressure on native plant communities and federally and state-listed species. Some deer browsing would continue even if the herd density were maintained at targeted levels. Potential impact on palatable sensitive plant species occurring outside fenced areas would be adverse, long term, and minor. Past, present, and future activities, combined with the continued pressure on federally and state-listed species expected under this alternative, would result in both beneficial and adverse impact. Adverse cumulative impact would be long term and minor.

Alternative D: Combined Lethal and Nonlethal Actions

Sharpshooting, followed by a combination of reproductive control and sharpshooting, would be used under alternative D to reduce and maintain the size of the deer herd. These actions would reduce deer density and browsing pressure on listed plants and promote growth and recovery of sensitive species if suitable habitat characteristics and seed stock were present. Placing and maintaining fencing around known locations of certain federally and state-listed species would protect some plants from deer browsing and have beneficial long-term effects. Some browsing of palatable sensitive plant species occurring outside fenced areas would be expected to occur even with reduced deer density (15 deer/mi^2). Overall impact would be beneficial and long term. Potential impact on listed plant and wildlife species would be adverse, long term, and minor.

Cumulative Impact

The same past, present, and reasonably foreseeable actions described under alternative A would also occur under alternative D. All of these actions, combined with a reduction in deer-browsing pressure resulting from a smaller deer herd, would result in both beneficial and adverse cumulative impact on listed species in the national lakeshore. Adverse cumulative impact would be long term and minor.

Conclusion

Impact on federally and state-listed species under alternative D would be both beneficial and adverse. Beneficial impact would be expected as a result of reducing deer density and browsing pressure on listed plant species. Although deer browsing would continue if herd density were maintained at targeted levels, vegetation recovery would occur more rapidly than it would under alternative B. Potential impact on palatable sensitive plant species occurring outside fenced areas would be adverse, long term, and minor. Past, present, and future activities, combined with the continued pressure on federally and state-listed plant species and wildlife habitat, would result in both beneficial and adverse impact. Adverse cumulative impact would be long term and minor.

CULTURAL RESOURCES

Guiding Regulations and Policies

Federal actions that have the potential to affect cultural resources are subject to a variety of laws. The National Historic Preservation Act (1966, as amended; NHPA) is the principal legislative authority for managing cultural resources associated with NPS projects. Generally, section 106 of the act requires all federal agencies to consider the effects of their actions on cultural resources listed on or determined to be eligible for listing on the National Register of Historic Places. Such resources are termed historic properties. Agreement on how to mitigate effects to historic properties is reached through consultation with state historic preservation officers; tribal historic preservation officers, if applicable; and the Advisory Council on Historic Preservation, as necessary. In addition, federal agencies must minimize harm to historic properties that would be adversely affected by a federal undertaking. Section 110 of the NHPA requires federal agencies to establish preservation programs to identify, evaluate, and nominate historic properties to the National Register of Historic Places.

Other important laws or Executive Orders designed to protect cultural resources include the following:

- Archeological Resources Protection Act, 1979
- Executive Order 11593, "Protection and Enhancement of the Cultural Environment," 1971

Through legislation, the NPS is charged with protecting and managing cultural resources in its custody. This mandate is further implemented through *NPS-28: Cultural Resources Management Guideline* (NPS 1997e) and its supplement, Director's Order 28A: *Archeology* (NPS 2004a); NPS *Management Policies 2006* (NPS 2006b); and the 1995 "Servicewide Programmatic Agreement among the National Park Service, the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers." These documents charge NPS managers with avoiding, or minimizing to the greatest degree practicable, adverse impact on national lakeshore resources and values. Although the NPS has the discretion to allow certain impact in lakeshores, that discretion is limited by the statutory requirement that national lakeshore resources and values remain unimpaired unless a specific law directly provides otherwise.

Assumptions and Methodology

The NPS categorizes cultural resources as archeological resources, cultural landscapes, historic structures, museum objects, and ethnographic resources. As noted under "Issues and Impact Topics" in Chapter 1: Purpose of and Need for Action, only impact on archeological resources and cultural landscapes is of concern for the deer management plan. No impact on the other cultural resource topics would be considered.

The descriptions of effects on cultural resources presented in this section are intended to comply with the requirements of both NEPA and section 106 of the NHPA. In accordance with the regulations of the Advisory Council on Historic Preservation implementing section 106 (36 CFR Part 800, "Protection of Historic Properties"), impact on cultural resources is to be identified and evaluated by

- determining the area of potential effects
- identifying cultural resources present in the area of potential effects that are either listed or eligible to be listed on the National Register of Historic Places

- applying the criteria of an adverse effect to affected cultural resources either listed or eligible to be listed on the National Register of Historic Places
- considering ways to avoid, minimize, or mitigate adverse effects

Under the advisory council's regulations, a determination of either *adverse effect* or *no adverse effect* must also be made for affected cultural resources eligible for listing on the National Register of Historic Places. An *adverse effect* occurs whenever an impact alters, directly or indirectly, any of the characteristics that qualify the resource for inclusion on the National Register of Historic Places (e.g., diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association). Adverse effects also include reasonably foreseeable effects caused by a proposal that would occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5, "Assessment of Adverse Effects"). A determination of *no adverse effect* means that either no effect would occur or that the effect would not diminish in any way the characteristics that qualify the cultural resource for inclusion on the National Register of Historic Places.

CEQ regulations and NPS Director's Order #12 also call for discussion of the appropriateness of mitigation, as well as analysis of the effectiveness of the mitigation in reducing the intensity of a potential impact (e.g., from major to moderate or minor). Any resulting reduction in intensity because of mitigation, however, is an estimate of the effectiveness of mitigation under NEPA only. Cultural resources are nonrenewable, and adverse effects generally consume, diminish, or destroy the original historic materials or form, resulting in a loss in the integrity of the resource that can never be recovered. Therefore, although actions determined to have an adverse effect under Section 106 of the NHPA may be mitigated, the effect remains adverse.

A section 106 summary is included in the impact analysis sections for archeological resources and cultural landscapes. The section 106 summary is an assessment of the effect of the undertaking (implementation of the alternative) only on cultural resources listed on or eligible for the National Register of Historic Places, based on the criteria of effect and adverse effect found in the regulations of the Advisory Council on Historic Preservation.

Archeological Resources

Methodology and Impact Definitions

National lakeshore staff and contracted archeologists have assessed archeological resources in areas of disturbance for specific projects. No comprehensive archeological inventory of the national lakeshore has been completed; therefore, archeological information is limited. Information used in this analysis was gathered from the national lakeshore's "Cultural Landscape Report" (NPS 2000b), an archeological inventory of selected areas (Frost 2001), evaluative testing reports for two sites (Stadler 2001; Sturdevant and Bringelson 2003), personal communications with NPS personnel, the national lakeshore website (NPS n.d.i), and other sources (NPS 1995c, 2000a, 2005).

Certain important research questions about human history can be answered only by the actual physical material of cultural resources. Archeological resources have the potential to answer, in whole or in part, such research questions. An archeological site or sites can be eligible for listing on the National Register of Historic Places if the site has yielded or may be likely to yield information important in prehistory or history. An archeological site can be nominated to the National Register in one of three historic contexts or levels of significance: local, state, or national (see NPS 2002b). To help analyze impact on archeological resources, the following thresholds of change for the intensity of an impact are based on the potential of a site to yield information important in prehistory or history, as well as the probable historic context of the affected site:

Negligible: The impact would be at the lowest level of detection, with neither adverse nor beneficial consequences. For purposes of section 106 of the NHPA, the determination of effect would be *no adverse effect*.

Minor: **Adverse** — An archeological site would be disturbed, resulting in little, if any, loss of integrity. For purposes of section 106 of the NHPA, the determination of effect would be *no adverse effect*.

Moderate: **Adverse** — An archeological site would be disturbed, resulting in a loss of integrity. For purposes of section 106 of the NHPA, the determination of effect would be *adverse effect*. A memorandum of agreement would be executed among the NPS and the state historic preservation officer and, if necessary, the Advisory Council on Historic Preservation, in accordance with 36 CFR 800.6(b). Measures identified in the memorandum of agreement to minimize or mitigate adverse impact would reduce the intensity of impact under NEPA from major to moderate.

Major: **Adverse** — An archeological site would be disturbed, resulting in loss of integrity. For purposes of section 106 of the NHPA, the determination of effect would be *adverse effect*. Measures to minimize or mitigate adverse impact could not be agreed upon, and the NPS and the state historic preservation officer and/or the Advisory Council on Historic Preservation would be unable to negotiate and execute a memorandum of agreement in accordance with 36 CFR 800.6(b).

Area of Analysis

For the purpose of this analysis, the area of potential effect is defined as Indiana Dunes National Lakeshore.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under alternative A, the national lakeshore staff would continue monitoring the deer population and would conduct activities to protect native plants, such as creating small-area protection fencing, maintaining the large-area exclosure, and applying repellents to landscaped areas. No known archeological impact is currently associated with deer or their browsing activity. Installing fencing around rare plant species throughout the national lakeshore could cause minimal ground-surface disturbance and would potentially disturb unknown archeological resources. Fences would be located so as to avoid direct impact on any archeological resources. However, as the deer population grows over time, more and more small fences could be required, increasing the likelihood that some archeological resources could be disturbed. Monitoring of sensitive areas would aid in mitigating potential adverse effects, resulting in adverse, long-term, negligible impact. Indirect impact from increased erosion due to a decrease in vegetative cover could adversely affect archeological resources in the long term. However, such impact would be no more than negligible.

Cumulative Impact

Because the national lakeshore lacks a systematic, comprehensive archeological survey, ongoing potential exists for adverse impact on archeological resources from any national lakeshore project that causes ground disturbance. Examples include adding or upgrading new utilities, landfills or small dumps, and roads and trails around the national lakeshore. When combined with the adverse effects expected under this alternative from construction of small-area fences, these existing and future projects could result in long-term, negligible to minor, adverse impact on national lakeshore archeological resources because of ground disturbance.

Conclusion

Installing small-area protection fencing and maintaining the large-area exclosure to protect individual plant groupings would result in adverse, long-term, negligible impact on national lakeshore archeological resources; however, the limited extent and location of potential disturbance associated with the fences and exclosures would minimize this likelihood. Furthermore, fences would be located so as to avoid direct impact on archeological resources. Cumulative impact from ground disturbance would be negligible to minor.

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

Under alternative B, nonlethal actions, including additional fencing and exclosures, increased use of repellents in limited areas where exclosures would not be appropriate or desirable, and reproductive control of does would be implemented in combination to protect forest resources. Up to 15 small protection fences would be installed per year, typically less than 43 square feet (4 square meters), in addition to fencing provided in alternative A. A minimum of 303 large-area exclosures would be installed over three years at various locations, as discussed in Chapter 2: Alternatives. These exclosures would typically be larger than 215 square feet (20 square meters), with metal posts every 12 feet and concrete-reinforced 4-inch-x-4-inch wooden posts every 100 feet as corner supports.

Installing small protection fences would result in impact similar to that described in alternative A. Installing the large-area exclosures, particularly the placement of concrete-reinforced wooden posts, could result in some ground-surface disturbance at the base of the posts. However, the perimeters of the exclosures would not be placed in the vicinity of known archeological resources. Of particular concern are those resources throughout the national lakeshore that have not yet been identified, recorded, and protected by the NPS. Monitoring would occur in potentially sensitive areas, and installation would stop should any archeological resources be discovered. As a consequence, large-area exclosure installation would result in adverse, long-term, negligible to minor impact.

Cumulative Impact

As described under alternative A, the national lakeshore lacks a systematic, comprehensive archeological survey, so ongoing potential exists for adverse impact on archeological resources from any national lakeshore project that causes ground disturbance. Existing and future projects have and could continue to result in long-term, negligible to minor, adverse impact on national lakeshore archeological resources from ground disturbance. However, the archeological surveys conducted in advance of exclosure construction would result in long-term, minor, beneficial impact because areas in the national lakeshore that could contain archeological resources would be identified, and valuable information would be provided to assist in project location.

Overall, the adverse impact of past and ongoing national lakeshore projects and the benefits of potential future surveys in combination with the activities of alternative B would result in adverse, long-term, negligible cumulative impact. Alternative B would contribute minimally to the total cumulative impact.

Conclusion

Installing small-area protection fencing and large-area exclosures with many support posts could cause some ground disturbance that could impact unknown archeological resources. Locating fences and exclosures away from known resources and monitoring in potentially sensitive areas would result in adverse, long-term, negligible to minor impact. Installing small-area protection fences around individual plant groupings could result in adverse, long-term, negligible impact on national lakeshore archeological resources. Cumulative impact would be adverse, long term, and negligible.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, sharpshooting activities would occur to reduce the herd size. Bait stations would not be set on known archeological resources. Small-scale fenced areas and repellents would also be used. Herd size would be substantially reduced in the short term under this alternative. Because deer populations do not directly affect archeological resources, potential impact would be related to fencing small areas and would be the same as alternative A.

Some minimal ground-surface disturbance could occur with the placement of fencing and the burial of deer carcasses. Burial sites for deer waste and carcasses would be in previously disturbed areas that do not contain archeological resources. The monitoring of sensitive areas would aid in mitigating potential adverse effects, resulting in adverse, long-term, negligible impact.

Cumulative Impact

As described under alternative A, ongoing potential exists for adverse impact on archeological resources from any national lakeshore project that causes ground disturbance. When combined with the adverse, long-term, negligible impact that could occur under alternative C, existing and subsequent future projects could result in long-term, negligible to minor, adverse impact on national lakeshore archeological resources from ground disturbance.

Conclusion

Sharpshooting would have no direct impact on archeological resources. Bait stations and burial pits would not be placed on known archeological resources. Installation of small fences could result in adverse, long-term, negligible impact. Cumulative impact would be adverse, long term, and negligible to minor, resulting from ground disturbance.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, direct reduction would reduce the size of the deer herd, and reproductive control with direct reduction (if needed) would be used to maintain the herd at lower numbers. Bait stations and disposal locations would not be set on known archeological resources. Small-area protection fencing and repellents would be used, similar to alternative B. The number of protected areas would differ from alternative B, with only five small fenced areas for plant protection installed annually throughout the life of the plan. This alternative would also include construction of one large-area exclosure (2 to 5 acres) every other year for plant protection.

Herd size would be substantially reduced under this alternative. Because deer populations do not directly affect archeological resources, potential impact would be related to small-area protection fencing, exclosures, and disposal pits for deer waste and/or carcasses. Some minimal ground-surface disturbance could occur with the placement of fencing and exclosures around plants and the burial of deer carcasses. However, only five small fenced areas would be installed annually and one large-area exclosure every other year. In addition, the burial sites would be located in already disturbed areas, reducing the likelihood that archeological resources would be disturbed. Monitoring sensitive areas would aid in mitigating potential adverse effects.

Cumulative Impact

Cumulative impact would result from the placement of fencing and exclosures under alternative D, as well as the creation of disposal pits, combined with the other past, current, and future activities described under alternative A. Cumulative impact would be adverse, long term, and negligible, resulting from ongoing ground disturbance.

Conclusion

Reduction of deer populations from sharpshooting and the use of reproductive controls would have no direct impact on archeological resources. Bait stations would not be set on known archeological resources. Installation of small-area fences or up to one large exclosure every other year could result in adverse impact, which would be offset by monitoring. Cumulative impact would be adverse, long term, and negligible because of ongoing ground disturbance.

National Historic Preservation Act, Section 106 Summary

This *Final White-Tailed Deer Management Plan/Environmental Impact Statement* analyzes impact on archeological resources of four alternatives (the no-action alternative and three action alternatives). Potential impact could result from ground-surface disturbance under any alternative because all include the construction of small fences around individual groups of plants or trees. However, such a disturbance would be highly unlikely because the fences generally enclose very small areas and are used to protect landscaping or other plants. Thus, *no adverse effect* (*no effect*) would be related to these small fences.

Larger fences or exclosures would be constructed under alternative B, which could have a negligible to minor adverse impact. A minimum of 303 exclosures larger than 215 square feet square would be constructed and would include metal posts every 12 feet and concrete-reinforced 4-inch-x-4-inch wooden posts every 100 feet as corner supports. Installing these large exclosures, particularly the placement of concrete-reinforced wooden posts, could result in some surface disturbance at the base of the posts. However, exclosures would not be constructed in areas with known or potential archeological resources, and mitigation measures would be taken to ensure that adverse impact would not exceed minor intensity, resulting in *no adverse effect* to archeological resources.

Burial of deer waste and carcasses could occur in alternatives C and D as a result of sharpshooting activities. Disposal pits measuring approximately 8 feet x 8 feet x 4 feet would be constructed in previously disturbed areas that contain no archeological resources. Therefore, the construction of these pits would result in *no adverse effect* to archeological resources.

Cumulative impact would primarily involve ground disturbance during construction of fences or exclosures. Past projects in the national lakeshore have caused some ground disturbance, but they have resulted in no more than minor disturbance to archeological resources. When combined with the alternatives in this plan, cumulative impact would result in *no adverse effect* on archeological resources.

In accordance with section 106 of the NHPA, implementing any of the four alternatives would have *no adverse effect* on archeological resources. NPS would mitigate any major adverse impact on archeological resources associated with the construction of small or large exclosures. In cases where impact has not been identified as part of this analysis, potential adverse impact (as defined in 36 CFR 800) on archeological resources listed or eligible for listing on the National Register of Historic Places would be coordinated between the NPS and the state historic preservation office to determine the level of effect on the property and any necessary mitigation measures. If necessary, additional mitigation measures would be developed in consultation with the state historic preservation officer. Continuing implementation of the *Cultural Resource Management Guideline* (NPS 1997e) and adherence to the NPS *Management Policies 2006* (NPS 2006b) and the 1995 "Servicewide Programmatic Agreement among the National Park Service, the Advisory Council on Historic Preservation and the National Conference of State Historic Preservation Officers" would all aid in reducing the potential to adversely impact historic properties.

Copies of the *Draft Final Deer Management Plan/Environmental Impact Statement* were distributed to the Indiana state historic preservation officer and the Advisory Council on Historic Preservation for review and comment related to compliance with section 106 of the National Historic Preservation Act.

Cultural Landscapes

Of the nine identified cultural landscapes in the national lakeshore, only Chellberg Farm has the potential to be affected by deer management activities. The farm is managed by the NPS as a working farm and is used extensively for interpretive and educational programs. Historic resources associated with the farm include a two-story brick farmhouse (ca. 1885), gable barn (ca.1880), and several other agricultural buildings, structures, and landscape features. Chellberg Farm is important as a historic vernacular landscape and as an ethnographic landscape (NPS 2000b). It is made up of eight component landscapes, as follows:

Buildings—Extant buildings include the barn, farmhouse, chicken house, granary, windmill, and sugar camp. The silo foundation and reconstructed water house are also contributing structures.

Yard—The utilitarian space between the barn and farmhouse.

Front Yard—The domestic space adjacent to the farmhouse, which included a fence, lawn, and ornamental plants.

Orchard—A 1-acre orchard that included apple, pear, cherry, peach, and crabapple trees.

Garden—A large rectangular vegetable garden where food was grown for the family.

Lane—A tree-lined entrance road to the farm.

Fields—Open areas that were cultivated or used for pasture.

Ravine—Wooded area with steeply sloping terrain that was used for cattle grazing and maple syrup extraction (NPS 2000b).

Methodology and Impact Definitions

Cultural landscapes are those that have been adapted for or influenced by human use. Cultural landscapes so designated in the national lakeshore have been determined to have historic significance and integrity. In analyzing how alternative approaches for deer management would affect the Chellberg Farm cultural landscape, attention was paid to the program's effect on vegetation as a character-defining feature of the cultural landscape and on views and vistas.

To assess potential impact on cultural landscapes, the principal sources reviewed were the national lakeshore's "Cultural Landscape Report" (NPS 2000b) and the "Chellberg Farm Management Plan" (NPS 2000a).

To analyze potential impact on cultural landscapes, the thresholds of change for the intensity of an impact are defined as follows:

Negligible:	The impact would be at the lowest level of detection, with neither adverse nor beneficial consequences. For purposes of section 106 of the NHPA, the determination of effect would be *no adverse effect*.
Minor:	**Adverse** — Alteration of a pattern(s) or feature(s) of the cultural landscape listed on or eligible for listing on the National Register of Historic Places would not

diminish the overall integrity of the landscape. For purposes of section 106 of the NHPA, the determination of effect would be *no adverse effect*.

Moderate: **Adverse** — The impact would alter a pattern(s) or feature(s) of the cultural landscape, diminishing the overall integrity of the landscape. For purposes of section 106 of the NHPA, the determination of effect would be *adverse effect*. A memorandum of agreement would be executed among the NPS and the state historic preservation officer and, if necessary, the Advisory Council on Historic Preservation in accordance with 36 CFR 800.6(b). Measures identified in the memorandum of agreement to minimize or mitigate adverse impact would reduce the intensity of impact under NEPA from major to moderate.

Major: **Adverse** — The impact would alter a pattern(s) or feature(s) of the cultural landscape, diminishing the overall integrity of the resource. For purposes of section 106 of the NHPA, the determination of effect would be *adverse effect*. Measures to minimize or mitigate adverse impact could not be agreed upon, and the NPS and the state historic preservation officer and/or Advisory Council on Historic Preservation would be unable to negotiate and execute a memorandum of agreement in accordance with 36 CFR 800.6(b).

Area of Analysis

Historically, Chellberg Farm comprised 80 acres, most of which (79.6 acres) is currently owned by the NPS. It is located in the south-central portion of the national lakeshore. It had significance during one historic period (1869 to 1932) and is important as a historic vernacular landscape and as an ethnographic landscape. For purposes of this analysis, the area of potential effect is all of the 79.6 acres that were historically part of Chellberg Farm.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under alternative A, the national lakeshore staff would continue monitoring the deer population and conduct activities to protect native plants, such as creating and monitoring small-area protection fencing and large-area exclosures and applying repellents to a small number of landscaped areas. However, deer populations would continue to exceed carrying capacity and browsing would continue, causing a decline in the long-term abundance and diversity of native plant species, contributing to further establishment of invasive exotic species in the cultural landscape, and decimating the crops grown on the farm as part of its interpretive program. As a result, the plant species and populations that have existed historically in the cultural landscape would continue to be reduced and, in some cases, could be lost. The decline in these plant communities and the impact on crop production would result in adverse, long-term, minor impact on the Chellberg Farm cultural landscape because native plant communities and cultivated fields are components of the cultural landscape's character-defining vegetation features. The degree of impact would depend on the size of the future deer population and the degree of continued decline in cultural landscape plant communities.

Small-area protection fencing and repellents could be used to protect individual trees and other vegetation from deer browsing in the vicinity of Chellberg Farm and elsewhere. The national lakeshore's "Cultural Landscape Report" states that forest vegetation is a contributing feature to the Chellberg Farm cultural landscape. Thus, protection of this landscape would result in beneficial, long-term, minor impact.

Cumulative Impact

Various past and present actions and events have affected the vegetation in the Chellberg Farm cultural landscape. The character of the woodland has changed with the elimination of grazing and the onset of a succession of young woody and herbaceous species that have encroached into previously open areas. The elimination of cattle grazing in the woods has had a dramatic impact by allowing a dense undergrowth in an area that was once very sparse and open. The overall condition of the orchard is poor, but the national lakeshore is planning its restoration.

Invasive exotic vegetation is a problem inside and outside the cultural landscape. Disturbance from natural events or from human activities can create favorable conditions for invasive exotic plant species. An intensive program to prevent the spread of invasive exotic vegetation in the cultural landscape over the long term would result in beneficial, minor impact on the cultural landscape.

Conclusion

Continued growth of the deer population and the associated ongoing decline in the abundance and diversity of native plant communities and decimation of crops would result in an adverse, long-term, minor impact to the cultural landscape under alternative A. The use of small-area protection fencing and repellents to protect naturally occurring trees and other vegetation in or near the cultural landscape could result in beneficial, long-term, minor impact on these parts of the cultural landscape's vegetation. Adverse, long-term, minor cumulative impact would result from the ongoing decline of native plant communities as a result of deer browsing and crop decimation, despite benefits from the use of this alternative's protective measures and exotic species control.

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

Under alternative B, nonlethal actions would be implemented in combination to protect national lakeshore resources. Actions would include additional fencing and exclosures, increased use of repellents in limited areas where exclosures would not be appropriate or desirable, and reproductive control of does. Up to 15 small-scale exclosures, typically less than 43 square feet (4 square meters), would be installed per year, in addition to fencing provided in alternative A. A minimum of 303 large-scale exclosures, typically larger than 215 square feet (20 square meters), with metal posts every 12 feet and concrete-reinforced 4-inch-x-4-inch wooden posts every 100 feet as corner supports, would be installed over three years at various locations, as discussed in chapter 2. None of the additional fencing or exclosures would be placed within the boundaries of the cultural landscape, which would allow for continued decimation of the landscape's crops and result in an adverse, minor, long-term impact.

As described in alternative A, repellents could also be used to protect character-defining vegetation features of the cultural landscape. Use of repellents would result in beneficial, long-term, minor impact on the cultural landscape because it would enable vegetation to regenerate and would prevent crop damage.

Using reproductive control techniques for does in the future would gradually limit deer population growth over the long term, allow for regeneration of native plant communities outside the exclosures, and reduce crop decimation. This would result in further beneficial, long-term, minor impact on the national lakeshore's cultural landscape.

Cumulative Impact

The impact of past, present, and reasonably foreseeable actions identified in alternative A would be the same for alternative B. Overall, the adverse, long-term, minor impact from vegetation changes and adjoining land-use changes, along with the beneficial impact of exotic species removal (explained in the cumulative impact analysis for alternative A), in combination with the impact of alternative B, would result in beneficial, long-term, minor cumulative impact.

Conclusion

Additional fencing and exclosures would allow regeneration of native woody plant populations outside the cultural landscape but would not inhibit crop damage from deer within the cultural landscape, resulting in adverse, long-term, minor impact. Deer repellents would be used to protect specific landscaped areas and crops, resulting in beneficial, long-term, minor impact. Reproductive controls, if implemented, could result in further beneficial, long-term, minor impact by reducing the deer population and subsequent browsing and crop decimation. Beneficial, long-term, minor cumulative impact would result from some regeneration of native plant populations, control of nonnative species, and crop protection. There would be no impairment of cultural landscapes under alternative B.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, sharpshooting would occur to reduce the herd size. Placing small fences around individual or small groups of plants or landscaping would be part of this alternative.

Reducing the deer population within about three years would result in diminished browsing pressure. Reduced pressure would allow agricultural activity at Chellberg Farm to take place without the severe depredation from deer that occurs now. Decreased browsing, as well as repellent use, would also help protect landscape plantings associated with farmstead remnants. Because the agricultural fields and garden are character-defining vegetation features of the cultural landscape, reestablishing or rehabilitating these features would result in beneficial, long-term, moderate impact on Chellberg Farm and component landscapes.

Sharpshooting related to deer reduction, including setting up bait stations, occupying shooting areas, and dragging deer to locations for processing and transport, would occur outside the boundaries of the cultural landscape, resulting in an adverse, short-term, negligible impact.

Where one to a few deer were shot, the waste or carcasses could either be scattered and left aboveground to be naturally scavenged and decompose or buried if meat is unsuitable for surface disposal or donation to charity. Surface disposal methods would occur in areas outside, invisible from, and not easily accessible to the cultural landscape, resulting in adverse, short-term, negligible impact. Similarly, disposal pits would be located in areas outside the cultural landscape. The impact to the cultural landscape would be adverse, short term, and negligible.

Cumulative Impact

The impact of past, present, and reasonably foreseeable actions identified in alternative A would be similar for alternative C. Overall, the adverse, long-term, minor impact from vegetation changes and adjoining land-use changes, in combination with the beneficial, long-term, moderate impact and adverse, short-term, negligible impact of alternative C, would result in beneficial, long-term, moderate cumulative impact.

Conclusion

Reduced browsing pressure and crop damage from sharpshooting would allow native plant populations to regenerate throughout the national lakeshore, and small fenced areas and repellents would help protect other character-defining vegetation within the cultural landscape. These actions would result in beneficial, long-term, moderate impact on Chellberg Farm and component cultural landscapes. Cumulative impact would be beneficial, long-term, and moderate because of crop protection and regeneration of native plant populations, which would benefit the forested landscape component.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, direct reduction would be implemented to reduce the size of the deer herd, and reproductive control with direct reduction (if needed) would be used to maintain the herd at lower numbers. Bait stations and disposal areas would be set outside the boundaries of the cultural landscape. Small-area protection fencing and repellents would be used, similar to alternative B. The number of protected areas would differ from alternative B, with only five small fenced areas for plant protection installed annually throughout the life of the plan. This alternative would also include construction of one large-area exclosure (2 to 5 acres) every other year for plant protection.

Herd size would be substantially reduced under this alternative; browsing pressure on crops and cultural landscapes would also be reduced, resulting in a beneficial long-term impact. Potential adverse impact would be related to small-area fencing, one large exclosure installed every other year, and disposal pits for deer waste and/or carcasses. Some minimal ground-surface disturbance could occur with the placement of fencing and exclosures and the burial of deer carcasses. However, only five small fenced areas would be installed annually and one large-area exclosure every other year. In addition, the burial sites would be located in already disturbed areas, reducing the likelihood that archeological resources would be disturbed. Monitoring sensitive areas would aid in mitigating potential adverse effects.

Cumulative Impact

The impact of past, present, and reasonably foreseeable actions identified in alternative A would be similar for alternative D. Overall, the adverse, long-term, minor impact from vegetation changes and adjoining land-use changes, in combination with the beneficial, long-term, moderate impact from reduced browsing pressure and adverse, short-term, negligible impact from ground disturbance, would result in beneficial, long-term, moderate cumulative impact.

Conclusion

Reduction of deer populations from sharpshooting and reproductive controls would have no impact on the cultural landscape. Bait stations would not be set within the boundaries of the cultural landscape. Installing small-area fences or up to one large exclosure every other year could result in adverse impact, which would be offset by monitoring. Cumulative impact would be primarily beneficial, long-term, and moderate.

National Historic Preservation Act, Section 106 Summary

The *Final Deer Management Plan/Environmental Impact Statement* analyzes the impact of four alternatives on one cultural landscape in the Indiana Dunes National Lakeshore. The alternatives include a no-action alternative and three action alternatives. Of the nine identified cultural landscapes in the national lakeshore, only Chellberg Farm has the potential to be affected by deer management activities. Other cultural landscapes at the national lakeshore do not include planned landscapes and, therefore, would not be affected by deer management activities.

Continued growth in the existing deer population and excessive deer browsing and crop decimation under alternative A would continue to limit successful regeneration of native plant communities in the cultural landscape, resulting in an adverse, long-term, minor impact. Potential beneficial impact on the cultural and component landscapes could result from the use of small fenced areas to protect small groups of native plants and crops. Protection of this landscape component would result in a beneficial, long-term, minor impact.

Deer population control measures would take several years to be effective under alternative B, and small- and large-scale fenced exclosures would be constructed to allow vegetation regeneration. The fences would not be constructed within the landscape, which would allow for continued decimation of the landscape's crops and result in an adverse, long-term, minor impact. Reproductive control of does would also be instituted in the future, controlling the national lakeshore deer population and its impact on vegetation over a longer period of time, which would result in beneficial, long-term, minor impact. Therefore, *no adverse effect* would result from actions taken under alternative B.

The quick reduction of the deer population under alternative C would cause a substantial decline in over-browsing of native plant populations and crop decimation. Native plants would begin to regenerate, resulting in long-term benefits for them and a character-defining vegetation feature in the cultural landscape; crop production would also increase. Therefore, *no adverse effect* would result from actions taken under alternative C.

The results of alternative D would be similar to those of alternative C and would result in *no adverse effect* to the cultural landscape.

Alternative D would be a combination of reproductive controls described in alternative B and sharpshooting described in alternative C. These combined actions would result in a direct reduction in deer populations and the protection of vegetation and crops that are identifying characteristics of the cultural landscape, resulting in *no adverse effect* under alternative D.

In accordance with section 106 of the NHPA, potential adverse impact (as defined in 36 CFR 800) on cultural landscapes listed or eligible for listing on the National Register of Historic Places would be coordinated between the NPS and the state historic preservation sfficer to determine the level of effect on the property and to determine any necessary mitigation measures. Continuing implementation of the *Cultural Resource Management Guideline* (NPS 1997e) and adherence to NPS *Management Policies 2006* (NPS 2006b) and the 1995 "Servicewide Programmatic Agreement among the National Park Service, the Advisory Council on Historic Preservation and the National Conference of State Historic Preservation Officers" would aid in reducing the potential to adversely affect historic properties.

VISITOR USE AND EXPERIENCE

Guiding Regulations and Policies

NPS *Management Policies 2006* (NPS 2006b) states that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks and that the NPS is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. The Indiana Dunes National Lakeshore's purpose includes providing educational, inspirational, and recreational opportunities compatible with preserving natural and cultural resource values, as well as inspiring in the public an appreciation of and a sense of personal stewardship for national lakeshore resources. The national lakeshore's legislative intent was to preserve certain portions of the Indiana dunes and other areas of scenic, scientific, and historic interest and recreational value in the state of Indiana for educational, inspirational, and recreational use.

Although recreation is a key component of the *NPS Management Policies*, the policies also instruct park units to maintain all native plants and animals as parts of the natural ecosystem. The NPS would achieve this by preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and their communities and ecosystems.(NPS 2006b, sec. 4.4.1).

With regard to recreation and conservation, the plan's objectives state that it should "provide opportunities for the public to experience a balanced, functioning Indiana Dunes National Lakeshore ecosystem where deer are not the driving force, and the visitor understands the natural role of deer in the ecosystem."

Assumptions, Methodology, and Impact Definitions

Past comments from the public (recorded as visitor use data) and personal observations of visitation patterns were used to estimate the effects of the alternative actions on visitors. The impact on the visitor's ability to experience a full range of the national lakeshore resources was analyzed by examining resources mentioned in the national lakeshore significance statement. It is assumed that visitation would increase approximately 1.5 percent per year in the immediate future. The impact levels and definitions are as follows:

Negligible: The action would be barely detectable and would affect few visitors. Visitors would not likely be aware of the effects associated with management actions.

Minor: The action would be detectable and affect only some visitors. Visitors would likely be aware of the effects associated with management actions. The changes in visitor use and experience would be slight but detectable; however, visitor satisfaction would not be measurably affected.

Moderate: The action would be readily apparent and affect many visitors. Visitors would be aware of the effects associated with management actions. Visitor satisfaction might be measurably affected (visitors could be either satisfied or dissatisfied). Some visitors would choose to pursue activities in other available local or regional areas.

Major: The action would affect the majority of visitors. Visitors would be highly aware of the effects associated with management actions. Changes in visitor use and experience would be readily apparent. Some visitors would choose to pursue activities in other available local or regional areas.

Area of Analysis

The area of analysis is the entire national lakeshore for all alternatives, including cumulative assessments. Neighboring landowners outside the national lakeshore boundaries are also included in this area of analysis.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under alternative A, the national lakeshore staff would continue creating and monitoring small-area protection fencing and spraying small areas of the national lakeshore to protect species from deer-browse impact. Monitoring and spotlight surveys would also continue. However, the national lakeshore would take no additional action to manage the deer population within its boundaries; therefore, visitors would not have the opportunity to experience a balanced, functioning ecosystem within the national lakeshore.

Small-area protection fencing and the large-area exclosure would be visible to national lakeshore visitors and local residents, resulting in a direct and adverse impact on the environment's natural setting. However, such fencing and exclosures would be limited and isolated, and visual intrusions would be minimal. It is likely that national lakeshore visitors consider monitoring activities an acceptable part of the routine for NPS staff and would not be disturbed by such ongoing efforts.

Visitors who value viewing deer would experience direct beneficial impact, particularly in the East Unit, where deer are most abundant. Visitors who ride horses (horseback riding occurs from mid-

March through mid-December) and cross-country ski might have more opportunities to see deer, which are more active in the fall during rut season. However, if deer herd health begins to decline because of overpopulation, visitors may be adversely affected by the sight of unhealthy deer. In addition, if the herd's health deteriorated enough to substantially reduce the herd size, visitors who enjoy viewing deer would have decreased opportunities to do so in the long term. Amateur botanists, birdwatchers, and viewers of other types of wildlife could be adversely affected, as increasing deer-browse impact could eventually reduce the potential to see these species. Some of the national lakeshore's interpretive programs, which focus on locating particular bird species, wildflowers, or other animals, could also be adversely affected in the long term if deer-browse impact diminishes the ecosystem's ability to support such species.

Visitors to historic Chellberg Farm currently experience an adverse impact from deer browsing the farm's cornfield. Of the many annual interpretive activities that the national lakeshore conducts for visitors, the Autumn Harvest is the only one that has been affected by deer. This is a festive period celebration of a successful harvest; however, visitors who come to help harvest are disappointed when there is no corn to gather. Deer browsing has resulted in less corn for visitors to harvest by hand. Corn harvesting is also part of an interpretive activity with school groups, who would be similarly affected (NPS 1995c; Indiana Dunes National Lakeshore cultural resources staff, pers. comm. 2006). Such impact would likely be minor, and some visitors may associate this impact with a natural event compatible with the historical setting. Deer are active year round but more so in the fall during rut season, when national lakeshore visitation is low and the corn crop has been harvested.

Visitors also come to the national lakeshore specifically to see the Karner blue butterfly, which until recently, existed only in the national lakeshore's West Unit. Adverse impact could occur if increased deer browsing decreases the presence of butterflies in this unit. During the summer of 2006, national lakeshore staff released some Karner blue butterflies into a section of the East Unit, restoring them to an area from which they had been extirpated (R. Knutson, Indiana Dunes National Lakeshore, pers. comm. July 20, 2006). This restoration could beneficially affect visitors to this area, but at the same time, increased deer-browsing pressure could interfere with the butterfly's ability to become reestablished in the East Unit.

The majority of the national lakeshore's visitors come for beach-related activities, such as swimming and sunbathing, hiking the dunes, and walking the shoreline. West Beach (which has fewer deer, concentrated in inland areas) is a popular attraction for such activities. Auto touring is also a very popular activity. Seeing a deer or bird may provide a secondary positive experience that augments the overall primary experience of visiting the beach, particularly because 73 percent of national lakeshore visitors come to "enjoy nature." However, not seeing deer would probably not diminish the overall visitor experience for these users.

Responses to visitor surveys show that 90 percent or more of national lakeshore visitors are satisfied with their recreational opportunities. This indicates that implementation of the no-action alternative would likely result in continuation of high levels of visitor satisfaction. However, if deer-browse impact adversely affected those visitors who focus on birding, wildlife viewing (in addition to deer), and botany, overall satisfaction could decrease. Given that the focus of most visitors is on beach-related activities, such a decrease would likely be relatively small.

The overall impact on visitor use and experience under this alternative would likely be negligible or undetectable to beach users, who are the majority of national lakeshore visitors. A negligible beneficial impact would be experienced by visitors who appreciate seeing deer, and a negligible to moderate adverse impact would be experienced by amateur botanists, birdwatchers, butterfly watchers, and people seeking other wildlife, depending on the extent of increased deer-browse pressure and the type of species affected.

Cumulative Impact

Staff at the national lakeshore expects a 1.5-percent increase in visitation in future years, which could result in increased pressure for various recreational uses and could adversely affect visitor experience.

The national lakeshore is actively closing roads as it acquires rights-of-way. It is possible that some of these roads may be converted to hiking/biking trails, as called for in the national lakeshore's general management plans. Some roads may be closed and restored to natural conditions, which could improve the quality of national lakeshore habitat (and could result in an increase in the deer population). The trails would enable hiking, interpretive activities, and cross-country skiing throughout the West Unit (NPS 1993a). An increase in trails would provide a beneficial impact to visitors seeking to observe deer and other animals, birds, or plant species. In addition, an increase in the quality of national lakeshore habitat, affected by restoring some trails and approximately 400 old home sites to natural conditions, could also increase the opportunity to view wildlife, but such an increase would likely be undetectable to visitors.

Neighboring land users plan to continue deer removal activities indefinitely into the future in efforts to either reduce or maintain deer population levels. Because these lands border much of the national lakeshore, particularly in the East Unit, visitors would be indirectly affected by these activities. A reduction in the area's overall herd size as a result of nearby hunting could reduce the ability to view deer but increase the ability to view other species, resulting in both adverse and beneficial impact, depending on the visitor's goals.

Off-road use is not permitted within the national lakeshore, but such use has occurred in the past and continues to occur. Ranger patrols and the use of wire cables and fencing have proven to be successful at preventing illegal off-road vehicle use within the national lakeshore and are expected to reduce such use in the future. Most of the cabling exists along roads and has not been a deterrent to deer movement, but the existence of these cables and fences would contribute to the overall visual interference of fencing and exclosures that have been and would be created for deer management purposes.

When combined with the beneficial and adverse impact expected under this alternative, the cumulative impact would also be both beneficial and adverse and range from negligible to moderate, depending on the visitor's goals.

Conclusion

The overall impact on visitor use and experience under alternative A would be negligible for beach users, who are the majority of national lakeshore visitors. A negligible beneficial impact would be experienced by visitors who appreciate seeing deer, and a negligible to moderate adverse impact would be experienced by amateur botanists, birdwatchers, butterfly watchers, and people seeking other wildlife in their natural habitat, depending on the extent of increased deer-browse pressure and the type of species affected. Implementation of the no-action alternative may result in the continuation of high levels of visitor satisfaction; however, visitors would not have the opportunity to experience a balanced, functioning ecosystem without a reduction in deer numbers. The cumulative impact would be both beneficial and adverse and range from negligible to minor, depending on the visitor's goals.

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

Under alternative B, a combination of nonlethal actions would be implemented, in addition to the actions described under alternative A, to protect plant species and biodiversity and to manage deer numbers in the national lakeshore. These actions would include additional fencing and exclosures for protection of herbaceous vegetation, more extensive use of repellents in areas where exclosures would not be appropriate or feasible, and control of doe reproduction. Repeated applications of spray repellents would be necessary due to the effects of weather and the emergence of new growth. The entire national lakeshore would not be fenced or exclosed.

The number of deer would not appreciably change in the short term (although deer may leave the national lakeshore boundaries in search of unprotected food), so visitors who appreciate seeing deer would not be adversely affected. In addition, minor to moderate beneficial impact on other visitors would be expected, compared to alternative A, because sensitive vegetation and cultural resources would be protected, helping to ensure sightings of birds, other wildlife, and rare plants. However, adverse impact would also be expected on visual resources, because the national lakeshore would appear to be more fragmented as a result of the hundreds of large-area exclosures and activities would be disrupted more often from repeated spraying of repellents.

Under this alternative, 7 percent of the entire national lakeshore would eventually be protected by exclosures. However, exclosures would be erected following a priority order. It is estimated that it would take three years (at a rate of 100 exclosures per year) to construct exclosures in all critical and high-priority areas. The large number of exclosures could adversely affect visitors; however, interpretive signs could be used as mitigation for potential visual impact and would present an opportunity to provide the public with information about the management of deer within the national lakeshore. In addition, a large-area exclosure may be removed after the successful reestablishment of a plant colony or habitat outside the exclosure, depending on how well the protected vegetation within the exclosure has recovered.

When defining areas to be fenced and the required level of exclosures, national lakeshore staff would consider the treatment in relation to visitor use areas (among other variables). Visitors would not be able to access fenced or exclosed areas, but the national lakeshore does not permit off-trail use, so these areas are not currently accessible. Table 7 under the description of alternative B in chapter 2 shows that the majority of acres of sensitive vegetation are in the East Unit, particularly the Dune Ridge zone. This area encompasses Lakefront Drive, Central Beach, and Mount Baldy, which constitute some of the national lakeshore's most highly visited attractions. Although visitors are primarily drawn to the national lakeshore for the beaches along Lake Michigan, 73 percent of visitors report coming to the national lakeshore to walk trails, and 69 percent come to walk or jog for exercise (which may or may not include visiting the beaches). These visitors, as opposed to those who come primarily for the beaches, would be the most likely to be affected by visual intrusion from the proposed 630 acres of protection (the majority of which would involve exclosures) called for in the Dune Ridge zone. Visitors to the East Unit's Dune Wood zone, which is farther inland, would also be adversely affected by the sight of exclosures. This area has no beaches, and most visitors likely come to walk or jog trails. However, only a small portion of this area would be protected.

The management units that would have the next largest amount of protected areas include the Heron Rookery and Pinhook Bog. The Heron Rookery is the national lakeshore's least-visited unit, and Pinhook Bog is accessible to visitors only through a guided, ranger-led tour. Therefore, the sight of exclosures in these areas would have an adverse impact on few visitors.

Approximately 20 acres would be protected in the West Unit's West Beach zone, which attracts the most national lakeshore visitors and has substantially fewer deer than the East Unit. Visitors who hike the trails in this unit would be the most affected, particularly those who come to see the Karner blue butterfly, but these visitors likely represent a small percentage of overall West Beach visitors.

The adverse impact described above would be short and long term for all deer management zones, as the need to erect fencing and exclosures and to apply spray repellents would continue indefinitely into the future.

Visitors would also be affected by fence and exclosure construction activities and the application of repellents with backpack sprayers. Both activities would result in visual intrusions, such as the presence of work crews and employees spraying vegetation in certain areas of the national lakeshore. Not all visitors would be affected, only those in areas where the activities occur. This impact would be short term (i.e., spraying would occur during the growing season) but would occur repeatedly over the life of the plan.

The use of reproductive controls on does would be based on available technology. Approximately 523 deer would need to be treated each year during September and October (the two months before the rut). Treatment would occur at approximately this level over the life of the plan (15 years). National lakeshore staff would give preference to conducting treatment activities during weekdays to the extent possible, and approximately 10 deer would need to be treated each day over a 60-day period. As described in theChapter 3 Affected Environment" the national lakeshore's most popular months for visitors are July, August, and June, respectively. Treatment would occur during off-peak visitor hours (early morning and evening) to the extent possible and during an off-peak visitation season. Therefore, few visitors would be exposed to treatment activities. To further reduce this likelihood, visitor access would be restricted around areas where bait piles were placed to attract deer for treatment; these areas would be chosen to minimize visitor inconvenience. However, area closures could concentrate visitors in other popular national lakeshore locations, diminishing the quality of visitor experiences there. To ensure that visitors understand the nature of the treatment efforts, the national lakeshore would conduct educational programs to inform visitors about the procedures and explain why the treatments are necessary.

Deer would likely need to be captured and manually treated with reproductive controls. Given the large number of deer that would need to be treated in a short timeframe, it is unlikely that national lakeshore staff could limit the action to off-peak visitor hours (early morning and evening). Restricting visitor access in some areas could extend the amount of time that visitors would be concentrated in other areas. To ensure that visitors understand the nature of the treatment efforts, educational programs would be provided if funding is made available.

Responses to visitor surveys show that 90 percent or more of national lakeshore visitors are satisfied with their recreational opportunities. Implementation of this alternative would likely result in continuation of high levels of visitor satisfaction, particularly because an increased number of sensitive plant species would be protected, benefiting those visitors who focus on birding, wildlife viewing (in addition to deer), and botany. A negligible to minor adverse impact from the visual intrusion of fencing and exclosures, as well as use of repellents, could occur, particularly in the East Unit, where the majority of protective activities would occur. However, educational and interpretive information would explain the use of fences and exclosures in the management of deer within the national lakeshore, which would help offset adverse impact. Given the focus of most visitors on beach-related activities, adverse impact would likely be negligible to minor. The beneficial impact would be minor to moderate and long term.

Cumulative Impact

Cumulative impact of alternative B would be similar to that expected under the no-action alternative. An increase in the number of trails would provide both additional opportunities to see wildlife, which could be more abundant because of the protection provided by this alternative, and opportunities to see more visually distracting large-area exclosures and application of repellents.

The existence of wire cables and fencing to prevent illegal off-road vehicle use would add to the visual distraction of additional exclosures proposed under this alternative—more so than expected under alternative A—because more extensive use of exclosures is proposed under this alternative.

Impact related to hunting on neighboring lands would likely be the same as under alternative A; such activities could increase if deer leave the national lakeshore boundaries to find better food sources.

When combined with the beneficial and adverse impact expected under this alternative, the cumulative impact would also be both beneficial and adverse and range from negligible to moderate, depending on the visitor's goals.

Conclusion

Wildlife viewers, amateur botanists, and other visitors would experience beneficial minor to moderate impact related to increased sightings of species protected by fencing, exclosures, and repellents and negligible to minor adverse impact related to visual intrusions and disruptions. Cumulative impact would also be both beneficial and adverse and range from negligible to minor, depending on the visitor's goals.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, qualified federal employees or authorized agents would shoot deer to reduce the size of the deer population. These employees would be experienced with sharpshooting methods and have the necessary sharpshooting qualifications. Bait stations may be used to attract deer. High-velocity rifles would be used from close range. Efforts would be made to make the shootings as humane as possible. Noise suppression devices and night vision equipment would be employed to reduce disturbance to the public.

Shooting would occur primarily at night and during the fall and winter months, when deer are more visible, to reduce the amount of time required to complete the action. The public would be notified of the days, times, and methods of the management action well in advance of the activities. In addition, exhibits would be displayed at visitor centers, and information would be posted on the national lakeshore's website to educate the public regarding deer management actions. Visitor access would be restricted as necessary during the time the reduction is taking place, and the national lakeshore would be patrolled by NPS law enforcement to ensure the public's safety. Because shooting would occur during the late fall and winter months, visitation levels would be low.

Under this alternative, few national lakeshore visitors would be adversely affected because shooting activities would occur primarily at night, when the national lakeshore is closed. Shooting could be conducted during the day only when necessary, minimizing the time of restrictions and resulting in minimal effect to visitors.

Some visitors may feel compelled to pursue their activities elsewhere due to safety concerns, national lakeshore closures, or strong negative reactions to sharpshooting, resulting in a negligible to moderate adverse impact, depending on the level of their reaction. This adverse impact would be short term because sharpshooting would occur during a limited time only. However, sharpshooting would potentially continue for several years until the desired deer population level is achieved.

To the extent possible, deer meat would be donated. If more deer are shot than can be collected in one night or delivered to a processor at one time, the national lakeshore would dispose of these remains in a local landfill or bury them on site (as described below). In cases where one or a few deer have been shot at a given site or shot in remote areas with difficult access, the carcass or internal organs would be scattered and left aboveground to be naturally scavenged and/or decompose. Should CWD be found in the deer herd, the national lakeshore would follow NPS Public Health Service guidelines for disposal of deer infected with the disease.

In cases where the meat from deer is unsuitable for donation to charity or for surface or landfill disposal, the carcasses and/or internal organs would be buried on the site. Disposal pits would be located at previously disturbed sites (e.g., razed building sites) throughout the national lakeshore. All of the potential disposal locations are in previously disturbed areas and none contains archeological resources. Pits would be dug before sharpshooting activities and covered and fenced to prevent entry. Soil removed from the pits would remain on site and covered. In addition, sharpshooting would occur during winter months, when few people visit the national lakeshore. Therefore, although the presence of additional fenced areas used for carcass disposal could detract from the national lakeshore's natural setting, few if any visitors would be exposed to deer remains or burial activities under this alternative.

Long-term beneficial impact would be expected for birdwatchers, amateur botanists, and other wildlife watchers, because the ecosystem would benefit from a lessening of deer browsing. Visitors who value seeing deer in the national lakeshore would experience adverse impact, because chances of such sightings would be diminished. However, the national lakeshore's goal is to maintain a deer population as part of a natural, functioning ecosystem, not to eradicate the species; thus, deer sightings would continue, resulting in only negligible impact.

Adverse impact on visitors would be short term because of national lakeshore swim advisories and possibly long term because of any enduring negative responses to shooting activities. The impact's intensity would vary, based on visitors' beliefs and wildlife values, and would range from negligible to moderate. A beneficial impact would result from a decrease in deer browsing, which would result in the ability to see a wider variety of natural resources, and would range from minor to moderate.

Cumulative Impact

An increase in the number of trails throughout the national lakeshore would provide a beneficial impact for visitors seeking all types of natural resources. An increase in the quality of the national lakeshore habitat by restoring some trails to natural conditions could also slightly increase the opportunity to view wildlife, which could increase in diversity if sharpshooting decreased the deer population.

The adverse impact on visitors related to hunting on neighboring lands would be similar to alternative A. Little to no additional noise from sharpshooting under alternative C would add to the noise from nearby hunting activities, because noise reduction devices would be used on firearms (see the "Soundscapes" section in this chapter for more information). A reduction in the area's overall herd size as a result of nearby hunts, combined with sharpshooting at the national lakeshore, would reduce the ability to view deer but increase the ability to view other species, resulting in both adverse and beneficial impact, depending on the visitor's goals. In addition, if the overall herd size decreased, the herd's health could improve, beneficially affecting visitors.

Swim advisories because of the presence of *E. coli* currently have an impact on some visitors and can result in temporary decreases in overall visitation. However, visitors can still access and use beaches during swim advisories. Additionally, closing the national lakeshore to visitors during deer management activities could temporarily affect overall visitation. However, such daytime closures related to sharpshooting would be isolated and rare, as activities would occur primarily at night.

When combined with the beneficial and adverse impact expected under this alternative, the cumulative impact would also be both beneficial and adverse and range from negligible to moderate, depending on the visitor's goals.

Conclusion

The adverse impact on visitors of alternative C would be short term due to required national lakeshore closures and possible negative responses to sharpshooting activities and would range from negligible to moderate. A beneficial impact would result from a decrease in deer browsing, which would result in visitors experiencing a wider range of natural resources in the long term. The cumulative impact would be both adverse and beneficial, ranging from negligible to moderate, as well, depending on visitors' beliefs and reasons for coming to the national lakeshore.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, small-area protection fencing and repellents would be used, similar to alternative B. However, only five small fenced areas for plant protection would be installed annually. This alternative would also include construction of one large-area exclosure (2 to 5 acres) every other year for plant protection. Sharpshooting would occur as described under alternative C, possibly followed by reproductive control of does, should such an option become viable.

Visitors would experience impact related to the existence of small-area protection fencing and large-area exclosures and implementation of sharpshooting. The beneficial impact related to increased biodiversity would occur quickly, because these actions would work together to reduce deer-browse pressure. The resulting impact on visitors, particularly birdwatchers and amateur botanists, would be beneficial and long term.

If reproductive controls were administered in the future, deer would need to be captured, radio-collared, and treated. The same animals would need to receive booster treatments in later years. Deer could also be treated using remote injections. Slight adverse impact could occur from visitors being exposed to reproductive control activities, even though areas where these activities occurred would probably be closed to visitor use, particularly because off-trail use in the national lakeshore is not permitted. In addition, educational and interpretive materials would explain the reason for the treatments, which would offset any adverse impact.

Overall, visitors would be most adversely affected by the sight of large exclosures in certain areas and by the possibility of closing areas of the national lakeshore for sharpshooting activities. However, only one large-area exclosure would be installed every other year. Adverse impact would be both short term (i.e., the duration of an area closure) and long term (exclosures would exist, and sharpshooting activities could occur for several years), ranging from negligible to minor. The beneficial impact, which would result from increasing biodiversity and restoring a more balanced, functioning ecosystem within the national lakeshore, would be long term and minor to moderate.

Cumulative Impact

The cumulative impact of alternative D would be similar to those under alternatives A, B, and C. However, the combined efforts of neighboring hunts, sharpshooting, and the use of exclosures, as well as potential reproductive control use would lead to faster and greater vegetation protection. No additional cumulative impact related to reproductive controls is anticipated. When combined with the impact expected under alternative D, the cumulative impact would be adverse and beneficial, ranging from minor to moderate.

Conclusion

The adverse impact on visitors of alternative D would be short term because of required national lakeshore closures and possible negative responses to sharpshooting activities and would range from negligible to moderate. The beneficial impact would result from a decrease in deer-browse pressure on natural resources. The cumulative impact would be adverse and beneficial, ranging from minor to moderate.

VISITOR AND EMPLOYEE HEALTH AND SAFETY

The health and safety of both visitors and NPS employees at the Indiana Dunes National Lakeshore could be affected by implementation of the proposed deer management actions. The impact on health is related to potential health issues concerning Lyme disease. The impact on visitor safety is related to the presence of fences and the use of dart guns under alternative B and the use of firearms under alternatives C and D, as well as any additional deer management activities. The impact on employee safety is related to the use of firearms and dart guns and the potential for accidents that could result from implementation of other proposed actions.

Guiding Regulations and Policies

The NPS *Management Policies 2006* states, "[w]hile recognizing that there are limitations on its capability to totally eliminate all hazards, the Service… will seek to provide a safe and healthful environment for visitors and employees." The policies also state, "the Service will reduce or remove known hazards and apply other appropriate measures, including closures, guarding, signing, or other forms of education" (NPS 2006b, sec. 8.2.5.1).

Assumptions, Methodology, and Impact Definitions

The purpose of this impact analysis is to identify the level of impact that implementing each of the proposed alternatives would have on the health and safety of visitors and employees at the Indiana Dunes National Lakeshore. State hunting safety records were used to assess the effects of the direct reduction alternative (alternative C). Past accident data, national lakeshore goals, and personal observations of safety issues were used to estimate the effects of the action alternatives on visitors' and employees' safety.

Visitor Health and Safety

The impact definitions for visitor health and safety are as follows:

Negligible: No discernible effects on visitor health or safety; slight injuries could occur, but none would be reportable.

Minor: Any reported visitor injury that would require first aid to be provided by the national lakeshore staff.

Moderate: Any reported visitor injury that would require further medical attention beyond what was available at the national lakeshore.

Major: A visitor injury that would result in permanent disability or death.

Area of Analysis

The study area for this analysis, including analysis of cumulative impact, is the Indiana Dunes National Lakeshore.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under the no-action alternative, the national lakeshore would create and monitor small-area protection fencing, maintain the large-area exclosure, and apply repellents as needed. No actions would be taken to reduce the size of the deer herd. As the herd continues to grow, national lakeshore visitors may be harmed by deer if visitors feed deer and the animals come to expect handouts.

However, no national lakeshore visitors have been harmed by wildlife to date; therefore, adverse impact related to feeding deer would be negligible.

Although deer–vehicle collisions have increased in Lake and LaPorte counties since 1999, such accidents decreased in Porter County, which encompasses a majority of the national lakeshore. Declines in the number of accidents may correlate to deer removal efforts on neighboring lands; therefore, hunting adjacent to the national lakeshore may have had a beneficial impact on deer–vehicle accident rates (see "Cumulative Impact" below). However, because the national lakeshore would take no action to reduce the number of deer in the area, deer–vehicle collisions could be expected to rise if the deer population does. The overall impact on visitor safety would be adverse, long term, and negligible.

An increase in the deer population (despite efforts by neighboring lands) could lead to the possibility of increased transmission of Lyme disease. However, most external parasites found on deer would not establish themselves on humans, and few if any parasites of deer are directly transmittable. Conflicting evidence supports or dismisses the viability of deer as hosts for Lyme disease. Four cases of Lyme disease were reported in Porter County (where the majority of the national lakeshore is located) between 1991 and 2000, which is approximately 0.5 case per year. If white-tailed deer do indeed represent a viable host for Lyme disease, an increasing deer population could result in a negligible, adverse, and indirect impact on visitor health.

Cumulative Impact

Hunting activities occur on neighboring lands and could have a cumulative impact on the safety of the national lakeshore's visitors. However, no visitors to the national lakeshore have been harmed by hunting activities occurring on neighboring lands. In addition, if hunting efforts on neighboring lands reduced the overall herd population in the short term, chances of disease transmission would be minimized. Roadway improvements, such as new roads and bridges, may increase overall driving safety, perhaps reducing the number of deer–vehicle collisions. Therefore, when combined with the adverse, negligible impact that would be expected under this alternative, the cumulative impact would be adverse, long term, and negligible to minor.

Conclusion

The impact related to increasing deer–vehicle collisions under alternative A would be adverse, long term, and negligible. The indirect impact related to possible Lyme disease transmission would be adverse, long term, and negligible. The cumulative impact related to improved roadway safety and hunting on adjacent lands would be primarily adverse, long term, and negligible to minor.

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

Several nonlethal actions would be implemented under alternative B, including construction of additional fencing and exclosures for protection of herbaceous vegetation, increased use of repellents, and reproductive control of does. Construction of hundreds of additional large-area exclosures and application of repellents throughout the national lakeshore could cause deer to leave the national lakeshore boundaries in search of other food sources. An increase in deer mobility could lead to an increase in deer–vehicle collisions. In addition, no immediate action would be taken to reduce the size of the herd, and the deer population would likely increase, thus increasing the likelihood of vehicle collisions in the short term, until reproductive controls take effect. An increase in the deer population could also increase the chance of disease transmission in the short term, as well.

Other impacts on visitor health and safety would be similar to those expected under the no-action alternative. Overall, the impact on visitor health and safety would be adverse, short and long term, and negligible.

Cumulative Impact

The cumulative impact related to disease transmission and nearby hunting would be similar to alternative A, although slightly increased, as does would become more mobile and the need for hunting on neighboring lands may increase. Roadway safety could be compromised further if deer become more mobile as they search for additional food sources. The cumulative impact would, therefore, be primarily adverse, long term, and minor.

Conclusion

Deer–vehicle collisions and the possibility of disease transmission could increase in the short term under alternative B until reproductive controls take effect. Hunters on neighboring lands could experience the indirect effects of the national lakeshore's treatment of deer with reproductive controls. The overall impact on visitor health and safety would be adverse, long term, and negligible. The cumulative impact would be primarily adverse, long term, and minor.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, sharpshooting would be used to control the deer population. Deer would be shot primarily at night and during the late fall and winter months. Noise suppression devices, spotlights, and night vision equipment may be used to reduce disturbance to the public. The public would be notified of any closures in advance. Visitor access would be denied as necessary, and NPS law enforcement would patrol the national lakeshore to ensure visitor safety. Bait stations would be established away from public use areas to draw deer into specific areas to maximize the efficiency and safety of the action. Visitor safety would be considered when placing bait stations, blinds, and sharpshooters.

The impact on visitors would be minimal because visitation to the national lakeshore during late fall and winter is low. In addition, the actions would occur primarily at night, when the national lakeshore is closed to visitors. Should sharpshooting be required during daylight hours, visitors would receive ample notification in advance of the activity and of its location, which would be closed to public use; such closure would be enforced by NPS patrol staff.

Local residents, particularly those at Dune Acres and Beverly Shores, would likely experience the most impact, because many live in the area year round. Bait stations would be placed away from public areas, and residents would also be notified of the action well in advance. NPS staff would patrol closed areas and help to ensure the safety of local residents. In addition, the communities of Dune Acres and Beverly Shores have implemented deer management actions, primarily hunting, on their lands in recent years and plan to continue doing so. These residents have, therefore, been exposed to hunting within their communities and likely have heightened awareness of the safety issues related to shooting deer. However, the issue of safety, particularly for residents of Beverly Shores, has been very divisive. There would likely be several residents of local communities who deeply oppose use of any type of firearm in the area for safety reasons.

Because sharpshooting would occur at night during the cold fall and winter months, it is likely that most residents would remain indoors during the activity, which would reduce safety risks. In addition, shooting would not occur when school is in session or when school buses are picking up or delivering children, which is a concern expressed by local residents. The use of bait stations and special equipment would aid in quickly locating and shooting deer, which would reduce the amount of required time to complete the effort, in turn reducing safety risks.

Deer may flee the sound of gunshots, even if suppressors are used, which could potentially increase the risk of deer–vehicle collisions. Because most collisions occur in early morning hours or between 6 p.m. and midnight, an increase in nighttime collisions could occur. However, this risk would be minimal, as deer would be located and shot as quickly and quietly as possible, reducing the likelihood of spooking other animals.

Under this alternative, the deer population would immediately decrease, and the possibility of transmitting Lyme disease also may decrease as an indirect result.

The overall impact on visitor health and safety would primarily result from the use of firearms and would be adverse, short term, and minor during the sharpshooting. Long-term impact would continue as these efforts carry on into the future. However, the long-term impact would diminish over time, as the need to use sharpshooting decreases with the size of the herd.

Cumulative Impact

The impact on visitor health and safety from sharpshooting would combine with managed hunts on nearby state park and local residential lands, all of which would occur during the fall and winter months. Local residents would need to be cognizant of shooting activities occurring during both daytime and nighttime hours. Because no deer-hunting accidents have occurred on neighboring lands since hunting began, it is likely that high levels of safety would continue during these efforts. However, those residents who have always opposed use of weapons would likely be more concerned for their safety if they perceive that risks would increase with additional shooting occurring on federal property that borders their land.

The cumulative impact related to roadway safety improvements would be similar to that expected under the no-action alternative. However, the inclusion of sharpshooting could lead to an increase in deer–vehicle collisions beyond those expected under alternative C alone, as deer become more mobile in reaction to the occurrence of shooting on adjacent lands. In addition, deer being hunted on nearby lands during the day may become more skittish, increasing the difficulty of sharpshooting on national lakeshore lands at night. This could potentially extend the amount of time needed to complete the reduction efforts, which would prolong any safety risks. However, the combined lethal measures of hunting outside and sharpshooting inside the national lakeshore should quickly reduce the number of deer in the herd, possibly offsetting these risks.

The combined local hunting and NPS sharpshooting efforts would lead to a quick reduction in the size of the deer herd, which could further minimize the chances of transmission of Lyme disease.

Overall, when combined with the adverse, minor, and primarily short-term impact expected under alternative C, the cumulative impact would be adverse, minor to moderate, and short term, diminishing in intensity in the long term.

Conclusion

The impact on visitor health and safety as a result of using firearms within the national lakeshore would be adverse, primarily for local residents. However, safety measures would be taken to offset potential risks, and sharpshooting would occur when visitation is low and residents are likely to be indoors, resulting in adverse, short-term, and minor impact. Impact intensity would diminish in the long term as the need to continue sharpshooting diminishes. The cumulative impact would be adverse, minor to moderate, and short term, diminishing in intensity in the long term.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, sharpshooting would be done initially to quickly reduce deer herd numbers. Reproductive control of does would then be implemented as a maintenance tool to keep deer numbers at an acceptable level (when an appropriate agent becomes available). Five small-area protection fences would be installed annually, as well as one large-area exclosure (2 to 5 acres) every other year for plant protection.

The impact would be similar to alternatives B and C; however, fencing and exclosures would be applied on a smaller scale compared to alternative B. Deer would be less apt to leave NPS boundaries in search of food compared to alternative B, which would affect the number of deer–vehicle collisions. Also, as described under alternative C, the deer population would decrease and the possibility of transmitting Lyme disease may also decrease.

The greatest impact on safety would be related to the use of sharpshooting to reduce the size of the deer herd, as described under alternative C. In addition, deer may become spooked during sharpshooting and may be more apt to flee, which could also affect the number of deer–vehicle collisions.

Some hunters have expressed concern about consuming the meat of deer treated with reproductive control methods. Therefore, indirect effects of reproductive control could apply to hunters who hunt at the Indiana Dunes State Park. However, only U.S. FDA-approved methods would be used on national lakeshore deer, and treated deer would be appropriately tagged.

Overall, the impact on visitor safety would be adverse compared to the no-action alternative, primarily for local residents. The long-term impact would continue as these efforts carry on into the future but would diminish over time as the herd size decreases.

Cumulative Impact

The cumulative impact of alternative D would be similar to that described under alternative C. In addition, hunters at the state park perceive a risk of consuming deer treated with reproductive control. If the possibility of being unable to eat the meat diminishes the desire to hunt, the state park could experience a decrease in the number of hunters participating in its deer reduction activities. However, as the overall, deer herd size diminishes throughout the area from the combined deer management efforts of all local entities, the need for hunting at Indiana Dunes State Park would eventually diminish, as well.

Overall, when combined with the adverse, moderate, and primarily short-term impact expected under alternative D, the cumulative impact would be adverse, moderate, and short term, diminishing in intensity in the long term.

Conclusion

The impact on visitor health and safety as a result of using firearms would be adverse, primarily for local residents. However, safety measures would be taken to offset these potential risks, resulting in adverse, short-term, minor impact. Impact intensity would diminish in the long term as the herd size decreases. Cumulative impact would be adverse, moderate, and short term, diminishing in intensity in the long term.

Employee Health and Safety

The impact definitions for employee health and safety are as follows:

Negligible: There would be no discernible effects to employee health or safety; slight injuries could occur, but none would be reportable.

Minor: Any reported employee injury that would require first aid to be provided by the national lakeshore staff and would involve less than eight hours of lost work time.

Moderate: Any reported employee injury that would require medical attention beyond what is available at the national lakeshore and would result in eight or more hours of lost work time.

Major: An employee injury that would result in permanent disability or death.

Area of Analysis

The study area for this analysis, including analysis of cumulative impact, is the Indiana Dunes National Lakeshore.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

National lakeshore staff would continue creating small-area protection fencing, maintaining the large-area exclosure, and applying repellents to landscaped areas under alternative A. They would also continue monitoring activities and surveys. No accidents or injuries have occurred to employees as a result of such activities, and no accidents are anticipated from their continuation. Even though the national lakeshore has not currently met its goal of reducing its loss time injury rate, the wildlife staff is limited to only two individuals, and no additional staff is expected. Therefore, very few employees would be involved in these activities and exposed to potential injuries. In addition, the most common injuries at the national lakeshore are punctures and bug bites, which would likely be considered slight but not reportable.

Employees would be working outside, constructing fences and applying repellents, potentially exposing them to a greater possibility of contracting Lyme disease than visitors who may come to the national lakeshore infrequently.

The impact on employee health from this alternative would be adverse, long term, and negligible.

Cumulative Impact

National lakeshore staff would engage in other maintenance-related activities that could potentially cause injury. Employees reported a total of 16 injuries in 2005. Injuries sustained were typically not serious or life-threatening. Other actions anticipated for the future, such as implementation of prescribed burns, could increase risks to employees. The impact from such activities would combine with the negligible impact expected under this alternative. Although the national lakeshore is not currently meeting its employee safety goal, the recent creation of the Occupational Health and Safety Program should help improve overall employee safety.

Employees could also be exposed to accidental injury related to hunting activities conducted on neighboring lands, as jurisdictional boundaries are very close. However, no deer-hunting accidents have occurred in the Indiana Dunes State Park or in the communities of Dune Acres and Beverly Shores since deer management reduction actions began in those areas, and the possibility of an employee being injured is low. The impact on employee health and safety would be adverse, long term, and minor to moderate, given the extent of lost work time that the national lakeshore has recently experienced.

Conclusion

The impact under alternative A would be adverse, long term, and negligible to minor. The cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore; this impact would be adverse, long term, and minor to moderate, as the national lakeshore is not meeting its current safety goal.

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

Several nonlethal actions would be implemented under alternative B, including construction of additional fencing and exclosures for protection of vegetation, increased use of repellents, and reproductive control of does. The potential for impact on NPS staff as a result of erecting more large-area exclosures and spraying repellents could increase compared to the no-action alternative, and these fences and exclosures would require periodic maintenance. Employees could be injured while constructing the fences and exclosures; however, national lakeshore staff would exercise caution and apply safety techniques in all construction projects. In addition, no discernible effects to employee safety are expected as a result of the increased use of repellents because no injuries from this activity have occurred to date.

Under this alternative, qualified federal employees or authorized agents would treat does with a reproductive control agent (if and when one becomes available), which would most likely be remotely administered with a dart gun. Bait piles would be placed to lure does to treatment locations, concentrating efforts in safe areas. As many does as possible would be treated daily, with the goal of treating 90 percent (a minimum of 523) of the does, which would take an estimated 52 days (10 deer treated per day). This activity would increase the potential for an employee to suffer an accident or injury. Safety precautions would be followed, and training in the use of treatment methods would help to ensure employee safety. If more than one shooting location was used to administer reproductive controls with dart guns, these areas would be adequately separated. If dart guns were not used, does would be captured and reproductive controls would be applied manually. No injuries to employees are expected from this method because the capture and treatment of deer would be conducted by qualified federal employees or contractors who are professionally trained to perform these tasks.

Employees would be subjected to deer–vehicle collisions in much the same way as visitors would be under this alternative. However, employees would likely be driving to and from work during early morning and early evening hours, when deer are more active and collisions more likely.

Because of increased exposure to potential injury under this alternative, the impact on employee safety would be adverse, long term, and negligible to minor, as any reported employee injury would likely require first aid provided by national lakeshore staff and would involve less than eight hours of lost work time.

Employees would be exposed to health risks associated with contracting Lyme disease because of the amount of time they would spend outside erecting fences and exclosures, applying repellents, and participating in the administration of reproductive controls. The likelihood of contracting this disease would remain low. In addition, federal employees or contractors would also be qualified to handle live deer to prevent disease transmission and harm to employees.

Cumulative Impact

National lakeshore staff would engage in maintenance-related activities as described under alternative A, but injuries sustained during these activities are typically not serious or life threatening. Other actions anticipated for the future (as well as the extent of lost work time that the national lakeshore has recently experienced) would combine with the increased exposure to safety risks under alternative B, increasing the adverse impact to moderate.

Conclusion

The impact under alternative B would be adverse, long term, and negligible to minor. The cumulative impact would be related to other injuries that employees might sustain while working in the national lakeshore; this impact would be adverse, long term, and moderate because the national lakeshore would not be meeting its current safety goal.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, qualified federal employees or authorized agents would reduce the deer population through sharpshooting. As described under alternative A, the adverse, short- and long-term, negligible impact related to erecting small fenced areas and applying repellents would apply to this alternative, as well.

NPS staff would be involved in supporting the sharpshooting operations, potentially increasing their safety risks. To offset such risks, sharpshooters would be specifically trained in all aspects of deer reduction operations. Training would include safety measures to protect both visitors and NPS employees. If more than one shooting location is used, these areas would be adequately separated to ensure safety. Every precaution would be taken to ensure the safety of employees, and employees would apply safety training and awareness activities designed to reduce safety risks. Activities would be in compliance with all federal firearm laws administered by the Bureau of Alcohol, Tobacco, and Firearms. Although more risks would be involved due to the use of firearms, adverse impact on the safety of employees would be short and long term and negligible to minor due to the safety precautions staff would follow. Any injuries or accidents that could occur under this alternative would be treatable at the national lakeshore and would result in less than eight hours of lost work time.

Employees would be subjected to deer–vehicle collisions as described under alternative B because they would likely be driving to and from work during early morning and early evening hours, when deer are more active and collisions are more likely.

As under alternative A, employees would be exposed to health risks associated with contracting Lyme disease. The likelihood of contracting this disease, which is already low, would decline with the rapid decrease in the deer population under this alternative.

Cumulative Impact

National lakeshore staff would engage in maintenance-related activities, as described under alternative A, but injuries sustained during these activities are typically not serious or life threatening. Other actions anticipated for the future (as well as the extent of lost work time the national lakeshore has recently experienced) would combine with the increased exposure to safety risks under this alternative. The use of firearms within the national lakeshore would combine with hunting (using firearms and bows) on neighboring lands outside NPS boundaries. The adverse cumulative impact would be moderate and both short term (occurring for duration of the sharpshooting effort) and long term (occurring for five years).

Conclusion

The impact of alternative C would be adverse, long term, and negligible to minor, as adequate training and safety precautions would be applied to all sharpshooting activities. The cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore, as well as the increased use of firearms in the region; this impact would be adverse, long term, and moderate.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, sharpshooting would be done initially to quickly reduce deer herd numbers. Reproductive control of does would then be implemented as a maintenance tool to keep deer numbers at an acceptable level, when an appropriate agent becomes available. Five small fenced areas for plant protection would be installed annually, as well as one large-area exclosure (2 to 5 acres) every other year for plant protection.

The impact under this alternative would be similar to alternatives B and C; however, fencing and exclosures would be applied on a smaller scale compared to alternative B. Employees would be exposed to the same safety risks associated with sharpshooting and, eventually, the activities involved in the administration of reproductive controls.

Employees would be subjected to deer–vehicle collisions, as described under alternative B, as they would likely be driving to and from work during the early morning and early evening hours, when deer are more active and collisions are more likely.

As under alternative A, employees would be exposed to health risks associated with contracting Lyme disease. However, the likelihood of contracting this disease, which is already low, would decline with the rapid decrease in the deer population under this alternative.

Overall, the impact would be adverse, short term, and negligible to minor during the sharpshooting effort. Long-term impact would continue as these efforts continue into the future but would diminish over time as the herd size decreases.

Cumulative Impact

National lakeshore staff would engage in maintenance-related activities as described under alternative A, but injuries sustained during these activities are typically not serious or life threatening. Other actions anticipated for the future (as well as the extent of lost work time that the national lakeshore has recently experienced) would combine with the increased exposure to safety risks under this alternative. The use of firearms within the national lakeshore would combine with hunting (using firearms and bows) on neighboring lands outside NPS boundaries, potentially putting employees at risk when working near jurisdictional boundaries during hunting season. The adverse cumulative impact would be moderate and both short and long term.

Conclusion

The impact under alternative D would be adverse, long term, and negligible to minor, as adequate training and safety precautions would be applied to all sharpshooting activities and administration of reproductive controls. Cumulative impact would be related to other injuries that employees could sustain while working in the national lakeshore, as well as the increased use of firearms in the area; this impact would be adverse, long term, and moderate.

SOUNDSCAPES

Guiding Regulations and Policies

The national park system includes some of the quietest places on earth, as well as a rich variety of sounds intrinsic to park environments. These intrinsic sounds are recognized and valued as a park resource, in keeping with the NPS mission (NPS 2006b, sec. 1.4.6), and are referred to as the park's natural "soundscape." The natural soundscape, sometimes called "natural quiet," is the aggregate of all the natural sounds that occur in parks, absent human-caused sound, together with the physical capacity for transmitting natural sounds (NPS 2006b, sec. 4.9). It encompasses all the sounds of nature, including such "nonquiet" sounds as birds calling, waterfalls, thunder, and waves breaking against the shore. Some natural sounds are also part of the biological or other physical resource components of parks (e.g., animal communication and sounds produced by physical processes, such as wind in trees, thunder, and running water).

NPS policy requires the protection of natural soundscapes from degradation due to noise (undesirable human-caused sound) (NPS 2006b, sec. 4.9). The NPS is specifically directed to "take action to prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" (NPS 2006b, sec. 4.9). Overriding all of this is the fundamental purpose of the national park system, established in law (e.g., 16 USC 1 et seq.), which is to conserve park resources and values (NPS 2006b, sec. 1.4.3). NPS managers must always seek ways to avoid or minimize, to the greatest degree practicable, adverse impact on park resources and values (NPS 2006b, sec 1.4.3).

Noise can adversely affect resources, including natural soundscapes. It can have a direct impact, for example, by modifying or intruding upon the natural soundscape. It can also have an indirect impact on resources, for example, by interfering with sounds important for animal communication, navigation, mating, nurturing, predation, and foraging.

Noise can also have an adverse impact on visitor experiences. Visitor experience can be defined as the opportunity for visitors to experience a park's resources and values in a manner appropriate to the park's purpose and significance and appropriate to the resource protection goals for a specific area or management zone within that park. In other words, visitor experience is primarily a resource-based opportunity appropriate to a given park or area within a park rather than a visitor-based desire. Noise impact on visitor experience can be especially adverse when management objectives for the visitor experience include solitude, serenity, tranquility, contemplation, or a completely natural or historical environment.

Management objectives (also called desired conditions) for resource protection and visitor experience are derived through well-established public-planning processes from law, policy, regulations, and management direction applicable to the entire national park system and to each specific park unit.

Assumptions, Methodology, and Impact Definitions

The methodology used to assess noise impact in this document is consistent with NPS *Management Policies 2006* (NPS 2006b), Director's Order #47: *Soundscape Preservation and Noise Management*, and the methodology being developed for the reference manual for Director's Order #47 (NPS 2000b).

Context, time, and intensity together determine the level of impact for an activity. For example, noise for a certain period and intensity would have a greater impact in a highly sensitive context, and a given intensity would have a greater impact if it occurred more often or for a longer duration. It is usually necessary to evaluate all three factors together to determine the level of noise impact. In some cases, an analysis of one or more factors may indicate one impact level, while an analysis of another factor may indicate a different impact level, according to the criteria below. In such cases, the best professional judgment, based on a documented rationale, must be used to determine which impact level best applies to the situation being evaluated. The following steps were undertaken to determine soundscape impact levels in the national lakeshore:

National literature was used to estimate the average decibel levels of the activity.

Areas of use by visitors were identified in relation to the location of the proposed activity. Personal observation from national lakeshore staff was used to identify these areas.

Other considerations, such as topography, were then used to identify areas where noise levels could be exacerbated or minimized.

The following impact definitions were used to determine the magnitude of effects on soundscapes:

Negligible: Natural sounds would prevail; activity noise would be very infrequent or absent, mostly immeasurable.

Minor: Natural sounds would predominate in areas where management objectives call for natural processes to predominate, with activity noise infrequent and at low levels. In areas where activity noise is consistent with the national lakeshore purpose and objectives, natural sounds could be heard occasionally.

Moderate: In areas where management objectives call for natural processes to predominate, natural sounds would predominate, but activity noise could occasionally be present at low to moderate levels. In areas where activity noise is consistent with the national lakeshore purpose and objectives, activity noise would predominate during daylight hours and would not be overly disruptive to noise-sensitive visitor activities in the area; in such areas, natural sounds could still be heard occasionally.

Major: In areas where management objectives call for natural processes to predominate, natural sounds would be impacted by activity noise sources frequently or for extended periods of time. In areas where activity noise is consistent with the national lakeshore purpose and zoning, the natural soundscape would be impacted most of the day. Noise would disrupt conversation for long periods of time and make enjoyment of other activities in the area difficult; natural sounds would rarely be heard during the day.

Area of Analysis

The area of analysis is the entire national lakeshore for all alternatives, including cumulative assessments. Noise sources adjacent to but beyond the national lakeshore boundaries were also factored into the cumulative assessments. Neighboring landowners outside the national lakeshore boundaries are also included in this area of analysis.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under alternative A, the national lakeshore would take no additional action to manage the deer population within its boundaries. However, national lakeshore staff would continue creating and monitoring small-area protection fencing and maintaining the large-area exclosure, as well as applying repellents to protect species that suffer from deer-browse impact. Noise from constructing fences and applying repellents would be minimal. National lakeshore staff may use trucks to reach areas to be fenced or monitored, but such additional sound impact would likely be indiscernible from other daily national lakeshore activities. No or negligible adverse impact on soundscapes would occur under alternative A.

Cumulative Impact

Beverly Shores, Dune Acres, and Indiana Dunes State Park (which all border the national lakeshore's East Unit) have taken actions to reduce the size of the local deer herd. Such activities are planned to continue indefinitely into the future until a specific deer herd size is reached or can be maintained. Beverly Shores plans to conduct bow hunts; Dune Acres would use sharpshooters; and the state park would permit hunting with firearms only (B. Weber, IDNR, pers. comm. May 11, 2004). Farm owners near the national lakeshore's boundaries have also conducted hunts and continue to receive permits from the IDNR for shooting deer on their property.

The adverse impact expected under this alternative would combine with hunting (particularly with firearms) for a specified time period (usually fall and winter) by landowners surrounding the national lakeshore during deer reduction efforts.

Noise generated from highways, trains, boats, planes, and nearby industry has had an impact and would continue to have an impact, on the national lakeshore's natural soundscape in both the short and long term. Although there are places in the national lakeshore where visitors can experience a natural setting and listen to the sounds of bird calls, water, and animals, complete solitude in the national lakeshore is unlikely, given its urban setting and discontinuous nature.

When combined with the no or negligible impact on soundscapes expected under alternative A, the cumulative impact would be minor to moderate in the short and long term, particularly related to deer reduction efforts on neighboring lands and the urban nature of the surroundings. Impact related to nearby hunting would be both short term, in that it would occur for a limited amount of time (fall and winter), and long term, in that hunting would likely continue for several years, possibly indefinitely, into the future, particularly if the national lakeshore takes no action to reduce the overall size of the area's deer herd.

Conclusion

No or negligible adverse impact on soundscapes would occur under alternative A. The cumulative impact would be minor to moderate and adverse in the short and long term due to the variety and abundance of noise sources that already exist around and within the national lakeshore, including the use of firearms for removing deer on neighboring lands.

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

In addition to actions that would occur under alternative A, alternative B would include added fencing and exclosures for protection of herbaceous vegetation important to the national lakeshore. In areas where the installation of a fence is undesirable, repellents would be used. Ensuing monitoring could result in placement of additional fences if new areas begin to show deer-browse impact. Repeated applications of spray repellents would be necessary due to weather and emergence of new growth. Reproductive control of does could eventually be implemented once an appropriate agent is approved.

Residents and visitors would experience short-term noise impact due to construction of fencing and exclosures in specific areas, particularly in the East Unit, where the largest percentage of exclosures would be located. Such construction would not affect all residents and visitors, only those in areas where fencing and exclosures have been identified as beneficial. However, because most of this activity would occur in the East Unit, residents of Beverly Shores and Dune Acres would be the most affected, as would visitors to this unit's popular attractions. Noise impact in the Heron Rookery and Pinhook Bog would be minimal, as there are few residences in the area and few visitors. Some residents and visitors would also experience a short-term noise impact from repellent spraying in isolated areas. The need for additional fencing and repeated spraying would result in adverse noise impact over the long term because such actions would occur for several years, but the duration of these activities and their associated noise would be short term. Very minimal noise impact is expected from administering reproductive control of does. Therefore, noise impact on residents and visitors would be primarily short term, negligible to minor (depending on the location), and adverse.

Cumulative Impact

Alternative B would not immediately affect the size of the local deer population; therefore, it is likely that hunting (and the associated use of firearms) on neighboring lands would continue indefinitely into the future as these landowners strive to maintain a specific herd size. Noise generated by highways, trains, boats, planes, and nearby industry would continue, as described under alternative A. That noise would combine with the minimal amount of noise that would be generated under this alternative, including intermittent construction of fencing and exclosures and spraying of repellents. When combined with the short-term, negligible to minor, adverse impact on soundscapes expected under alternative B, the cumulative impact would be minor to moderate and adverse in the short and long term.

Conclusion

The impact on soundscapes would be short term, negligible to minor, and adverse under alternative B because of intermittent construction and spraying activities. The degree of the impact would vary by location. Although individual construction and spraying events would be short term, they would continue indefinitely, resulting in a long-term, negligible to minor, adverse impact. The cumulative impact due primarily to the variety and abundance of existing noise sources and the continuation of hunting on neighboring lands would be minor to moderate and adverse in the short and long term.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, sharpshooting would be used to reduce the deer herd size. Only shooters who are highly skilled and trained in the use of firearms and public safety would participate in this activity. Bait stations may be used to attract deer. High-velocity rifles (likely .223 rifles with a noise level of 155.5 dB) would be used from close range. Efforts would be made to make the shootings as humane as possible; it is anticipated that only one shot or possibly two would be required per deer. Noise suppression devices and night vision equipment may be employed to reduce disturbance to the public.

Shooting would occur primarily at night and during the fall and winter months, when deer are more visible in the national lakeshore, to reduce the amount of time required to complete the action. The public would be notified of the days, times, and methods of the management action well in advance of the activities. In addition, exhibits would be displayed at visitor centers, and information would be posted on the national lakeshore's website to educate the public regarding deer management actions. Visitor access would be restricted as necessary during the time the reduction is taking place, and the national lakeshore would be patrolled by NPS law enforcement to ensure safety of the public. Because shooting would occur during the winter months, visitation levels would be low.

The impact on national lakeshore visitors would be minimal, as implementation of this alternative is planned for fall or winter and would occur after sunset, when fewer visitors would be present. Local residents would likely experience the most impact. An individual approximately 500 feet from the source of a firearm discharged without a suppressor (in this case, a .223 rifle at approximately 160 dBA) would experience a noise level of about 106 dBA, which is considered very loud and comparable to highway construction noise. Use of a suppressor (as defined under this alternative) would bring that down to approximately 76 dBA, which is comparable to busy traffic. However, this does not consider attenuation factors that would decrease the decibel levels, particularly if residents were indoors. Sound impact would likely be somewhat less in densely vegetated or hilly areas of the East Unit, which contains several buildings and structures to attenuate the noise, as compared to the more thinly vegetated and less-populated West iUnit. Sound would also be attenuated if shooting blinds were carefully positioned in areas that are heavily wooded; beside a hill, dune, or unoccupied structure; and as far from residences as possible.

If decibels were thereby reduced to a range of 55 to 65 dBA, perceived annoyance would be moderate (Suter 1991). However, because the national lakeshore intends to perform sharpshooting primarily at night, the perceived annoyance level would likely be higher than if conducted during the day. The sounds of such noise during meal times or leisure times can increase levels of annoyance. However, no shooting would occur late at night, when the impact would be most disturbing.

Firearm noise differs from continuous noise, such as traffic or construction, in that it is an impulse noise. The impulse nature of firearm noise would cause a startle reflex in local residents and visitors (if sharpshooting occurred during the day), and the unpleasant connotations associated with gunfire could cause negative psychological impact on these individuals, as well. However, local residents have been exposed to hunting activities in recent years as nearby communities have taken action to reduce the size of the deer herd. In addition, because residents and visitors would be made aware of sharpshooting activities in advance, the psychological impact of the sound of firearms could be minimized. Despite such warnings, individuals who oppose shooting would experience greater psychological impact upon hearing the sound of gunfire. Many sound phobias reflect personal attitudes toward the sound maker (Truax 1999), which in the case of gunfire, can be very negative.

Efforts would be made to schedule sharpshooting activities during the fall or winter, while other land agencies are also performing similar activities, so as not to prolong the action. In addition, every attempt would be made to expedite the process and carry it out as humanely as possible. Therefore, the impact on soundscapes under this alternative would be adverse and short term. Long-term impact would occur as the activity is repeated over time (possibly several years) to maintain herd numbers at a specified level.

The intensity of the adverse impact would vary depending on several factors, particularly perceived levels of annoyance. Individuals who are farther from the source of the firearm, support the removal efforts, and have experienced hunting in their area in the past would likely experience minor adverse impact. Individuals who are closer to the source of the firearm, are opposed to the action, and have never accepted sharpshooting or hunting as a viable deer management option would likely experience moderate to possibly major adverse impact if such sounds made enjoyment of other activities in the area difficult. However, because most of the national lakeshore closes at night and visitation is lowest during the fall and winter, when sharpshooting activities would occur, the impact on visitors would likely be minimal.

Cumulative Impact

Implementation of alternative C would increase the amount of noise in the area in the short term, as noise from national lakeshore sharpshooting efforts would combine with hunting efforts that are expected to continue on neighboring lands. However, the need for continued hunting in nearby communities and the state park could decrease in the long term as all landowners in the area undertake concurrent direct reduction actions and the herd size decreases. These combined efforts would eventually result in a decrease in noise as the need for hunting on neighboring lands—which has been occurring for the past several years—diminishes, resulting in a long-term beneficial impact. Firearm noise at the national lakeshore, nearby communities, and the state park would not occur year round but only on specific days and for a short period of time.

The Indiana Dunes National Lakeshore experiences noise from several urban sources, including trains, jets and other aircraft, utility lines, highways, construction, and industrial activities, such as production at steel mills. These sounds would also combine with the direct reduction of deer under alternative C to increase overall noise levels in the area; the increase would occur during specific time periods only yet continue for several years.

Given the planned continuance of hunting on neighboring lands and the urban, industrialized nature of the national lakeshore's surroundings, the cumulative impact would be adverse, short and long term, and moderate when combined with the effects anticipated under this alternative. This impact would be expected to decrease in the long term as deer populations in all affected areas decrease and the need for removal efforts decreases, as well.

Conclusion

The impact on soundscapes from sharpshooting would be short and long term and adverse, primarily affecting local residents because sharpshooting would occur primarily at night and during off-peak visitation seasons. The perception of the intensity of the impact would vary depending on several factors, including attenuation levels, distance from the source, and attitude toward the action, resulting in minor to moderate impact on individuals experiencing the sound. The cumulative impact would be adverse, short and long term, and moderate. However, this impact would be expected to decrease in the long term as deer populations in all affected areas decrease and the need for direct reduction decreases, as well.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, small-area protection fencing and repellents would be used, similar to alternative B, but on a smaller scale. This alternative would also include construction of one large-area exclosure every other year. Sharpshooting would be used to immediately reduce the deer population, possibly followed by reproductive control of does in the future.

Noise related to construction of fencing and exclosures, use of repellents, and ensuing monitoring would continue as the national lakeshore implements such measures to protect small areas of sensitive species. Noise impact related to this component of alternative D would be short term, adverse, and negligible. Long-term impact would continue as more fencing, exclosures, and spraying are required; however, the need for such actions is expected to decrease because implementation of this alternative would control the size of the overall deer herd.

The greatest impact would be from the use of firearms. As described under the sharpshooting alternative, intensity of the noise impact would vary based on several factors, including proximity to the firearm, use of noise suppression devices, perceived annoyance level, and attitude toward sharpshooting. The need for further sharpshooting efforts would likely decrease over the long term if the effects of this action and the possible use of reproductive controls result in a decrease in the size of the deer herd. Therefore, the overall effect of implementation of all components of this alternative would be short term, adverse, and minor to moderate, with expected decreases in intensity over the long term.

Cumulative Impact

The cumulative impact of alternative D would be similar to those described under alternatives A, B, and C. As described under alternative C, the need for continued sharpshooting under this alternative and by nearby communities and the state park could potentially decrease as the deer population decreases, reducing the amount of firearm noise in the area and resulting in a beneficial impact.

The Indiana Dunes National Lakeshore experiences noise from several urban sources. Because of the discontinuous nature of the national lakeshore, ambient sound levels vary by deer management zone and proximity to specific noise sources, such as steel mills or rail lines. Cumulative noise impact would vary depending on the zone and its proximity to particular noise sources. For example, noise sources at Pinhook Bog would likely be limited to traffic from Interstate 80 and aircraft over-flights, but industrial noise from the steel mills, NIPSCO, and the Port of Indiana would not reach this area.

Given the planned continuance of hunting on neighboring lands and the urban, industrialized nature of the national lakeshore's surroundings, the cumulative impact would be adverse, short and long term, and moderate when combined with the effects anticipated under this alternative. The impact would be expected to decrease in the long term as deer populations in all affected areas decrease and the need for direct reduction decreases, as well.

Conclusion

The overall impact on soundscapes under alternative D would be short term, adverse, and minor to moderate, particularly due to the use of firearms. The perception of impact intensity would vary based on several factors, particularly the reaction to firearms. However, the long-term impact would be expected to decrease as the overall herd population decreases, reducing the need for direct reduction. Given the planned continuance of hunting on neighboring lands and the urban, industrialized nature of the national lakeshore's surroundings, the cumulative impact would be adverse, short and long term, and moderate.

SOCIOECONOMICS

Guiding Regulations and Policies

NEPA requires that economic and social impacts be analyzed in an EIS when they are interrelated with natural or physical impacts. Economic impact would potentially result from deer-browsing damage to crops and landscaping on private lands adjacent to the national lakeshore as a result of changes in deer populations at the national lakeshore itself; therefore, economic impact is addressed in this document.

Assumptions, Methodology, and Impact Definitions

Because of the expected increase in deer populations over time and the limited supply of deer forage within the national lakeshore, deer that frequent the national lakeshore may also browse on grain crops and landscaping plants, as well as natural vegetation (such as in the Indiana Dunes State Park) outside the national lakeshore on adjacent public and private lands. The home range for deer within the national lakeshore may extend one-third of a mile from the national lakeshore boundary. The IDNR notes that deer generally occupy a home range of 1 to 2 square miles (IDNR n.d.c). Therefore, it is assumed that deer that are habituated to the national lakeshore may seek food sources outside its boundaries as the quality and quantity of browse diminish. The Iowa Department of Natural Resources indicates that white-tailed deer ranges may expand seasonally based on breeding activity and food availability (Iowa DNR 2005).

Damage to agricultural plants, private landscaping, and natural vegetation on non-NPS property is an issue beyond the purview of the national lakeshore and is a common problem throughout many areas of the United States. Economic losses associated with deer damage to alfalfa, grain crops, orchards, and landscaping plants have been estimated through studies in a number of northeastern states, including Maryland and New York. Some of the methodologies and crop damage estimates presented in these studies and outlined below are applicable to agricultural lands surrounding the national lakeshore and have been used to determine the potential impact on landowners from the deer management alternatives considered in this document.

McNew and Curtis (1997) estimated the extent of deer damage to grain crops in Maryland by multiplying farmer-reported acreage losses due to deer by grain prices at harvest. They then used a regression analysis of reported damage estimates and local deer populations to calculate a deer population elasticity of crop damage. This elasticity measure enables an approximate estimation of the additional crop damage that would occur given an increase in the deer population.

Based on research by McNew and Curtis (1997), Table 46 shows that for a 10-percent increase in the local deer population, there would be a 3.4-percent bushel-per-acre increase in crop damage to corn, a 3.0-percent bushel-per-acre increase in damage to soybeans, and a 6.5-percent bushel-per-acre increase in damage to wheat. Using harvest season prices for corn from 1996 and the total statewide acreage planted in corn, McNew and Curtis estimated that more than $420,000 in additional losses would occur to corn farmers in the state with each 10-percent increase in the deer population. The estimated annual loss statewide in 1996 for all three grain crops would total approximately $1.16 million. In 2006 dollars, this loss would be substantially greater.

TABLE 46: ECONOMIC LOSS FROM A 10-PERCENT INCREASE IN THE LOCAL DEER POPULATION

Crop	Deer Population Elasticity of Crop Damage	Crop Damage Sample Mean* (bushels per acre)	Local Deer Population (sample mean*)	Additional Damage from a 10-Percent Increase in Deer Population (× $1,000)
Corn	0.34	8.45	61.6	429
Soybeans	0.30	5.38	68.4	633
Wheat	0.65	1.44	67.9	94
Total				$1,156

Source: McNew and Curtis 1997
* Sample means are from the sample used in the regression analysis.

These percentage increases in crop damage that could result from a 10-percent change in deer population can be applied to agricultural lands surrounding the Indiana Dunes National Lakeshore as an example of how crop damage might change. Using this elasticity of crop damage, the estimated yield per acre for a farmer's crop, and the average yield loss from deer browsing (presented in Chapter 3: Affected Environment), the additional damage loss a farmer might incur given a potential increase in the local deer population can be estimated. However, this estimate can be used only to compare the relative magnitude of the economic impact between alternatives because it is unknown whether a 10-percent increase in the national lakeshore's deer population would cause deer to expand or shift their home range outside the national lakeshore, resulting in a similar 10-percent increase in deer populations outside the boundary. The impact on crops would most likely be less because some deer could remain in the national lakeshore rather than shifting their home range and browsing in adjacent private lands.

The estimates of crop damage presented in the impact analysis are examples based on the studies identified above. As previously discussed, the crop damage and its economic value that would occur under each deer management alternative could vary substantially from the estimates provided, depending on the actual deer population, average deer damage per acre for different crops in the vicinity of the national lakeshore, crop prices, and other factors. Thus, any economic costs or benefits presented are most useful for relative comparison between alternatives rather than seen as absolute costs.

Impact threshold definitions for socioeconomic conditions focus on crop depredation and damage to vegetation (both natural, in the case of the state park, and ornamental, in the case of local residents) from deer browse on neighboring lands. These definitions are as follows:

Negligible: No effects would occur, or the effects on neighboring landowners or other socioeconomic conditions would be below or at the level of detection.

Minor: The effects on neighboring landowners or other socioeconomic conditions would be small but detectable. The impact would be slight but not detectable outside the neighboring lands and would affect only a few adjacent landowners.

Moderate: The effects on neighboring landowners or other socioeconomic conditions would be readily apparent. Changes in economic or social conditions would be limited and confined locally, and they would affect more than a few landowners.

Major: The effects on neighboring landowners or other socioeconomic conditions would be readily apparent. Changes in social or economic conditions would be substantial, extend beyond the local area, and affect the majority of landowners.

Area of Analysis

The area of analysis includes private agricultural lands, the Indiana Dunes State Park, and neighboring residential communities within the approximate one-third–mile deer home range at the Indiana Dunes National Lakeshore.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under alternative A, NPS staff would continue current deer management actions, including construction and monitoring of small-area protection fencing and maintenance of the large-area exclosure, limited application of repellents, and inventory and monitoring efforts. These controls would protect important resources, but they would not affect the size of deer populations in the national lakeshore. Deer populations would continue to grow over time, although numbers would fluctuate annually due to winter temperatures, snow depths and duration of snow cover, food availability, reproduction and mortality rates because of poor herd health, and other factors. Some deer would continue to use their existing home range, which may extend up to one-third of a mile outside the national lakeshore. Other deer, such as young bucks, might expand their home range beyond the boundary if browse became scarcer in the national lakeshore.

As a result, some increased browsing could occur outside the national lakeshore boundaries. Crops grown on private lands adjacent to the national lakeshore could be browsed more heavily, resulting in an adverse economic impact on farmers. Crops that would most likely be affected are corn and soybeans. The degree of physical and economic damage that agricultural landowners would experience would depend on the anticipated growth in deer populations, the types of crops and number of acres in each crop, the market value of current crops, and the protections that landowners use to manage deer.

Increased browsing outside national lakeshore boundaries could also affect the towns of Beverly Shores and Dune Acres by increasing the duration or intensity of the ongoing deer removal efforts that have been underway in these communities in recent years. The Indiana Dunes State Park could also experience similar increases regarding staff time and manpower to manage deer hunts to maintain the current size of the deer herd.

Increased deer removal efforts would attract hunters into the area of the national lakeshore, which could have a beneficial economic impact on the local economy; hunters may purchase food, supplies, and possibly, overnight accommodations, depending on how far they travel. In 2001, the average trip-related expenditure per hunter in Indiana was $156. Hunters spent an average of $91 per person on food and lodging for hunting within Indiana in 2001 (USDOI 2001).

Crop Damage. As noted in the "Assumptions, Methodology, and Impact Definitions" section above, it is assumed that each 10-percent increase in the national lakeshore's deer population could result in an approximate 3.4-percent bushel-per-acre increase in damage to corn and an approximate 3.0-percent bushel-per-acre increase in damage to soybeans. For example, a farm that is planted in corn yields approximately 98.2 bushels per acre when harvested; damage from deer browsing would result in a loss of approximately 9.6 bushels per acre, or 9.8 percent of the harvested yield (MASS 2002). For a 100-acre farm, this loss would amount to 960 bushels of corn. Assuming a 2004 market price for corn of $2 per bushel (MASS 2004), the total economic loss for this farm would be $1,920, or $19.20 per acre. With each 10-percent increase in deer population, this loss would increase.

Multiple factors affect deer populations and have caused considerable fluctuations over time; therefore, the population growth percentage is difficult to predict. Assuming that some increase in the deer population would occur and that deer would include private lands within one-third mile of the national lakeshore boundary within their home range, farmers could anticipate that soybean and corn crop damage from deer browsing could increase by approximately 3 percent and 3.4 percent, respectively, with each 10-percent increase in the deer population. This additional damage would result in adverse, long-term, and minor to moderate impact on farmers, with the extent of damage and the degree of impact dependent on the specific crop, the location relative to the national lakeshore, and other factors. These percentages are rough estimates based on available research and could vary substantially depending on deer population fluctuations, how deer adjust their home range in response to food scarcity, and other factors.

In any given year, deer populations could also increase rapidly due to increased reproduction, decreased mortality, and other factors, then subsequently decline a year later. A growing deer population would most likely have a nonlinear effect on crop damage, meaning that crop damage costs could increase proportionately more than increases in the deer population (McNew and Curtis 1997). Thus, a short-term increase in the deer population could cause potentially large increases in costs associated with crop damage, assuming that deer would use private lands within their home range or shift or expand their home range if browse became scarce within the national lakeshore. Thus, in the short term, farmers could anticipate that crop damage due to a potentially substantial deer population would increase. These costs could result in an adverse, short-term, and moderate impact on farmers surrounding the national lakeshore.

Landscaping and State Park Damage. Similar to the crop damage discussed above, private landowners adjacent to the national lakeshore, such as residents in Beverly Shores or Dune Acres, could anticipate increased deer browsing on plants in landscaped areas over the short and long term, particularly if food sources decreased within the national lakeshore due to population pressures. The Indiana Dunes State Park would experience increasing damage to the plants within its boundaries. These increases could result in adverse, short- and long-term, and moderate impact.

Protection Mechanisms and Costs. In a 1996 survey conducted by the Maryland Department of Natural Resources, approximately 40 percent of farmers who reported deer-related damage used some form of preventive measure to protect crops, yards, and gardens (Lynch 1997). Farmers' costs to prevent deer damage averaged $144 per farmer statewide in New York in 2002, ranging from $47 in western New York to $1,382 on Long Island (Brown, Decker, and Curtis 2004).

Landowners could incur additional costs for fencing, repellents, and other forms of deer control to protect their crops and landscaping as the deer population grows under this alternative. Beverly Shores, Dune Acres, and the state park have all incurred expenses related to managing hunts on their lands. Agricultural landowners have also incurred expenses for hunting deer on their property. McNew and Curtis (1997) found that the higher the loss-per-acre yield due to deer damage, the more likely it is that a farmer requested a deer damage permit. Increased deer browsing could lead to additional monetary and time costs associated with the continued harvesting of deer through control mechanisms, such as the two forms of IDNR damage permits. With no deer removal efforts occurring within the national lakeshore, such costs are likely to continue indefinitely.

The time and monetary costs associated with acquiring additional protection measures would result in adverse, long-term, and minor impact on private landowners, depending on the number of landowners who used such measures. Increases in requests for deer damage permits could also result in more labor hours for IDNR staff, resulting in adverse, long-term, and negligible impact on the state agency.

Cumulative Impact

Population in the national lakeshore's three-county region (Lake, Porter, and LaPorte) increased from 711,592 in 1990 to 741,468 in 2000 (29,876 additional residents, or a 1.9-percent increase). Lake County increased 1.9 percent to 484,564; Porter County increased 13.9 percent to 146,798; and LaPorte County increased 2.8 percent to 110,106. Of the overall 29,876 increase across all three counties, the majority (60 percent) occurred in Porter County, where most of the deer management activities outside the national lakeshore take place (NIRPC n.d.b). The lack of predators and conversion of land to residential uses could encourage deer populations in these areas to grow, potentially increasing the impact.

Hunting in the Indiana Dunes State Park, Beverly Shores, and Dune Acres, as well as hunting that occurs on nearby agricultural lands, helps regulate local and regional deer populations in the national lakeshore's vicinity. Although these hunting activities provide long-term benefits to the landowners who implement them, in the form of reduced deer numbers, an adverse impact results in the form of increased costs for ongoing deer removal efforts. However, these costs may be offset by the beneficial impact of hunting on the local economy that would combine with the local hunts that have been occurring (and are expected to continue) on neighboring lands during the past several years, particularly public hunts at the state park. As the size of the deer population throughout the vicinity of the national lakeshore decreases in the long term through management actions combined with local hunting efforts, this benefit would also decrease, as fewer hunters would be needed to maintain the deer population on other public and private property in the area.

Overall, in the state of Indiana, from 2004 to 2005, corn production decreased 13 percent and soybean production decreased 7 percent. Although neither Porter nor LaPorte County is considered among the state's top 10 corn- or soybean-producing counties, agriculture plays an important role in both, and corn and soybeans represent a substantial portion of crops planted. LaPorte County experienced its largest decrease in crop sales between 1997 and 2002, and the amount of prime farmland in Porter County is limited. Crop damage due to increased deer browsing would combine with other impacts, leading to a decrease in production in the affected counties and the state.

Other wildlife also damage landscaping and crops. For example, in Indiana, damage to landscaping from geese can be considerable and expensive to repair or replace. Because they are active grazers, geese are particularly attracted to lawns and ponds located near apartment complexes, houses, office areas, and golf courses. Geese can rapidly denude lawns, turning them into barren dirt areas. Raccoons are also notorious for raids on sweet corn (IDNR n.d.d).

Some local residents and visitors to the national lakeshore have been known to feed deer. Feeding deer was considered "the greatest attraction for bringing so many deer into the Beverly Shores Island" area (Beglin and Drake 2001). When people provide deer with readily available food, the deer spend less energy foraging. More energy is thus available for bearing and raising offspring, and as a result, the population increases. Thus, when visitors and local residents feed deer, they are actually contributing to an increase in the local deer population abundance (NPS 2000b). Such an increase could lead to an adverse socioeconomic impact on the national lakeshore's neighbors.

The benefits of hunting on state and private lands and the adverse impact of continued development and other wildlife damage, when combined with the adverse impact expected under alternative A, would result in an adverse, moderate cumulative impact in the short term and an adverse, minor cumulative impact relating to damage to crops and landscaping.

Conclusion

Increased deer browsing because of increases in long-term deer populations would result in additional landscaping, vegetation, and crop damage to corn and soybeans on agricultural and other private and state lands adjacent to the national lakeshore. This additional damage would result in adverse, long-term, and minor to moderate impact on residents and farmers, with the extent of agricultural damage and the degree of impact dependent on the farmer's crop, location relative to the national lakeshore, and whether deer would use private lands within their existing home range or expand or shift their home range as browse became scarcer within the national lakeshore. Large fluctuations in annual deer populations could result in varying impact. Landowners would also incur additional costs for fencing, repellents, managed hunts, and other forms of deer control to protect their crops, landscaping, and vegetation. The cumulative impact would be adverse and beneficial, short and long term, and moderate due to crop and landscaping damage and would include the costs of local deer removal efforts and the impact of combined hunting expenditures on the local economy.

Alternative B: Combined Nonlethal Actions–Fencing, Repellents, and Reproductive Control

Several nonlethal actions would be implemented under alternative B. Actions include additional fencing and exclosures for protection of herbaceous vegetation, more extensive use of repellents, and possible phasing in of reproductive control of does.

Reproductive control of deer, if successful, would gradually reduce the population over the long term. However, deer numbers within the national lakeshore would not be immediately reduced, and numbers would fluctuate annually. As the population expands, the home range of deer within the national lakeshore could expand, resulting in greater deer browsing outside the national lakeshore's boundaries, where food may be more plentiful but where treated deer could be shot by hunters. If a meat withdrawal period is advised for treated does, they would be appropriately marked. The impact on hunters on neighboring lands who may not wish to use the meat of treated does would be adverse and long-term but negligible.

However, the number of deer that would seek food sources outside the national lakeshore could be slightly greater under this alternative, because the large-area exclosures constructed under this alternative would exclude deer from browsing on about 936 acres (the estimated critical and high-priority areas that would require exclosures), or about 7 percent, of the national lakeshore at any given time. It is estimated that it would take three years (at a rate of 100 exclosures per year) to construct exclosures in all critical and high-priority areas.

Crop Damage. Deer displaced by more than 300 large-area exclosures could slightly increase per-acre damage to corn and soybeans compared to alternative A, adversely affecting adjacent farmers. Repellents would also exclude deer and would be used experimentally until the level of effectiveness was established. It is estimated that repellent use would double from what was described in alternative A and would primarily be implemented in restoration planting areas. In the Inland Marsh deer management zone, 27.3 of the zone's 1,090 acres, or 2.5 percent, qualify as critical or high-priority areas requiring large exclosures. In the Pinhook Bog deer management zone, 47.2 of the zone's 404 acres, or 11.7 percent, would be exclosed. (These zones are adjacent to the farmers experiencing deer-browsing damage to their crops.)

The amount of additional crop damage that could result from additional large-area exclosures and use of repellents is unknown. It could be greater than the 3- to 3.4-percent increase in soybean and corn crop damages estimated under alternative A with each 10-percent increase in deer population—assuming that the national lakeshore deer population would browse on private lands within one-third of a mile of the boundary or expand or shift their home range. Deer damage to farmers' crops in the Pinhook Bog area could be greater than in the Inland Marsh area, given the larger percentage of national lakeshore lands that would be exclosed at Pinhook Bog. More farmers could be affected because more of them have applied for deer damage permits in recent years in this area. (Only one farmer has been affected near Inland Marsh.)

This additional deer damage would result in adverse, long-term, and minor to moderate impact on farmers, with the extent of damage and degree of impact dependent on such factors as the particular crop, the location of the crop relative to the national lakeshore, and existing protection measures.

Any large annual increase in deer populations plus the reduced availability of forage could also cause a greater increase in crop damage in the short term. If the deer population experienced dramatic increases in numbers and exclosures prevented browsing in about 7 percent of the national lakeshore, the potential for short-term damage to crops for that year could increase proportionately. As indicated in alternative A, crop damage costs could increase proportionately more than increases in the deer population (McNew and Curtis 1997). If such a scenario occurred in the short term, the adverse impact on farmers could be moderate, because more than a few farmers in the local area would likely be affected and the change in crop damage would be readily apparent. Alternatively, the deer population could also decline, resulting in fewer, less severe impacts.

The implementation of reproductive controls would limit deer population increases in the long term and moderate the impact associated with the exclosures. A reduced deer population would result in less browsing pressure on private land, with the adverse impact reduced to minor over the long term. Short-term adverse impact would remain minor to moderate because of the potential population fluctuations and the deer population's continued growth in the short term.

Landscaping and State Park Damage. As with crop damage impact, private and state landowners adjacent to the national lakeshore could anticipate increased deer browsing in the short term. Resulting damage would occur to plants within landscaped areas and plants within the Indiana Dunes State Park until reproductive controls took effect.

Beverly Shores, Dune Acres, and the state park all are situated within the national lakeshore's East Unit boundaries. Although approximately 7 percent of the entire national lakeshore would be exclosed under this alternative, nearly 9 percent of the East Unit would contain large exclosures. The majority of the East Unit's exclosures would occur in the Dune Ridge deer management zone, which surrounds Beverly Shores and is adjacent to the state park's eastern boundary. In this zone, 547.5 of the 2,817 acres (19.4 percent) would be exclosed. In the Dune Wood deer management zone, which primarily borders the state park's southern boundary, 6.7 percent of the zone's acreage would be exclosed. In the Cowles Dune deer management zone, which surrounds the town of Dune Acres and is adjacent to the state park's western boundary, only 1.6 percent of the total acreage would be exclosed. Therefore, Beverly Shores would likely experience the most adverse impact from the construction of exclosures in the national lakeshore's East Unit.

The West Beach deer management zone surrounds Ogden Dunes in the national lakeshore's West Unit. Of the zone's 1,408 acres, 54.2, or 3.8 percent, would be exclosed. Although Ogden Dunes has not taken action to reduce the deer population on its land, if more deer are forced out of national lakeshore lands into the town, damage could occur to landscaping and vegetation there.

The degree of impact throughout the national lakeshore could be greater than under alternative A and would vary by deer management zone, based on the number of acres that would be exclosed per zone and the proximity of each zone to urban neighbors. Adverse impact on vegetation would likely be moderate. The introduction of reproductive controls could reduce the long-term impact on landscaping to minor, which is an impact rating similar to crop damage.

Protection Mechanisms and Costs. Landowners adjacent to the national lakeshore would continue to incur additional costs for fencing, repellents, hunting, and other forms of deer control to protect their crops, landscaping, and vegetation. Because deer would be displaced from the national lakeshore due to the exclosures (and, to a lesser extent, the use of repellents), these costs would most likely be greater than in alternative A. Landowners currently receiving IDNR deer damage permits would continue to do so and would incur the additional monetary and time costs associated with harvesting deer on their lands. In recent years, additional landowners in the Pinhook Bog area have requested permits; this trend shows that increased deer browsing on private lands could encourage other landowners to request permits for the first time. Educational efforts on the part of the national lakeshore would help inform adjacent landowners of deer management activities in the national lakeshore and their potential effects and provide information on management mechanisms, such as deer damage permits, that are available to landowners.

The time and monetary costs associated with additional protection measures would result in adverse, long-term, minor to moderate impact on farmers and other private landowners, similar to alternative A. Increases in requests for deer damage permits could also result in more labor hours for IDNR staff, causing an adverse, long-term, minor impact on the state agency. The availability and effectiveness of reproductive controls in the future could reduce the intensity of this impact because the deer population would decrease gradually, minimizing crop and landscaping damage and reducing the need for protection mechanisms.

Cumulative Impact

The cumulative impact for alternative B would be similar to alternative A, except that actions associated with alternative B could result in a more adverse cumulative impact because deer would be displaced by exclosures on 936 acres of national lakeshore land. The extent of the cumulative impact would vary by deer management zone; for example, the town of Beverly Shores may have to increase the amount of hunting on its land just to keep the current deer population at its present number. Thus, the benefits of hunting and the adverse impact of development and other wildlife damage, in combination with the adverse impact of alternative B, would result in an adverse, short- and long-term, moderate cumulative impact.

Conclusion

Under alternative B, reproductive controls (if successful) would allow for only a gradual reduction in the number of deer, and there could be some displacement of deer from the national lakeshore because of the exclosures. This could result in slightly greater per-acre damage to landscaping, vegetation, and field crops (such as corn and soybeans) on adjacent private lands than under alternative A. The adverse long-term impact on farmers would be moderate, with the extent of damage and degree of impact dependent on such factors as the location of the crop relative to the national lakeshore, deer feeding habits, and whether deer would use private lands within their existing home range or expand or shift their home range as browse became scarcer within the national lakeshore. Over the long term, reproductive controls could lessen the adverse browsing impact. Due to potentially large annual fluctuations in the deer population and the presence of exclosures, the short-term impact could be more severe than under alternative A, resulting in adverse, short-term, and moderate impact on farmers and other landowners. Landowners would also incur additional costs for fencing, repellents, hunting, and other forms of deer control to protect their crops, vegetation, and landscaping. The cumulative impact would be adverse and moderate over the short and long term.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, sharpshooting would quickly reduce the herd size. This approach would continue into year 3 or until the national lakeshore's deer density was approximately 15 deer/mi^2. Additional deer would be removed in subsequent years to maintain the population.

Crop, Landscaping, and State Park Damage. The reduction of the existing deer population over the short and long term may result in fewer deer leaving the national lakeshore boundaries and browsing on crops, vegetation, and landscaping on adjacent lands, depending on where the sharpshooting was focused and the home range locations of the deer. Acreage within the national lakeshore would most likely provide sufficient browse for a reduced deer population. Thus, the bushels-per-acre lost to national lakeshore–related deer damage for such crops as corn and soybeans would most likely be substantially reduced, resulting in an increased total harvested yield.

The degree of reduction in crop damage is unknown. Available studies, such as those by McNew and Curtis (1997) and Brown et al. (2004), indicate, based on survey results, that per-acre damage is greater in regions of Maryland and New York where deer populations are potentially the highest or most protected from deer management measures, such as hunting, and much less in regions where deer populations are lower. However, the authors who summarized the New York survey data state:

> It is impossible to tell from this study the extent to which the high variation in estimated deer damage from farm to farm is due to differences in deer populations, feeding habits, and other factors such as types of crops raised and proximity of farm to deer refugia (e.g., National Lakeshore, posted lands), versus measures farmers have taken… to reduce deer damage. (Brown et al. 2004, 23)

With a substantial reduction in the deer population, the related reduction in crop, vegetation, and landscaping damage would result in a beneficial long-term impact on farmers and other private and public landowners, assuming that national lakeshore deer populations are currently foraging on lands adjacent to the national lakeshore and within their home range. Reducing the deer density from 35 deer/mi^2 in the west (and outlying) zones to 15 deer/mi^2 (a 57-percent reduction) would have readily apparent results and would beneficially affect the farmers near the Inland Marsh and Pinhook Bog. Reducing the deer density from 70 deer/mi^2 to 15 deer/mi^2 in the east zones (a 79-percent reduction) would have a substantial benefit for Beverly Shores and Dune Acres and for the state park.

Adverse short- and long-term impact would be reduced from moderate under alternative A to minor under alternative C. However, if deer populations outside the national lakeshore remain high, the benefits would be limited.

Annual controls to maintain a reduced national lakeshore deer herd would help prevent any large annual population fluctuations that could occur, resulting in reduced short-term crop damage and short-term benefits to farmers and other landowners.

Protection Mechanisms and Costs. A corresponding decline in costs for fencing, repellents, hunting, and other forms of deer control to protect crops, vegetation, and landscaping could occur as the national lakeshore's deer population is reduced. Assuming that national lakeshore deer are using adjacent lands as part of their home range, fewer deer and decreased deer browsing on private and adjacent public lands could also result in fewer landowners acquiring deer damage permits and lower monetary and time costs associated with harvesting deer on their lands. Those landowners who currently receive permits may need fewer in the future, and landowners who are currently contemplating permits may not need to purchase them. Reduced time and monetary costs associated with protection measures would, in turn, reduce the adverse long-term impact on farmers and other private landowners to the minor category. Issuance of fewer permits in the vicinity of the national lakeshore would probably not affect the IDNR.

Cumulative Impact

As described under alternative A, continued development in the region, damage from other wildlife, and the results of feeding deer would cause minor adverse socioeconomic impact on landowners adjacent to the national lakeshore. Hunting in the Indiana Dunes State Park, Beverly Shores, and Dune Acres, as well as hunting that occurs on nearby agricultural lands, would help regulate local and regional deer populations in the vicinity of the national lakeshore, particularly when combined with NPS deer removal efforts under alternative C. This impact, in combination with the benefits of alternative C, would be beneficial compared to alternative A, because the adverse impact would be reduced to minor over the short and long term.

Conclusion

The reduction of the existing deer populations in both the short and long term could result in fewer deer leaving the national lakeshore and browsing on crops, vegetation, and landscaping on adjacent lands, assuming that these lands are currently within the home range of the national lakeshore's deer population. The degree of reduction in crop damage is unknown; however, the reduction would most likely be measurable, reducing the adverse impact on farmers and other landowners to the minor category over the short and long term by increasing harvested yield, preserving landscaping, and preserving vegetation in the state park. A corresponding decline in costs for fencing, repellents, hunting, and other forms of deer control to protect crops and other vegetation could also occur. The cumulative impact would be beneficial compared to alternative A; the adverse impact would be reduced to minor over the short and long term.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, sharpshooting would be used initially to quickly reduce deer herd numbers. Reproductive control of does would then be implemented as a maintenance tool, when a reproductive control agent becomes available, to keep deer numbers at an acceptable level. Small-area protection fencing and repellents would be used, similar to alternative B. However, only five small fenced areas for plant protection would be installed annually. This alternative would also include construction of one large-area exclosure (2 to 5 acres) every other year.

As demonstrated in the analyses for alternative C, direct reduction methods would be the most effective actions to minimize crop damage from deer browsing. Nonlethal methods, such as small-area fencing, one large-area exclosure installed every other year, and repellents, would protect national lakeshore resources from further damage but would not reduce crop, vegetation, and landscaping damage on lands adjacent to the national lakeshore. Of the combined lethal and nonlethal methods under this alternative, the direct reduction method would most affect the degree of crop, vegetation, and landscaping damage. Reproductive controls, rather than sharpshooting, would then be used to maintain the size of the herd. Therefore, the impact associated with alternative D would be the same as alternative C. The damage to such crops as corn and soybeans would most likely be measurably reduced, resulting in a beneficial effect compared to alternative A. Over the long term, the adverse impact on adjacent landowners related to per-acre and total harvested yields and costs for protection measures would be reduced to negligible or minor.

Cumulative Impact

The same cumulative impact described under alternative A would result under alternative D. However, the impact associated with past, present, and future actions described in alternative A, when combined with the overall beneficial impact of alternative D, would result in a beneficial impact compared to alternative A. The cumulative impact would be adverse and minor over the short and long term because some level of deer-browsing impact would continue.

Conclusion

Sharpshooting under alternative D would reduce crop and landscaping damage to the same degree as alternative C, resulting in beneficial impact compared to alternative A. The deer-browsing impact would continue at some level, but the adverse impact on farmers and other landowners would be reduced to negligible or minor levels over the short and long term due to improved harvested yields and preserved landscaping and vegetation. Costs to farmers and other landowners for fencing, repellents, and other forms of deer control could also decline. The cumulative impact would be beneficial compared to alternative A, and the adverse impact would be reduced to a minor level.

NATIONAL LAKESHORE MANAGEMENT AND OPERATIONS

The category of national lakeshore management and operations refers to the current staff who are available to adequately protect and preserve vital national lakeshore resources and provide an effective visitor experience. This topic also includes the operating budget necessary to conduct national lakeshore operations.

Assumptions, Methodology, and Impact Definitions

The discussion of impact on national lakeshore operations focuses on (1) the number of staff available to ensure visitor and resident safety and (2) the ability of national lakeshore staff to protect and preserve resources given current funding and staffing levels. This discussion assumes that the national lakeshore's annual budget would be increased to implement a particular chosen alternative. However, this funding is not guaranteed; thus, the impact of receiving or not receiving additional funding is weighed for each alternative. Knowledge of national lakeshore staff was used to evaluate the impact of each alternative, and the evaluation is based on the description of national lakeshore operations presented in Chapter 3: Affected Environment. Definitions of impact levels are as follows:

Negligible: National lakeshore operations would not be affected.

Minor: National lakeshore operations would be affected, and the effect would be detectable, but current funding and staffing levels would be adequate and other national lakeshore operations would not be reduced.

Moderate: National lakeshore operations would be affected, the effect would be readily apparent, increased staff and funding would be needed, or other national lakeshore operations would have to be reduced or priorities changed.

Major: National lakeshore operations would be affected, the effect would be readily apparent, increased staff and funding would be needed, or other national lakeshore programs would have to be eliminated.

Area of Analysis

The area of analysis is the entire national lakeshore for all alternatives, including cumulative assessments.

Impact of the Alternatives

Alternative A: No Action (Existing Management Continued)

Under alternative A, the national lakeshore would take no additional action to manage the deer population within its boundaries. However, national lakeshore staff would continue to create and monitor small-area protection fencing, maintain the large-area exclosure, and apply limited amounts of repellents to protect vegetation.

Because such activities fall within the staff's current workload, the no-action alternative would not likely incur substantial additional expenses or staff time. However, if deer-browse pressure continues, expenses and required staff time could increase to the point where such protection activities become costly. Therefore, the impact from implementation of alternative A would likely be adverse, long-term, and negligible to minor.

Cumulative Impact

The town of Porter is considering annexing portions of land east of its eastern boundary, much of which is located within the Indiana Dunes National Lakeshore. The national lakeshore generally maintains and patrols its own streets; however, it relies on Porter for fire protection, with the exception of grass fires. Should annexation occur, the national lakeshore would continue to own the land it now holds. National lakeshore management sees no real advantage to annexation, other than the fact that such action would enable some of its law enforcement and fire services personnel to work more closely with the town of Porter.

Beverly Shores, Dune Acres, and the Indiana Dunes State Park (all of which border the national lakeshore's East Unit) have taken actions to reduce the size of the local deer herd. Such activities are planned to continue indefinitely until a specific deer herd size is reached or can be maintained. A reduction in the deer herd size would benefit management and operations of the national lakeshore because deer move freely between these land areas. Fewer deer in the general area of the national lakeshore would mean less impact on natural resources from deer browsing, resulting in a decreased need to create fences and exclosures and apply repellents. It is important to note, however, that the overall deer population in the national lakeshore area is expected to continue to increase in the long term despite deer removal efforts on neighboring lands that may reduce the herd size in the short term.

When combined with the adverse, negligible to minor impact expected under alternative A, the cumulative impact on national lakeshore management and operations would be long term and negligible to minor.

Conclusion

Alternative A would result in a negligible long-term impact on national lakeshore management and operations because staff would continue to create and monitor small-area protection fencing and to apply repellents in limited situations. The cumulative impact on national lakeshore management and operations would be long term and negligible to minor.

Alternative B: Combined Nonlethal Actions—Fencing, Repellents, and Reproductive Control

Under alternative B, the national lakeshore would create additional fencing and exclosures for protection of herbaceous vegetation, apply repellents more extensively, and implement reproductive control of does when an appropriate agent becomes available. Priority areas of sensitive resources would be protected from deer browse, and the entire national lakeshore would not be fenced or exclosed. Repeated applications of spray repellents would be necessary due to weather and emergence of new growth. The national lakeshore staff would apply repellents with backpack sprayers or with an all-terrain vehicle (ATV) sprayer.

Additional costs to national lakeshore management and operations in the form of labor and materials would be incurred from installation of exclosures, which would eventually cover 7 percent of the national lakeshore, and related monitoring. The use of repellents would also incur additional costs, not only for the initial application but also for repeat application and monitoring. Qualified federal employees or authorized agents trained in the administration of reproductive controls would treat deer with an appropriate agent when one becomes available. If NPS personnel were used to conduct the actions, time and money would necessarily be spent on appropriate training. If contractors were used, NPS would need to pay their salaries. The impact on labor would depend on the extent of NPS involvement in this activity but would, at a minimum, include setting bait piles, closing areas to visitor use, notifying the public of closures, and providing general logistical assistance.

Participating in all these deer management activities, including monitoring, would likely preclude national lakeshore staff from working on other tasks or projects, which could have an adverse effect on national lakeshore operations. For these reasons, implementation of alternative B would result in a major, long-term, adverse impact in terms of material costs and labor expenses.

Cumulative Impact

The cumulative activities of alternative B would be similar to those described under alternative A; however, more extensive fencing and exclosures within the national lakeshore may push deer onto neighboring lands. This situation may increase the need for neighboring landowners to remove more deer, which could decrease the overall herd size in the short term, thus benefiting all area landowners.Nevertheless, the deer population would likely continue to increase throughout the area until the effects of reproductive controls take hold. When combined with the minor to possibly major adverse, long-term impact expected under alternative B, the cumulative impact would be adverse, long term, and major.

Conclusion

Alternative B would result in a minor to possibly major, long-term, adverse impact on national lakeshore management and operations due to increased deer management activities, particularly erecting a large number of exclosures, monitoring and maintaining them, and administering reproductive control of does. The cumulative impact would be adverse, long term, and major.

Alternative C: Lethal Action—Sharpshooting

Under alternative C, sharpshooting would be conducted to reduce the deer population. Only shooters who are highly skilled in the use of firearms and public safety would participate. Bait stations would be placed to attract deer to safe removal locations. Safety zones would be established, and areas of the national lakeshore might be closed. Sharpshooting would occur primarily after sunset, with minimal effect to national lakeshore visitors, thereby reducing the need to manage visitor access.

Once this alternative is implemented, a minimum of five consecutive years of removals would occur, with corresponding monitoring. The number of deer to be removed each ensuing year would be adjusted based on the initial removal number and other factors, including monitoring.

If NPS personnel were used to conduct the actions, time and money would necessarily be spent on appropriate training. In addition, personnel assigned to sharpshooting activities would be taken away from their normal national lakeshore responsibilities. If contractors were used for sharpshooting actions, their salaries would need to be paid by the NPS. National lakeshore staff labor would be required to close certain areas and set up safety zones, place bait stations, and generally administer the actions.

Costs would vary depending on several factors. As described in Chapter 2: Alternatives, costs would increase if deer and bait stations are difficult to access, deer are wary of humans, the removal area is large, removal numbers are high, and densities are low. Costs would be lower if reverse conditions are present.

Because sharpshooting would occur only once during the year, the national lakeshore would experience a short-term impact associated with the event that would be adverse and minor to moderate, depending on the factors listed above. Long-term impact would also be adverse and moderate as associated costs accrue each year and monitoring continues, depending on how far into the future removals are deemed necessary.

Cumulative Impact

As described under alternative A, the national lakeshore's neighbors have conducted and are likely to continue to conduct hunts on their lands. Such activities, when combined with sharpshooting efforts on the part of the national lakeshore, should help further reduce the size of the overall deer herd, thus reducing the amount of effort required by all parties. However, national lakeshore management and operations would experience an adverse impact until the deer herd population reaches a size that no longer requires national lakeshore management activities. Therefore, the cumulative impact would be adverse, short or long term (depending on the number of years required to implement deer management actions), and moderate.

Conclusion

Under alternative C, the national lakeshore would experience short-term, adverse, and minor to moderate impact. The long-term impact would also be adverse and moderate as associated costs accrue each year. However, the need to construct small fences and apply repellents to protect plant species may diminish as the deer population decreases, offsetting a small portion of costs associated with deer management activities. The cumulative impact would be adverse, short or long term (depending on the number of years required to implement deer management actions), and moderate.

Alternative D: Combined Lethal and Nonlethal Actions

Under alternative D, sharpshooting would be used initially to quickly reduce deer herd numbers. Reproductive control of does would then be implemented as a maintenance tool (when an appropriate agent becomes available) to keep deer numbers at an acceptable level. Five small fenced areas for plant protection would be installed annually. along with one large-area exclosure (2 to 5 acres) every other year for plant protection.

The impact would be similar to alternative B but on a smaller scale because fewer fences and exclosures would be constructed. In addition, reproductive control would be used to maintain the deer herd size rather than reduce it to levels defined under alternative B. The impact would be most similar to alternative C because sharpshooting would be implemented in the same manner. Therefore, the impact on management and operations would be adverse, long term, and moderate.

Cumulative Impact

The cumulative impact of alternative D would incorporate actions expected under alternatives A, B, and C. The impact would be primarily related to hunting on neighboring lands, which would both affect and be affected by deer management actions under this alternative, particularly when combined with sharpshooting. The cumulative impact would be adverse, short or long term, and moderate.

Conclusion

The impact of alternative D would be similar to alternative B but on a smaller scale because fewer fences and exclosures would be constructed and reproductive control would be used only as a maintenance tool. The impact would be most similar to alternative C because sharpshooting would be implemented in the same manner, resulting in adverse, long-term, and moderate effects. The cumulative impact would be adverse, short or long term, and moderate.

UNAVOIDABLE ADVERSE IMPACT

The NPS is required to consider whether or not the alternative actions would result in an impact that could not be fully mitigated or avoided (NEPA section 101(c) (ii)).

Alternative A

Alternative A would result in long-term, unavoidable, and adverse impact on vegetation, white-tailed deer, other wildlife and habitat, and sensitive and rare plant species because of the continued increase in the deer population over time and the associated damage to vegetation. In addition, there would be continued unavoidable, minor, and adverse impact on soils and water quality due to the removal of vegetation by deer browsing and subsequent erosion and sedimentation. Increased fecal loading in the watershed would result, along with some unavoidable adverse impact on those wildlife species that depend on ground cover and seedlings for their food and cover. An unavoidable adverse impact on archeological resources would occur from installing small-area protection fences, and an unavoidable adverse impact on cultural landscapes would occur from crop damage at Chellberg Farm. There would also be a long-term, unavoidable, and adverse impact on visitors who enjoy amateur botany and wildlife viewing because of the lack of vegetation and associated wildlife and scenery. An unavoidable adverse impact on health and safety would occur from increased deer–vehicle collisions and from disease or infections. An unavoidable adverse impact would continue on national lakeshore management and operations because of demands placed on NPS staff related to continued monitoring and resource management.

Alternative B

Alternative B would include most of the unavoidable adverse impact described for alternative A over the life of the plan because the benefits of reproductive control would not be realized until much later, given the length of time needed to realize a reduction in deer herd numbers based solely on reproductive control. Unavoidable adverse effects to some sensitive plant species would be mitigated, however, by the use of exclosures. Installation of additional small-area protection fences and large-area exclosures would also protect cultural landscapes. Unavoidable adverse impact on soils and water quality would diminish as revegetation occurs inside exclosures. Unavoidable adverse impact on archeological resources would increase with the additional use of fences and installation of exclosures. Visitors would see more abundant and diverse vegetation inside exclosures. Reproductive control may have some unavoidable adverse impact if the actions are visible or disturbingly audible to national lakeshore visitors. Providing interpretive materials may help mitigate some of this effect; however, reproductive control, as proposed under this alternative, would likely require a substantial effort to treat the required number of deer. Unavoidable adverse impact on national lakeshore operations and management would increase compared to alternative A because of the demands on staff in implementing the program.

Alternatives C and D

Unavoidable adverse impact would be greatly reduced under alternatives C and D compared to alternatives A and B because the reduction in deer numbers would occur relatively rapidly and the national lakeshore's vegetation would begin to recover over the life of the plan. The rapid reduction in deer numbers and recovery of vegetation would mitigate adverse effects on vegetation, soils and water quality, white-tailed deer, other wildlife and habitat, sensitive and rare plants, archeological resources, and cultural landscapes. There may be some unavoidable adverse effects on visitors and social values relating to the implementation of sharpshooting and reproductive control if visitors are disturbed by these actions. Reproductive control would require the treatment of a smaller number of deer compared to alternative B. Conducting sharpshooting at night and providing interpretive materials would help mitigate some of the adverse effects of alternative D. Hunting (under alternative C) would occur during the day and require daytime closures of areas of the national lakeshore to visitors. Unavoidable adverse impact on national lakeshore operations and management would increase compared to alternative A because of the demands on staff in implementing the program and would be greater under alternative D because of the combination of techniques being proposed. Unavoidable adverse impact on soundscapes would occur under these alternatives from the use of firearms. This impact would be less intense under alternatives C and D due to the use of noise-suppression devices.

SUSTAINABILITY AND LONG-TERM MANAGEMENT

In accordance with NEPA and as further explained in NPS Director's Order #12: *Conservation Planning, Environmental Impact Analysis, and Decision-making*, consideration of long-term impact and the effects of foreclosing future options should pervade any NEPA document. According to Director's Order #12 and as defined by the World Commission on Environment and Development, "sustainable development is that which meets the needs of the present without compromising the ability of future generations to meet their needs." For each alternative considered in a NEPA document, considerations of sustainability must demonstrate the relationship between local, short-term uses of the environment and the maintenance and enhancement of long-term productivity. This relationship is described below for each alternative.

The NPS must consider whether or not the effects of the alternatives involve tradeoffs of the long-term productivity and sustainability of resources for the immediate, short-term use of those resources. It must also consider whether the effects of the alternatives are sustainable over the long term without causing adverse environmental effects for future generations (NEPA section 102(c)(iv)).

Alternative A

Alternative A would trade any long-term productivity for short-term use of national lakeshore resources. The deer population would continue to grow over time and use the national lakeshore's vegetation at the expense of the long-term productivity and sustainability of the vegetation and other affected wildlife, as well as the national lakeshore's cultural landscapes. Impairment of the national lakeshore's vegetation, deer herd, other wildlife and habitat, and sensitive and rare species would likely occur over the long term.

Alternative B

Alternative B would involve a similar trade for short-term use of national lakeshore resources at the expense of long-term productivity for the duration of the plan. This tradeoff would occur because the reproductive controls would not reduce the numbers of deer in the national lakeshore over the life of the plan. The construction of fences and exclosures would involve a short-term impact related to their construction and visual impact on visitors, but they would help preserve some of the national lakeshore's long-term productivity by exclosing more than 900 acres of vegetation. Therefore, impairment of vegetation is not expected over the long term. However, for this alternative to be truly sustainable, the reproductive control aspect must be continually managed; it must be successful; and fences and exclosures may need to remain in place beyond the life of this plan.

Alternative C

The sharpshooting alternative would require a short-term commitment of human resources and would result in a short-term impact on the national lakeshore's visitors and environment during deer reduction activities. This impact would be due to national lakeshore closures and the activities of sharpshooters and hunters, such as trampling. However, the result of implementing this alternative would be long-term productivity of the national lakeshore's vegetation and habitat and a sustainable use of resources in the national lakeshore. No impairment of national lakeshore resources would occur, but to be sustainable, this alternative would require long-term management, including monitoring and adaptive management to protect resource productivity.

Alternative D

Alternative D would involve a short-term commitment of human resources and would have a short-term impact on the national lakeshore's visitors and environment during the initial sharpshooting actions, but the result would be long-term productivity of the national lakeshore's vegetation and habitat and a sustainable use of resources. Alternative D would require more resources focused on reproductive control because this aspect of the alternative is experimental in a free-ranging population. No impairment of national lakeshore resources would occur, but this alternative would require long-term management to be sustainable, including monitoring and adaptive management to protect resource productivity.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

The NPS must consider whether the effects of the alternatives cannot be changed or are permanent (i.e., the impact is irreversible). The NPS must also consider whether the impact on national lakeshore resources would mean that once gone, the resource could not be replaced; in other words, the resource could not be restored, replaced, or otherwise retrieved (NEPA section 102(c) (v)).

Alternative A

Under alternative A, the impact on vegetation from continued over-browsing by deer could result in an irreversible impact on the national lakeshore's vegetation if no actions are taken to reduce deer numbers. Exotic plants that are not palatable to deer would exploit openings in the vegetation, and animal species that rely on native ground vegetation might not remain in or return to the national lakeshore. Even if fencing were used to protect some sensitive species, it would be impossible to identify all individual plants, and over-browsing of new plants located outside the fenced areas could occur. In addition, the deer herd at the national lakeshore could suffer irretrievable adverse effects if no action is taken.

Alternative B

Alternative B has the potential for some irreversible impact if some areas of the national lakeshore's vegetation are adversely affected to the point of nongeneration or if invasive exotic plants take over some areas before reproductive controls have had time to stabilize deer herd numbers. Exclosures would not cover the entire national lakeshore; thus, some of the irreversible impact described for aAlternative A would likely occur under alternative B, as well.

Alternatives C and D

Alternatives C and D present the least potential for irreversible or irretrievable commitments of resources. Although deer would be removed under both alternatives, the deer population would continue at a sustainable level. Because the herd would be reduced relatively rapidly—thereby reducing deer browsing—there would be little chance that vegetation (including sensitive and rare species) or other species that are dependent on native ground cover would be irretrievably lost; the impact on vegetation of deer browsing would be lessened beginning with the life of the plan.

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Chapter 5
CONSULTATION AND COORDINATION

CHAPTER 5: CONSULTATION AND COORDINATION

The intention of NEPA is to encourage the participation of federal and state-involved agencies and affected citizens in the assessment procedure, as appropriate. This section describes the consultation that occurred during development of this *Final White-Tailed Deer Management Plan/Environmental Impact Statement*, including consultation with scientific experts and other agencies. This chapter also includes a description of the public involvement process and a list of the recipients of the final document.

SCOPING AND PUBLIC INVOLVEMENT

The scoping and public involvement activities for this EIS fulfill the requirements of NEPA and NPS Director's Order #12 (NPS 2001b).

EIS Scoping

The NPS divides the scoping process into two parts: internal scoping and external or public scoping. Internal scoping involves discussions among NPS personnel regarding the purpose of and need for management actions, issues, management alternatives, mitigation measures, the analysis boundary, appropriate levels of documentation, available references and guidance, and other related topics.

Public scoping is the early involvement of interested and affected members of the public in the environmental analysis process. The public scoping process helps ensure that people have an opportunity to comment and contribute early in the decisionmaking process. For this planning document and impact statement, individuals, agencies, and organizations received project information early in the process, and people had opportunities to express concerns or views and to identify important issues or other alternatives.

Taken together, internal and public scoping are essential elements of the NEPA planning process. The following sections describe the various ways scoping was conducted for this EIS.

Internal Scoping

A Dunes Region Deer Study Committee was formed in February 1999 to "develop recommendations for the Indiana Department of Natural Resources (IDNR), other land holding agencies, and communities for managing deer along the Lake Michigan Shoreline" (Case and Seng 1999). Specific areas of concern included Indiana Dunes State Park, Indiana Dunes National Lakeshore, and the communities of Dune Acres and Beverly Shores. The committee included representatives from local communities, state agencies, counties, hunting groups, environmental groups, and Indiana Dunes National Lakeshore. The process included nine meetings and two field trips. In August 1999, the committee released a final report detailing management recommendations on which it had agreed (Case and Seng 1999) and held a workshop with national lakeshore staff to develop objectives and initial alternatives and to discuss deer issues.

An internal scoping meeting was held in 2002 to discuss managing white-tailed deer as part of a healthy and functioning ecosystem at Indiana Dunes National Lakeshore. The goal of this meeting was to determine the purpose, need, and objectives for managing deer at the national lakeshore, as well as to identify issues and concerns associated with current deer populations and their impact on the national lakeshore ecosystem. Preliminary alternatives were also discussed.

A science team was established to provide guidance and decisionmaking about monitoring protocol and impact thresholds to determine when management action would be necessary. The committee consisted of national lakeshore staff, natural resource experts, and various public agency personnel.

A followup internal scoping meeting was held at the national lakeshore in August 2003 to review and finalize issues and discuss public involvement efforts. Two public meetings were held in mid-September 2003. Public comments were also received via regular mail and e-mail. Details about these meetings and public involvement for this project are in the "Public Scope" section below.

Public understanding and support are extremely important for any future efforts to maintain deer populations as a healthy component of the national lakeshore ecosystem. Because the issue of deer management generates substantial public controversy, an EIS is the most appropriate compliance pathway for this process.

Consultation with the State Historic Preservation Office and the IDNR, the USFWS and the USGS was will be undertaken as part of the planning process.

Public Scoping: Notification, Meetings, and Comments

The notice of intent to prepare an EIS was published in the *Federal Register* on July 23, 2003.

A public involvement plan was developed to open the lines of communication between different interest groups and to develop a management strategy that would have community support and minimal opposition. A brochure announcing the proposed deer management plan/EIS was mailed to 206 recipients, who were invited to attend two public scoping meetings held in September. The brochure described the proposal, the history of deer management activities at the national lakeshore, the purpose and need for taking action, and the plan's objectives. A total of 26 people attended the public meetings (20 on September 11, 2003, and 6 on September 13, 2003). Information was also available for review at the visitor center and headquarters and on the national lakeshore website.

The purpose of the open houses was to inform the public about the EIS process and obtain input on the initial range of alternatives. The first open house was held on September 11 from 5:00 p.m. to 9:00 p.m. at the Dorothy Buell Memorial Visitor Center in Porter and hosted 20 attendees. The second was held on September 13 from 10:00 a.m. to 2:00 p.m. at the Northwest Indiana Regional Planning Commission office in Portage and hosted 6 attendees. Public comments were also received via regular mail and e-mail.

The national lakeshore received 811 comments favoring a nonlethal method of deer management and opposing use of any lethal method. Of these, 14 specifically supported alternative A (fencing and repellents) and 11 specifically supported alternative B (which, at the time, included only reproductive control). Two comments supported alternative D, and 3 supported the no-action alternative. However, some comments received during the public scoping meetings supported using lethal methods.

Agency Consultation

U.S. Fish and Wildlife Service

NPS obtained a list of federally listed candidate, proposed, threatened, or endangered species from the USFWS website. On February 19, 2008, NPS sent a letter to the USFWS to begin informal consultation and request a list of federally listed species with potential to occur in the national lakeshore.

The USFWS responded as follows as excerpted from their consultation letter: The U.S. Fish and Wildlife Service has reviewed the Draft White-tailed Deer Management Plan/Environmental Impact

Statement concerning the proposed management of white-tailed deer at the Indiana Dunes National Lakeshore… We concur that Alternative D is the most appropriate alternative for INDU. Alternative D would quickly and safely reduce the very high deer population to a density that is beneficial to the deer, the ecosystem, and the public and maintain those lower numbers for the life of the plan. The U.S. Fish and Wildlife Service therefore concurs that the proposed deer management plan at the Indiana Dunes National Lakeshore is not likely to adversely affect … endangered, threatened, and candidate species. This precludes the need for further consultation on this project as required under Section 7 of the Endangered Species Act of 1973, as amended. If, however, new information on endangered species at INDU becomes available or if the deer management plans are changed significantly, please contact our office for further consultation. Thank you for the opportunity to review this document. We believe that it adequately addresses the expected impacts of the deer management plan as proposed at the Indiana Dunes National Lakeshore.

Indiana Department of Natural Resources

Information on the presence of state-listed rare, threatened, or endangered species in the vicinity of the national lakeshore was obtained from the IDNR website. This information, along with species inventory data from Indiana Dunes National Lakeshore, was used to create the list of state rare, threatened, and endangered species analyzed in this document.

In a letter dated 24 April 2009, IDNR indicated that they had reviewed the Draft EIS and recommended that NPS use public hunting rather than sharpshooting to manage the deer herd. In response to this comment as well as other commenters recommending a public hunt, NPS stated that a public hunting alternative was not carried forward for further analysis because it would be inconsistent with existing laws, policies, regulations, and case law regarding public hunts in units of the National Park System; it would be inconsistent with long-standing basic policy objectives for National Park System units; and the likelihood that the NPS would change its long-standing Service-wide policies and regulations regarding hunting in parks is remote and speculative.

Indiana State Historic Trust

Indiana Dunes National Lakeshore submitted the draft final EIS for review in accordance with section 106 of the National Historic Preservation Act to the state historic preservation officer. A copy of the final EIS was sent to the Indiana Historical Trust to complete Section 106 compliance.

IDNR's Division of Historic Preservation and Archaeology responded in a letter dated 13 January 2011 as follows: "We concur with the National Park Service's December 17, 2010 finding that there are no historic buildings, structures, districts, objects, or archaeological resources within the area of potential effects that will be adversely affected by the above indicated project provided that all proposed ground disturbance (fencing and disposal pits) will be in areas previously disturbed or in areas subjected to archaeological reconnaissance or archaeological monitoring to avoid currently known and previously unrecorded archaeological resources".

REVIEW OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

Pursuant to NEPA, its implementing regulations, and NPS guidance on meeting NEPA requirements, Indiana Dunes National Lakeshore must solicit, assess, and consider comments on the *Draft White-tailed Deer Management Plan/Environmental Impact Statement* (plan/DEIS) and respond to substantive public comments. The following paragraphs describe how NPS fulfilled that requirement.

On January 29, 2009, the Indiana Dunes National Lakeshore plan/DEIS was released through a Notice of Availability, opening an 85-day public comment period that closed on April 24, 2009. During this period, which was announced through the national lakeshore's website (www.nps.gov/indu), press releases, and newspapers, the plan/DEIS was accessible through the NPS's Planning, Environment, and Public Comment (PEPC) website (http://parkplanning.nps.gov). Hard copies of the plan/DEIS were available at the Dorothy Buell Memorial Visitor Center and the national lakeshore headquarters building. Copies also were mailed to interested parties, elected officials, and appropriate local and state agencies. The public was encouraged to review the plan/DEIS and submit comments through the PEPC website or by postal mail sent directly to the national lakeshore.

During the public comment period, NPS held an open meeting between 5:00 and 8:00 p.m. on March 12, 2009, at the Indiana Dunes National Lakeshore Visitor Center. The purpose of the meeting was to present the plan, respond to questions, and facilitate public involvement and community feedback. Release and availability of the draft plan, as well as the public meeting, were advertised as described above.

Appendix G provides details of the comments, concerns, and responses to comments on the DEIS.

RECIPIENTS OF THE FINAL PLAN/ENVIRONMENTAL IMPACT STATEMENT

This *Final White-Tailed Deer Management Plan/Environmental Impact Statement* was sent to the following agencies, organizations, and businesses, as well as to other entities and individuals who request copies.

Federal Departments and Agencies

Environmental Protection Agency

National Park Service

U.S. Attorney's Office

U.S. Fish and Wildlife Service

State Agencies

Indiana Department of Environmental Management

Indiana Department of Natural Resources

Indiana Dunes State Park

State of Indiana (Governor)

County and Local Agencies

Beverly Shores Town Council

Burns Harbor Town Council

Chesterton Town Council

City of Gary (Mayor)

LaPorte County

Northern Indiana Public Service Company

NW Indiana Regional Planning Commission

Ogden Dunes Town Council

City of Michigan City (Mayor)

City of Portage (Mayor)

Dunes Acres Town Council

Lake County

Pines Town Council

Porter County Commission

Porter County Convention and Visitor Commision

Town of Beverly Shores

Organizations and Businesses

Association of Beverly Shores Residents

Bethlehem Steel Corporation

Chicago Wilderness

Ivy Tech State College

Izaak Walton League

Purdue University Calumet

Save the Dunes Conservation Fund

Save the Dunes Council

Shirley Heinze Environmental Fund

Jasper–Pulaski Fish and Wildlife Area

Little Calumet River Basin Development Commission

National Audubon Society

National Humane Education Society

The F.A.W.N. Society, Inc.

The Nature Conservancy

USX Corporation

Workforce Intervention, LLC

Native American Tribes

Citizen Band Potawatomi Nation of Oklahoma

Grand Traverse Band of Ottawa and Chippewa Indians

Hannahville Indian Community of Wisconsin

Little River Band of Ottawa Indians of Michigan

Little Traverse Bay Bands of Odawa Indians

Miami Tribe of Oklahoma

Ottawa Tribe of Oklahoma

Huron Potawatomi, Inc., Michigan

Pokagon Band of Potawatomi Indians of Michigan

Potawatomi Indians of Michigan

Prairie Band of Potawatomi Indians of Kansas

SCIENCE TEAM MEMBERS

Name	Title	Organization/Location
Mr. Randy Knutson	Project Manager/Lakeshore Contact	NPS – Indiana Dunes National Lakeshore
Mr. Ralph Grundel	Animal Ecologist and Research	USGS – Indiana Dunes National Lakeshore
Mr. Noel Pavlovic	Plant Ecologist and Research	USGS – Indiana Dunes National Lakeshore
Mr. Peter Dratch	Endangered Species Specialist	NPS – Fort Collins
Dr. H. Brian Underwood	Wildlife Biologist Leader of the Cooperative Park Studies Unit of the USGS, Patuxent Wildlife Research Center	USGS Cooperative Park Studies Unit
Dr. William F. Porter	Professor of Wildlife Ecology	College of Environmental Science and Forestry – Syracuse
Dr. Jim Mitchell	Deer Management Specialist	IDNR
Ms. Beth Kunkel	Wildlife Biologist – Team Facilitator	URS Corporation
Mr. Rusty Schmidt	Biologist	URS Corporation
Mr. Jeff Dawson	Plant Ecologist	URS Corporation
Ms. Lisa Petit	Wildlife Biologist	NPS – Cuyahoga Valley National Park
Mr. Michael A. Coffey	Wildlife Program Manager	NPS – Biological Resource Management Division
Mr. Jim Voigt	Natural Resource Manager	NPS – Catoctin Mountain National Park

PREPARERS AND CONSULTANTS

Name	Title	Education/Responsibility	Experience
National Park Service – Indiana Dunes National Lakeshore			
Mr. Randy Knutson	Wildlife Biologist	B.S., Fisheries and Wildlife Biology. Coordinated the collection of data used in the deer management plan/EIS.	18 years with the NPS 16 years at Indiana Dunes National Lakeshore
Environmental Quality Division, Washington Office			
Mr. Michael Mayer	Environmental Protection Specialist	B.S., Wildlife and Fisheries Biology; M.S., Wildlife Conservation; J.D., Environmental Law. Responsible for NEPA policy, guidance, and technical review. Project manager, technical reviewer.	10 years
Consultants for Draft EIS – URS Corporation			
Mr. Dan Niosi	NEPA/Natural Resource Specialist	Responsible for writing/editing the soils, water quality, wildlife, vegetation, and rare species sections. Six years of experience in environmental planning, NEPA documentation, and Endangered Species Act documentation.	
Ms. Nancy VanDyke	Senior Consultant and Leader, Regulatory Team	B.A., Biology and Geography; M.S., Environmental Sciences. Responsible for technical review of document and water quality methodology.	More than 22 years in environmental planning, assessment, and compliance
Ms. Patti Steinholtz	Senior NEPA Planner, Editor/Graphic Illustrator	B.A., Communications and English. Responsible for research, coordination, and preparation of document.	5 years with NEPA documentation; 10 years as a graphic artist; 6 years as a technical writer
Mr. Greg Sorensen	Technical Writer/Editor	B.A., International Affairs. Responsible for technical review of document.	27 years
Mr. Rusty Schmidt	Landscape Ecologist	B.S., Biology; M.S., Landscape Architecture (pending). Responsible for writing wildlife, vegetation, and rare species sections.	4 years in NEPA documentation; 8 years in data collection and resource management
Dr. Robert Mutaw	Cultural Resources Specialist	Ph.D., Anthropology. Responsible for cultural resources analysis and technical review.	More than 23 years in cultural resources analysis, including various NEPA projects
Ms. Beth Kunkel	Natural Resources/NEPA Manager, Professional Wetland Scientist/Wildlife Biologist	B.S., Wildlife Management. Responsible for leading science team meetings and writing/editing the wildlife, vegetation, and rare species sections.	16 years in environmental planning and NEPA documentation
Ms. Juanita Barboa	Technical Editor	Owner, The Final Word. B.S., Technical Communication. Responsible for technical editing.	17 years
Consultants for Public Review of Draft EIS, Comments and Responses, and Preparation of Final EIS – Mangi Environmental Group, Inc.			
Dr. Philip Sczerzenie	Project Director/ NEPA Specialist	Ph.D., Wildlife Ecology and Management. Responsible for supporting public review of the draft EIS and writing/editing the comments and concerns and responses to comments.	30 years in environmental planning, assessment, and NEPA compliance
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Appendices

APPENDIX A: NON-IMPAIRMENT DETERMINATION FOR THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

NPS *Management Policies* 2006 (section 1.4) require analysis of potential effects to determine whether or not an NPS action would impair a park's resources and values. The preferred alternative identified for managing deer at Indiana Dunes National Lakeshore is Alternative D, Combined Lethal and Nonlethal Actions.

The fundamental purpose of the national park system, established by the Organic Act and reaffirmed by the *General Authorities Act*, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values. However, the laws do give the National Park Service (NPS) the management discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of the park. That discretion is limited by the statutory requirement that the NPS must leave resources and values unimpaired unless a particular law directly and specifically provides otherwise.

Pursuant to NPS *Management Policies 2006*, impairment is an impact that, in the professional judgment of the responsible NPS manager, "would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values." Whether an impact constitutes impairment depends on the particular resources that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts.

An impact on any park resource or value may, but does not necessarily, constitute impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; or
- key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- identified in the park's general management plan or other relevant NPS planning documents as being of significance.

An impact would be less likely to constitute impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and it cannot be further mitigated.

Impairment may result from visitor activities, NPS administrative activities, or activities undertaken by concessioners, contractors, and others operating in the park. Impairment may also result from sources or activities outside the park.

For the preferred alternative, a determination of impairment is made for each of the impact topics carried forward for detailed analysis in the environmental impact statement. Pursuant to *the Interim Guidance for Impairment Determinations in NPS NEPA Documents* (2010), impairment findings are not necessary for visitor experience, health and safety, environmental justice, or park operations because these impact topics are not generally considered to be park resources or values, and are therefore not subject to the written impairment determination requirement found in NPS

Management Policies 2006. A description of the current state of each of the resource topics evaluated for impairment can be found in Chapter 3 of the EIS, "Affected Environment".

The park's purpose and significance were considered during the impairment determination process for the preferred alternative. The park was designated by Congress in order to, "preserve for the educational, inspirational, and recreational use of the public certain portions of the Indiana Dunes and other areas of scenic, scientific, and historic interest and recreational value in the State of Indiana." The purposes of the park include:

- Preserve, maintain, and restore the integrity and character of the natural resources and processes and protect cultural resource values.
- Provide educational, inspirational, and recreational opportunities compatible with preserving natural and cultural resource values.
- Inspire in the public an appreciation of and a sense of personal stewardship for national lakeshore resources.
- Interpret, encourage, and conduct scientific research in the tradition of pioneer investigators.

Statements of a park's significance describe why the park is important within a global, national, regional, and ecosystem-wide context and are directly linked to the purpose of the park. Indiana Dunes National Lakeshore is significant for the following reasons:

- The national lakeshore contains exceptional biological diversity and outstanding floral richness resulting from the combination of complex geological processes and the convergence of several major North American life zones.
- The national lakeshore's cultural resources represent the cultural evolution of northern Indiana from prehistoric times to the present day.
- The national lakeshore's extensive reach of undeveloped dunes provides recreational, educational, and inspirational opportunities within a one-hour drive of a major metropolitan area.
- The national lakeshore offers outstanding opportunities for scientific research because of the diversity and complexity of its natural systems and provides a dynamic laboratory for early plant succession and faunal studies.
- The presence of heavy industry, long-standing transportation corridors, residential use areas, and natural areas at the Indiana Dunes National Lakeshore offers an outstanding opportunity to show visitors how these elements interrelate.
- The dunes provide a striking physical and inspirational relief to the surrounding flat and highly developed landscape

NATURAL RESOURCE TOPICS

Vegetation

Healthy, native terrestrial vegetation is necessary to fulfill the purposes for which the national lakeshore was established and is key to the natural integrity and enjoyment of the national lakeshore. The national lakeshore contains exceptional biological diversity and outstanding floral richness, resulting from the combination of complex geological processes and the convergence of several major North American life zones. The national lakeshore comprises more than 15,000 acres of wetlands, pannes, dunes, forests, prairies, savannas, and open water and supports more than 1,100 species of flowering plants and ferns. Major plant communities include those typical of the Eastern Deciduous Forest, Northern Boreal Forest, Atlantic Coastal Plain, and tall-grass prairies. The national lakeshore offers outstanding opportunities for scientific research because of the diversity and complexity of its natural systems and provides a dynamic laboratory for early plant succession and faunal studies.

The national lakeshore has been monitoring vegetation growth using paired plots since 1997. Although the plots have shown an increase in the density of woody-stemmed plants and an increase in percentage cover, they did not provide enough data to indicate that cover types were changing (increasing or decreasing) more rapidly in these areas versus the control areas. However, "moderate" or greater impact from browsing can cause changes to the species composition of plant communities. For example, sweet cicely (*Osmorhiza* spp.) is the first plant to be affected in plant communities that support this species, as well as white baneberry (*Actaea pachypoda*) and jack-in-the-pulpit (*Arisaema triphyllum*); sweet cicely is also usually among the first to disappear from a site. Results from national lakeshore monitoring data suggest that all three species show signs of deer-browsing impact; given that stem heights for jack-in-the-pulpit have decreased, it can be assumed that deer have browsed preferred forage in some areas of the national lakeshore to the point that they have begun to fall back on secondary preferred species.

Data from 2009 sampling of 26 trillium plots indicated that action should be taken in the Dune Ridge, Dune Wood, Cowles Dunes, Little Calumet, and Heron Rookery management zones. Data on the remaining management zones are insufficient for making a control decision at this time.

The preferred alternative would enhance native vegetation reproduction by quickly reducing deer-browsing pressure and by maintaining a smaller deer population through the use of reproductive control and sharpshooting, resulting in beneficial long-term impact because native vegetation could recover throughout the national lakeshore. In the short term, implementation of the preferred alternative would result in a continued moderate impact on vegetation due to deer continuing to browse. As deer numbers were further reduced over the long term, native plant diversity and abundance would increase, resulting in a reduction of adverse impact to minor levels. Less than 1 percent of the national lakeshore's vegetation would be affected by trampling at shooting, treatment, or disposal sites. Therefore, adverse impact of these actions would be short term and negligible. After approximately 10 years, monitoring is expected to show that the majority of the paired plots would have plant heights reaching or exceeding the minimum heights required for successful plant reproduction. Past, present, and future activities, combined with reduced browsing stress on native vegetation and subsequent increase in plant diversity and abundance, would result in beneficial, long-term cumulative impact. Overall, under the preferred alternative, impacts to vegetation in the national lakeshore would be beneficial, and the vegetation would thrive. Therefore, no impairment of vegetation resources would occur under this alternative.

Soil and Water Quality

Without deer management at the national lakeshore, soils would continue to be affected, primarily by erosion resulting from loss of vegetative ground cover because of deer browsing. At the same time, water quality would continue to be affected, primarily by the associated sedimentation, as well as increases in E. coli levels from higher deer density. Approximately 5 percent of the soils in the national lakeshore have a moderate or severe soil-erosion hazard. Soils in the national lakeshore classified as moderate or severe erosion hazards are found on slopes of up to 40 percent on uplands, small knolls, wooded breaks along major streams, narrow ridges, escarpments, outwash plains, moraines, lake plains, sand dunes, and beach ridges and along drainage ways and streams.

The potential for water contamination is exceptionally high at the national lakeshore because of the proximity of heavy industry, transportation corridors, and agricultural lands. Water quality and quantity are affected by the amount of ground cover in the national lakeshore. As noted, a reduction of ground cover by deer browsing could lower water quality because of increased turbidity from increased surface-water runoff; turbidity is an indirect measure of sediment in surface waters.

Impacts on soil and water quality under the preferred alternative would be beneficial and long term as a result of rapidly reducing the number of deer in the national lakeshore and maintaining a population of 15 deer/mi2 after the third year of implementation. A smaller deer herd would reduce fecal loading into surface waters, resulting in lower E. coli levels and providing a beneficial long-term impact on water quality. The long-term maintenance of a small herd would allow vegetative ground cover to reestablish throughout the national lakeshore and potentially reduce soil erosion, providing beneficial long-term impact on the soils and water quality of the national lakeshore. The use of animal disposal pits presents a potential for minor, long-term, adverse impacts on groundwater quality; however, this impact would be mitigated with proper disposal pit site.

Soil and water quality would improve under the preferred alternative, allowing for continued enjoyment of such resources for future generations. Therefore, there would be no impairment of national lakeshore soils or water resources under the preferred alternative.

White-tailed Deer and Habitat

The deer population density in the national lakeshore has varied and will continue to vary over time, depending on such factors as winter temperatures, snow depth and duration, disease, habitat conditions, deer movements, hunting pressure outside the national lakeshore, acorn production, and availability of other foods (herbaceous vegetation). However, based on national lakeshore observations and trends in other units of the national park system, the deer population is likely increasing. In the absence of any deer management measures, this increase is expected to continue over time, with some fluctuations due to weather and other factors. When deer density is high, signs of nutritional stress (such as low body and internal organ mass, low fecal nitrogen levels, and high prevalence of parasitic infections) typically occur. When deer density is reduced to the nutritional carrying capacity, all these indicators show improvements.

The habitat most affected by heavy deer browsing is the herbaceous and woody vegetation of a forest understory because deer can directly browse vegetation from ground level to an average of 5 feet above the ground. A variety of other wildlife also uses this understory habitat and competes with deer for available resources. These animals include squirrels and mice, which feed on acorns; rabbits and woodchucks, which feed on young woody stems and green vegetation; and box turtles, which are dependent on the vegetation, fruits, and insects of the forest understory.

Implementation of the preferred alternative would have long-term and beneficial effects on deer and deer habitat. The currently observed adverse impact on deer habitat would be reduced to negligible or minor levels over the long term as the deer population decreased. Past, present, and future activities, combined with the reduced pressure on deer habitat expected under this alternative, would result in beneficial, long-term cumulative impact on deer. Under the preferred alternative, the deer population is expected to stabilize, and deer health and habitat quality is expected to increase. Current and future generations would be able to view healthier deer and deer habitat than is currently the case. Therefore, there would be no impairment of the white-tailed deer population or habitat under the preferred alternative.

Other Wildlife and Wildlife Habitat

Vegetation/habitat conditions indicate that deer have already affected the vegetation (reduced abundance and diversity) and, thus, habitat for other wildlife species within the national lakeshore. The ground and shrub layers of the national lakeshore habitat have been heavily browsed by deer, suggesting that the abundance and diversity of other wildlife using this habitat are currently lower than what they would be if deer-browsing pressure were reduced. High deer numbers cause a reduction in ground cover that affects the ability of small mammals, such as moles, squirrels, and ground-nesting or -feeding birds, to conceal themselves from predators, such as hawks, owls, coyotes, foxes, skunks, and raccoons.

With no control on deer population growth, vegetation used as food and cover would become less abundant for other wildlife.

The coyote is the only predator species in the national lakeshore that uses deer as a food source and could benefit from high deer density or open understory conditions. Other animals, such as box turtles, vultures, crows, and chickadees, may also feed on deer carcasses. Small predators, such as foxes, hawks, owls, skunks, and raccoons, may decline as prey, as have mice, rabbits, and ground-nesting birds.

Scientific studies indicate that a number of intermediate-canopy–nesting songbirds are affected by deer browsing; less conclusive is the impact to ground- and upper-canopy–nesting species. Heavy deer browsing also results in lack of cover for small mammals, as well as snakes, frogs, and small ground-nesting or -feeding birds, making the habitat less suitable for small mammals. Species that depend primarily on other habitats (such as wetlands) may also be affected by high deer numbers. Areas of greater herbaceous cover support more amphibians than areas with less cover, though forest structure is an important factor in amphibian abundance only when suitable hydrology is present. Some frogs, snakes, salamanders, and turtles (e.g., bullfrogs, snapping turtles) live close to water during much of their lives and are, therefore, less affected by deer; however, high-quality herbaceous cover would benefit these species. Other aquatic species (e.g., box turtles, hognose snakes, American toads, and gray tree frogs) also depend on vegetation, fruits, and insects found in the ground/shrub habitat, and their habitat is similarly affected by high deer numbers. Heavy deer browsing may not directly affect fish habitat, but increased vegetative cover would enhance aquatic habitats along stream banks. Such animals as box turtles, rabbits, mice, and ground- and intermediate-nesting birds, which require ground and intermediate-canopy vegetation to maintain viable populations, would be adversely affected by high deer densities (greater than 20 deer/mi2) because available food and cover would be greatly reduced by browsing. As browsing impact increased, even more wildlife species would be adversely affected by these changes

Under the preferred alternative, impacts on other wildlife would be long term and beneficial because of rapidly reduced deer numbers in the national lakeshore, resulting in decreased browsing pressure on habitat and allowing increased abundance and diversity of other wildlife that depend on ground/shrub habitat, such as ovenbirds, wood frogs, eastern hognose snakes, and box turtles. Long-term management of the deer population would be implemented through the use of sharpshooting or reproductive control, resulting in continued long-term beneficial impact through maintenance of the population at desired levels. Over time, the current adverse impacts that have been observed to other wildlife and other wildlife habitat would be reduced to negligible or minor levels. Other wildlife would be temporarily affected by trampling at bait stations and shooting sites, application of reproductive control techniques, or disposal of deer carcasses. However, the adverse impact of these isolated actions on other wildlife would be short term and negligible. Overall, the preferred alternative would result in beneficial impacts to other wildlife species and habitat, and both other wildlife and habitat will thrive within the national lakeshore, allowing for continued enjoyment by the current and future generations. Therefore, there would be no impairment of other wildlife species or habitat under the preferred alternative.

Sensitive and Rare Species

Viable populations of sensitive and rare species are necessary to fulfill the purposes for which the national lakeshore was established and are key to its natural integrity. Sensitive and rare species at Indiana Dunes National Lakeshore are those listed by either the USFWS as endangered, threatened, candidate, or of special concern or by the state of Indiana as endangered, threatened, rare, extirpated (no longer present), or on a watch list. The national lakeshore has two federally endangered species, the Karner blue butterfly and the Indiana bat. Three additional species are listed as endangered but are thought to have been extirpated from the national lakeshore (American burying beetle, Hine's emerald dragonfly, and Mitchell's satyr). Two threatened species also occur at the national lakeshore, the bald eagle and the Pitcher's thistle. Indiana Dunes National Lakeshore has one candidate species, the eastern massasauga. The national lakeshore also has critical habitat for one endangered species, the piping plover. Several state-listed species (23 invertebrates, 28 birds, 2 fish, 8 reptiles, 4 amphibians, 4 mammals, and 123 plants) are also included in this analysis.

Under the preferred alternative, federally listed and state-listed plant species would benefit from reduced deer density and browsing pressure. The Karner blue butterfly is locally abundant and is being managed through reintroduction efforts and a habitat restoration program. Wild lupine, the sole food source for Karner blue larvae, is thought to be a palatable species to deer. Deer have been observed eating wild lupine flowers, which could affect lupine reproduction and long-term survival, thereby indirectly affecting the viability of the Karner blue butterfly. Because deer browsing would occur at greatly reduced levels under the preferred alternative, vegetation recovery would occur more rapidly. Current and future generations would be able to experience the Karner blue butterfly and other sensitive and rare species in greater numbers than now exist. Therefore, no impairment of listed plant or wildlife species in the national lakeshore would occur under the preferred alternative.

CULTURAL RESOURCE TOPICS

Archeological Resources

Archeological resources are necessary to fulfill the purposes for which the national lakeshore was established and are key to its cultural integrity. Because of the extensive development and industrialization outside its boundaries, the area of the Indiana Dunes National Lakeshore likely provides the best remaining record of early use and occupancy. Approximately 240 prehistoric archeological sites—containing projectile points, pottery fragments, scrapers, fire-cracked rock, and other materials—have been identified to date during annual investigations associated with construction or demolition activities. Prehistoric occupations within the national lakeshore are currently interpreted as seasonal campsites focusing on the variety of resources available in the dune and wetland ecosystems.

Reduction of deer populations from sharpshooting and the use of reproductive controls would have no direct impact on archeological resources. Bait stations would not be set on known archeological resources. Installation of small-area fences or up to one large exclosure every other year could result in adverse impact, which would be offset by monitoring. Cumulative impact would be adverse, long term, and negligible because of ongoing ground disturbance; however, both the character and integrity of the national lakeshore's archeological resources would remain intact. Because current and future generations would be able to experience the park's archaeological resources in the same manner as they do presently, no impairment of the national lakeshore archeological resources would occur.

Cultural Landscapes

Of the nine identified cultural landscapes in the national lakeshore, only Chellberg Farm has the potential to be affected by deer management activities. (Other cultural landscapes at the national lakeshore, such as the Bailly Homestead, do not include planned landscapes and, therefore, would not be affected by deer management activities.) Chellberg Farm serves an important role in the national lakeshore's interpretive and environmental education programs. The NPS acquired the property in 1972 and manages it as a working farm. The overall property maintains a moderate to high level of integrity.

Under the preferred alternative, herd size would be substantially reduced. Browsing pressure on crops and cultural landscapes would also be reduced, resulting in a beneficial long-term impact. Potential adverse impact would be related to small-area fencing, one large exclosure installed every other year, and disposal pits for deer waste and/or carcasses. Some minimal ground-surface disturbance could occur with the placement of fencing and exclosures and the burial of deer carcasses. However, only five small fenced areas would be installed annually and one large-area exclosure every other year. In addition, the burial sites would be located in already disturbed areas, reducing the likelihood that archeological resources would be disturbed. Monitoring sensitive areas would aid in mitigating potential adverse effects. Cumulative impacts would be primarily beneficial, long term, and moderate. Because there is only potential for minimal disturbance, current and future generations would be able to experience the park's cultural landscape in the same manner as they do today. Therefore, no impairment of cultural landscapes would occur.

OTHER RESOURCE TOPICS

Soundscapes

Because of the national lakeshore's proximity to human-altered environments, visitors encounter both natural and disturbed conditions (NPS 1993a). Natural sounds at the national lakeshore include bird calls, wind, and the sound of trickling streams and waves breaking along the shore. Animal movements and insect sounds can also be heard along the trails. The sands of the dunes create an unusual musical sound when visitors walk on them due to a combination of quartz crystals, moisture, pressure, and friction (NPS n.d.j).

Since the creation of the national lakeshore, development has increased to the point that most of its boundary now consists of homes, farms, roads, or businesses. The national lakeshore experiences a great deal of noise from sources outside its boundaries. The extreme west end of the national lakeshore borders a large steel-making facility that has been operating since 1906 and continues to operate today (as do all the steel mills in the area). The large industrial complex that bisects the two units includes two steel companies, a Northern Indiana Public Services Company (NIPSCO) coal burning power plant, and the Port of Indiana (NPS 1997d). Several smaller businesses associated with the steel-making industry are located near the steel mills. Another public service facility exists just east of Mount Baldy, the national lakeshore's only active dune (NPS 2003d). Additional sound sources include railways, highways and motorboat use outside of park boundaries.

Noise related to construction of fencing and exclosures, use of repellents, and ensuing monitoring would continue as the national lakeshore implements such measures to protect small areas of sensitive species. Noise impact related to this component of the preferred alternative would not be very noticeable; it would be short term, adverse, and negligible. Long-term impact would continue as more fencing, exclosures, and spraying are required; however, the need for such actions is expected to decrease because implementation of the preferred alternative also includes elements to control the size of the overall deer herd.

The greatest impact to soundscapes as a result of the preferred alternative would be from the use of firearms; the intensity of the impact would vary based on several factors, including proximity to the firearm, use of noise-suppression devices, perceived annoyance level, and attitude toward sharpshooting. The need for further sharpshooting efforts would likely decrease over the long term if the effects of this action and the possible use of reproductive controls result in a decrease in the size of the deer herd. Therefore, the overall effect of implementation of all components of this alternative would be short term, adverse, and minor to moderate, with expected decreases in intensity over the long term.

The adverse impact expected under the preferred alternative would combine with hunting outside park boundaries (particularly with firearms) for a specified time period (usually fall and winter) by landowners surrounding the national lakeshore during deer reduction efforts.

The overall impact on soundscapes from the preferred alternative would be short term, adverse, and minor to moderate, largely resulting from the use of firearms. The perception of impact intensity would vary based on several factors, particularly individuals' reactions, including proximity, to firearms. However, the long-term impact would be expected to decrease as the overall herd population decreases, reducing the need for direct reduction. Given the planned continuance of hunting on neighboring lands and the urban, industrialized nature of the national lakeshore's surroundings, the cumulative impact would be adverse, short and long term, and moderate.

While noise generated from highways, trains, boats, planes, and nearby industry has had an impact and would continue to have an impact on the national lakeshore's natural soundscape in both the short and long term, the impacts directly related to implementation of the preferred alternative would be noticeable only while firearms are used. Current and future generations of visitors would still be able to experience a natural setting and listen to the natural sounds originating inside the park, including bird calls, wind, and the sound of trickling streams and waves breaking along the shore. Animal movements and insect sounds could also be heard along the trails. Current and future generations would continue to enjoy the park in the same manner they do today, in line with the expected experience in an urban park. Therefore, no impairment of the national lakeshore's soundscapes would occur under this alternative.

CONCLUSION

In the best professional judgment of the NPS decision-maker, based upon the impact analysis the EIS, relevant scientific and scholarly studies, advise or insights offered by subject matter experts and other who have relevant knowledge or experience, and the results of civic engagement and public involvement activities, no impairment of park resources or values would result from implementation of the preferred alternative.

APPENDIX B: INDICATOR SPECIES DESCRIPTIONS

Sweet Cicely, White Baneberry, and Jack-in-the-Pulpit

Existing Literature

Webster and Parker (2000) studied sweet cicely, white baneberry, and jack-in-the-pulpit as potential indicators of the overabundance of white-tailed deer. Webster et al. (2001) noted that "while flowering status of jack in the pulpit and white baneberry were strongly related to plant height, sweet cicely flowering status showed no relationship to height. Examining the heights of these three species may provide an efficient and accurate method of evaluating the impacts of deer abundance on forest plant communities." Based on data collected in several hunted and unhunted parks in northern Indiana, including Indiana Dunes State Park, a stem height was established for each of the three species to indicate the extent of deer-browse impact. The stem heights were defined as 42 centimeters for sweet cicely, 25 centimeters for white baneberry, and 37 centimeters for jack-in-the-pulpit. If the average plant height sampled in an area is taller than these heights, the deer-browse pressure is assessed as light and not adversely affecting the plants. However, if the average height of any of these species is shorter than the specified heights, deer-browse pressure is assessed as moderate to severe and is likely having an adverse impact on the species.

Current Monitoring

The national lakeshore collected monitoring data from three 20-meter-square exclosures during 1997 and 2000, including stem heights for these three species (NPS n.d.f). A clear difference in stem heights was shown for species inside the exclosures compared to those outside the exclosures, and these heights correlate with the Webster and Parker (2000) findings described above.

Threshold for Action

The threshold for action for these species is the mean basal stem height established for the state park (Webster et al. 2001). If the mean height in at least 50 percent of the transects for any of these three species in a zone is below the indicator height of 42 centimeters for sweet cicely, 25 centimeters for white baneberry, or 37 centimeters for jack-in-the-pulpit, the action threshold would be triggered.

Trillium

Existing Literature

Several studies (Augustine and Frelich 1998; Anderson 1994) monitored deer damage to trillium. Anderson (1994) indicated that deer population density should be managed so that a minimum stem height for trillium of 13 centimeters is maintained for the Lake County area in Illinois. This stem height occurred when deer density was at or below 10 to 16 deer/mi^2 for deciduous forests in northeastern Illinois. Augustine and Frelich (1998) stated that deer focus their grazing on large, reproductive trillium plants and that trillium population structure was skewed toward small plants. At densities greater than 10 to 20 deer/mi^2, deer consistently caused more than 50-percent reduction in trillium reproduction during the growing season. This research also indicated that individual plants need protection from deer for at least two growing seasons to show a dramatic increase in flowering rates and leaf area. However, in the first year or two after a trillium population is protected by an exclosure, it may exhibit shorter flowering height in direct response to elimination of browsing as the colony puts more energy into flower production than plant growth (R. Anderson, Illinois State University, pers. comm. 2004).

The size of the exclosures and plots used varied with each study examined. The sizes of the exclosures ranged from 52 x 22 meters to 10 x 10 meters, with 1-x-1-meter plots being measured. One study used transects of 50 meters long by 2 meters wide in areas with differing deer densities. The size of the exclosures and the number of plots were ultimately determined by density of the trillium populations studied.

Note that not all deer browse on trillium is negative. For example, Vellend et al. (2003) noted, "viable seeds of Trillium grandiflorum, an ant-dispersed forest herb in eastern North America, are dispersed via ingestion and defecation by white-tailed deer." Therefore, exclusion of deer from forest ecosystems is not the end goal; rather, the goal is to restore a balance that allows trillium to successfully reproduce.

Current Monitoring

Trillium is monitored in 15 of 17 existing small exclosures at the national lakeshore. Each paired exclosure and control plot is located in patchy trillium populations, with the exclosure plots selected randomly. The paired plots are identical 1-meter squares within 2.25-square-meter exclosures surrounding the exclosure plots. The existing paired plots are being measured for growth indices (height), flower production, and landscape features. Examples of landscape features include canopy cover, browse lines, and percentage cover for landscape.

The paired plots being monitored in the national lakeshore are in the East Unit and Heron Rookery. Four species of trillium are being observed, including *Trillium cernuum*, *T. grandiflorum*, *T. flexipies*, and *T. recurvatum*. *Trillium recurvatum* is the most common of the four, though none of the species is common in the national lakeshore. *Trillium cernuum* is state listed as endangered.

The national lakeshore plans to expand the number of plots (adding 50 new paired plots) as part of all alternatives (as described in alternative A) for monitoring trillium and other indicator species.

Because the trillium species found in the national lakeshore are not widely distributed or very abundant, they have been identified as an indicator for rare species' reaction to browse pressure. If trillium species are being affected by browsing deer, it is assumed that other rare, palatable species are also affected.

Threshold for Action

Initially, if the mean plant height for any trillium species monitored is below the height indicator set by Anderson (1994) for *Trillium grandiflorum* (13 centimeters), the action threshold would be triggered. A minimum of two years of data collection may be necessary to calibrate the proper height indicator for each trillium species and to refine the action threshold to be species-specific. A mean plant height would be determined for each trillium species after two years of monitoring data.

Indicator Species Monitoring for 2009

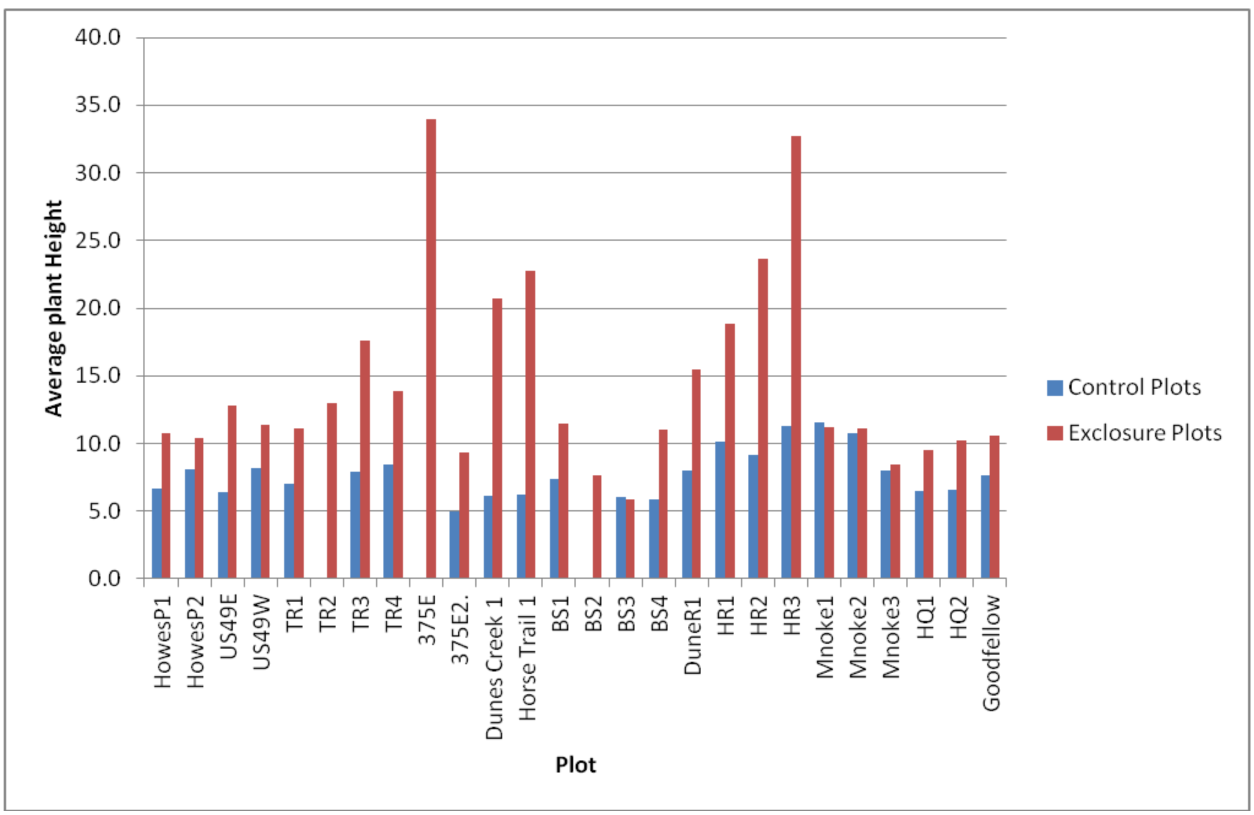
Following the recommendations of the science team, multiple sampling plots are being used to monitor for deer impacts on indicator plant species in each management zone. The plots are paired 1-meter squares with a control plot (open to deer) and a fenced plot (protected from deer). The protected plot (deer exclosure) has fencing with large enough gaps to allow the entry of other animals, such as rabbits and woodchucks, but to exclude deer. Monitoring data have been collected and analyzed for the 26 trillium monitoring plots that have been installed to date. Additional plots will be installed to provide monitoring data for all deer management zones. Indicator species for other management zones are being studied but have not been established. To ensure that the quality of the monitoring program is maintained and that monitoring data are kept up to date, the NPS will work with USGS scientists. These ongoing analyses will ensure that the current protocols continue to provide an accurate representation of deer impacts on the landscape.

Data from 2009 sampling of the 26 trillium plots indicated an unacceptable level of impact in the Dune Wood management zone. The average trillium height for all eight control plots was shorter than the recommended action threshold of 13 centimeters, and the average height for six of the eight exclosure plots was taller than the action threshold.

The control plots in the Heron Rookery management zone showed similar unacceptable levels of impact. Stem heights in the control plots in the Cowles Dunes, Dune Ridge and Little Calumet management zones were all shorter than the recommended height, indicating an unacceptable level of impact from deer. However, the exclosure plots for these zones have not shown the same recovery after fencing as the Dune Wood plots. The plants in the exclosures may be utilizing additional energy gained from decreased browse pressure to produce more flowers rather than a taller stem. Although it is not one of the indicators recommended by the science team, the flowering of plants in the Dune Ridge management zone was markedly different between unfenced and fenced plots. None of the trillium plants in the control plots was flowering, compared to 41 percent in the exclosure plots.

As shown in Figure B-1, the 2009 vegetation monitoring indicated that action should be taken in the Dune Ridge, Dune Wood, Cowles Dunes, Little Calumet, and Heron Rookery management zones. Data on the remaining management zones are insufficient for making a control decision.

FIGURE B-1: 2009 TRILLIUM PLOT DATA



LUPINE

Existing Literature

Some literature exists to document the effects of deer browsing on lupine. Heavy spring flower browse reduces the number of seedpods for that season's lupine (Straub 1994). Ecologists with the New Hampshire Natural Heritage Inventory Program have observed deer damage on wild lupine, an obligate larval food source for the Karner blue butterfly (Miller et al. 1992). This plant species is important because of its abundance in savanna habitats at the national lakeshore and because the Karner blue butterfly, a federally listed endangered species, depends on lupine. This species should be monitored to provide additional documentation of the effects of deer-browse pressure.

Current Conditions

National lakeshore staff members have observed deer browsing lupine flowers heavily but have not measured the impact through any previous monitoring program.

This herbaceous perennial has erect stems that are 20 to 60 centimeters tall. It produces a large number of flowers in terminal clusters above the leaves. The Karner blue butterfly feeds exclusively on the leaves throughout its larval stage. Adult butterflies use the flower as a nectar source, but they also feed on nectar of other flowering plants in the area. Even though the adult butterfly does not depend solely on lupine flowers, the survival of the plant (and, therefore, the survival of the butterfly) depends on successful flower and seed production and regeneration of the plant (E. McCloskey, USFWS, pers. comm. 2004).

Threshold for Action

Despite the lack of existing literature, the status of the Karner blue butterfly and the importance of lupine to this species are sufficient reasons to use lupine as an indicator of the impact of deer browsing. Plant height would be used as the initial indicator for deer-browse impact on lupine; however, in the future, the quality of the flowering structure may provide more information to determine a refined action threshold. Observations by national lakeshore staff and general life-history information for lupine indicate that a mean plant height of 30 centimeters should be used as the initial threshold level for detecting deer impact.

Initial monitoring would use the new paired plots as described for trillium. After two years or more of monitoring data from these plots, if the mean plant height of 30 centimeters is confirmed as the height for detecting deer impact, then the monitoring method for this species could be switched to transects rather than plots. If not confirmed, the mean plant height would be adjusted or additional monitoring would be required before making any modifications to the monitoring method. See the "Adaptive Management" section in Chapter 2.

CANADA MAYFLOWER, SOLOMON'S SEAL, AND FALSE SOLOMON'S SEAL

Existing Literature

Fletcher et al. (2001) used exclosures to field-test five understory plants in the lily and orchid family for effects of deer browsing. Two plants appeared to be most strongly affected by browsing: Solomon's seal and false Solomon's seal, which are considered preferred browse and are sensitive to heavy browsing. Fletcher's findings suggest that reduction in flowering activity caused by deer browse is common in plants of the lily and orchid families.

Crawford (1982) determined that during late spring, herbaceous plants accounted for nearly three-fourths of the deer diet. Bluebead (*Clintonia borealis*) and Canada mayflower (*Maianthemum canadense*) accounted for more than 50 percent, by weight, of all plants eaten by deer during late spring (Crawford 1982). Canada mayflower, the most preferred herb, supplied 20 percent, by weight, of the total diet (Skinner and Telfer 1974).

Canada mayflower can be found with trillium, Solomon's seal, and false Solomon's seal. Because deer highly prefer Canada mayflower, it should be a good indicator for taking action, especially if monitored in conjunction with Solomon's seal and false Solomon's seal.

Current Conditions

The national lakeshore collected limited data on these species in three existing 20-square-meter exclosures from 1997 to 2000. Solomon's seal and false Solomon's seal were identified and measured within the exclosure, with a paired plot outside the exclosure. Consistent with Fletcher's findings, these data indicated a height difference between plants inside the exclosures and those outside the exclosures.

Threshold for Action

Existing national lakeshore data suggest a height indicator of 16 centimeters should be used for Solomon's seal and 10 centimeters for false Solomon's seal, measuring the basal stem height. A plant height of 8 centimeters would be used as the indicator for determining impact on Canada mayflower; however, in the future, the quality of the flowering structure may provide more information to determine a refined action threshold. These heights were estimated from the data documented from the three large exclosures for herbaceous plants the national lakeshore established in 1997 and monitored until 2000.

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APPENDIX C: CHRONIC WASTING DISEASE

This appendix summarizes guidance provided by the National Park Service (NPS) in response to chronic wasting disease (CWD) and outlines management options available to parks for implementation in the absence of a specific CWD plan.

As of March 2011, CWD has been diagnosed in only two national parks—Rocky Mountain and Wind Cave. However, several national park system units are at high risk because of their proximity to known CWD cases in many areas of the United States. There is a high likelihood that the disease will be detected in other areas of the country following increases in disease surveillance and disease spread. CWD presents population-decline risks to wild cervids, and although there is no evidence to suggest that CWD is transferred to domestic animals or humans, these risks are not completely understood. Therefore, CWD has become an issue of national importance to wildlife managers and other interested members of the public and public entities, as well as NPS managers.

NPS Policy and Guidance

Director's CWD Guidance Memorandum (July 26, 2002)

The NPS director provided guidance to regions and parks on NPS response to CWD in a memorandum dated July 26, 2002. Even though the memo predates current CWD distribution in the national park system, the guidance remains pertinent. The guidance addresses surveillance, management, and communication regarding the disease. It also strictly limits human-assisted translocation of deer and elk into or out of national park system units. Deviation from the guidance memo requires a waiver approved by the director.

A National Park Service Manager's Reference Notebook to Understanding Chronic Wasting Disease (Version 4: July 2007)

This notebook serves as an informational reference that summarizes some of the most pertinent CWD literature, management options, and policies as they pertain to units of the national park system. It is not meant to be an all-inclusive review of current literature or management options. CWD is an emerging disease, and the knowledge base is continuing to expand. This document will be updated as necessary to include information pertinent to the NPS.

Elk and Deer Meat from Areas Affected by Chronic Wasting Disease: A Guide to Donation for Human Consumption (May 2006)

This document provides an overview of the issues surrounding CWD as it relates to public health and includes NPS recommendations for the use of cervid meat for human consumption from parks affected by CWD surveillance and management actions within or near areas where CWD has been identified or where CWD testing is being conducted.

Description and Distribution

CWD is a slowly progressive, infectious, self-propagating neurological disease of captive and free-ranging mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), Rocky Mountain elk (*Cervus elaphus nelsoni*), and moose (*Alces alces*). The disease belongs to the transmissible spongiform encephalopathy (TSE) group of diseases (similar to scrapie and bovine spongiform encephalopathy). CWD is the only TSE currently found in free-ranging animals. TSEs are characterized by accumulations of abnormal prion (proteinaceous infectious particle) proteins in neural and lymphoid tissues (Prusiner 1982, 1991, 1997).

There is evidence that human-associated movement of cervids has aided in the spread of the disease in captive and, likely in free-ranging, deer and elk (Miller and Williams 2003; Salman 2003; Williams and Miller 2003). Localized artificial concentration of cervids in areas with few natural predators likely aids in disease transmission (Spraker et al. 1997; Samuel et al. 2003; Farnsworth et al. 2005; Wild et al. 2011). There is strong evidence to suggest that anthropogenic factors, such as land use, influence CWD prevalence (Farnsworth et al. 2005). Therefore, human influences are likely a significant component of observed CWD distribution and prevalence. CWD is considered a non-native disease process (Wild et al. 2011).

As of March 2011, CWD had been found in captive/farmed cervids in 12 states and 2 Canadian provinces and in free-ranging cervids in 15 states and 2 provinces. The historic area of CWD infection encompasses northeastern Colorado, southeastern Wyoming, and the southwest corner of the Nebraska panhandle (Williams and Miller 2002; Williams et al. 2002b). However, with increased surveillance that has occurred since 2001, the disease has been found with increasing frequency in other geographically distinct areas (Joly et al. 2003).

Clinical Signs

The primary clinical signs of CWD in deer and elk are changes in behavior and body condition (Williams et al. 2002b). Signs of the disease are progressive. Initially, only someone who is quite familiar with a particular animal or group of animals would notice a change in behavior. As the clinical disease progresses over the course of weeks to months, animals demonstrate increasingly abnormal behavior and additional clinical signs (Williams and Young 1992). Affected animals can lose their fear of humans, show repetitive movements, and/or appear depressed but quickly become alert if startled. Affected animals rapidly lose body condition, despite having an appetite (Williams et al. 2002b). In the end stages of the disease, they become emaciated. Once an animal demonstrates clinical signs, the disease is invariably fatal. There is no treatment or preventive vaccine for the disease.

Diagnosis and Testing

CWD was initially diagnosed in deer and elk by testing a portion of the brain (histopathology techniques) (Williams and Young 1993). Although this method is effective at diagnosing relatively advanced cases, it is not sensitive enough to detect early disease stages (Spraker et al. 1997; Peters et al. 2000).

In contrast, immunohistochemistry (IHC) is a sensitive, specific, and reliable test that can be used to identify relatively early stages of CWD. This technique can detect CWD prions in many tissues (brain, retropharyngeal lymph nodes, and tonsils) (O'Rourke et al. 1998).

In addition to immunohistochemistry, which takes several days to complete, new rapid tests also employ antibody technology to diagnose CWD. Each has various advantages and disadvantages. Only certified laboratories can perform immunohistochemistry or the rapid CWD tests.

No test available is 100 percent sensitive for CWD, which means that a negative test result is not a guarantee of a disease-free animal.

Transmission

There is strong evidence that CWD is infectious and is spread by direct (animal to animal) or indirect (environment to animal) lateral transmission (Miller et al. 2000; Miller and Williams 2003). Bodily secretions, such as feces, urine, and saliva, have all been suggested as possible means of transmitting the disease between animals and disseminating infectious prions into the environment (Miller et al. 2000; Williams et al. 2002b; Williams and Miller 2003). Maternal transmission cannot be ruled out, but it does not play a large role in continuing the disease cycle in either deer or elk (Miller et al. 1998; Miller et al. 2000; Miller and Williams 2003; Miller and Wild 2004).

As with other contagious diseases, CWD transmission increases when animals are highly concentrated. High animal densities and environmental contamination are important factors in transmission among captive cervids. These factors may also play a role in transmission in free-ranging animals (Miller et al. 2004).

Management actions that increase mortality rates in diseased populations can retard disease transmission by:

- Reducing the average lifetime of infected individuals. Reduced lifespan, in turn, can compress the period of time when animals are infectious, thereby reducing the number of infections produced per infected individual.
- Reducing population density. The effect of reduced intervals of infectivity is amplified by reductions in population density because there are potentially fewer infectious contacts made.

Both of these mechanisms may retard the transmission of disease. If these mechanisms cause the number of new infections produced per infected individual to fall below one, then the disease will be eliminated from the population (Tompkins et al. 2001). The likelihood of this occurring is unknown at this time.

Disposal of CWD-Infected Organic Material

Discarding known or suspected CWD-contaminated organic material, such as whole or partial carcasses, will probably become an important issue for national park system units in the future. Each state, EPA region, and refuse disposal area is likely to have different regulations and restrictions for disposal of potentially infected tissues. Currently, there is no national standard for disposal. Because infected carcasses serve as a source of environmental contamination (Miller et al. 2004), it is recommended that known and suspected CWD-positive animals be removed from the environment.

Given the type of infectious agent in CWD (prions), there are limited means of effective disposal. In most cases, however, off-site disposal of infected material is recommended in approved locations. The available options for each park will vary and will depend on the facilities present within a reasonable distance from the park. Disposal of animals that are confirmed to be infected should use one of the following methods:

Alkaline Digestion — Alkaline digestion is a common disposal method used by veterinary diagnostic laboratories. This method uses sodium hydroxide or potassium hydroxide to catalyze the hydrolysis of biological material (protein, nucleic acids, carbohydrates, lipids, and so on) into an aqueous solution consisting of small peptides, amino acids, sugars, and soaps. During this process, the prion proteins are destroyed.

Incineration — Incineration is another disposal method commonly used by veterinary diagnostic laboratories. This method burns the carcass at intense temperatures (600 to 1000 degrees centigrade).

Landfill — The availability of this option varies by region, state, and locality. Local landfills must be contacted for more information regarding carcass disposal to determine if they can and will accept CWD-positive carcasses or carcass parts.

MANAGEMENT

CWD has occurred in a limited geographic area of northeastern Colorado and southeastern Wyoming for more than 30 years. Relatively recently, it has been detected in captive and free-ranging deer and elk in several new locations, including Nebraska; South Dakota; New Mexico; Utah; new areas of Wyoming and Colorado; east of the Mississippi River in Wisconsin, Illinois, West Virginia, New York, and Michigan; and most recently in North Dakota, Minnesota, Virginia, and Maryland.

The NPS does not have a single overarching plan to manage CWD in all parks. However, it has provided guidance to parks for monitoring and minimizing the potential spread of the disease, as well as removing infected animals from specific areas. Generally, two levels of action have been identified, based on risk of transmission: (1) when CWD is not known to occur within a 60-mile radius from the park, and (2) when the disease is known to occur within the park or within a 60-mile radius.

The chance of finding CWD in a park is related to two factors: (1) the risk of exposure to the disease (the likelihood that the disease will be introduced into a given population), and (2) the risk of amplification of the disease once a population of animals has been exposed. The first risk is important for national park system units where no CWD cases have been identified within 60 miles of their borders. The second risk applies to units where CWD is close to or within their borders, as well as in proactive planning efforts. By evaluating the risk of CWD exposure and amplification, managers can make better decisions regarding how to use their resources to identify the disease.

Actions available to identify CWD are linked to the risk factors present in and around the park. When risk factors are moderate, surveillance for CWD can be less intense (e.g., opportunistic) than when risk is high (NPS 2007). When the risk is higher, surveillance of all types should be increased. Other management actions that are in place for the host species may limit risk of exposure or transmission by maintaining biologically appropriate population densities. Whether CWD is within 60 miles of a unit or not, coordination with state wildlife and agriculture agencies when conducting CWD surveillance is strongly encouraged.

Opportunistic Surveillance

Opportunistic surveillance involves taking diagnostic samples for testing from deer found dead or harvested through a management activity within a unit of the national park system. Cause of death may be culling, predation, disease, trauma (caused by a collision with a car), or undetermined. Opportunistic surveillance has little if any negative impact on current populations. Unless deer are culled, for either population management or research goals, relatively small sample sizes may be available for opportunistic testing. Animals killed in collisions with vehicles may constitute a biased sample that could help detect CWD. Research has indicated that CWD-infected mule deer may be more likely to be hit by vehicles than non-CWD–infected deer (Krumm et al. 2005).

Opportunistic surveillance is an excellent way to begin monitoring for the presence of CWD without changing management of the deer population. This is a good option for park units where CWD is a moderate risk but where it has not yet been encountered within 60 miles of the park. Opportunistic surveillance should also be used in parks in close proximity to the disease.

Targeted Surveillance

Targeted surveillance entails lethal removal of deer that exhibit clinical signs consistent with CWD. Targeted surveillance has negligible negative effects on the entire population, removes a potential source of CWD infection, and is an efficient means of detecting new centers of infection (Miller et al. 2000). One limitation to targeted surveillance is that environmental contamination and direct transmission may occur before removal. Targeted surveillance is moderately labor intensive and requires educating park staff in recognition of clinical signs, as well as vigilance in continued observation and identification of potential CWD-suspect animals. Training is available through the NPS Biological Research Management Division. Targeted surveillance is recommended in areas with moderate to high CWD risk (within 60 miles of known CWD occurrence) or in park units where CWD has already been identified.

Population Reduction

Population reduction involves randomly culling animals within a population in an attempt to reduce animal density and, thus, decrease transmission rates. In captive situations, where animal density is high, the prevalence of CWD can be substantially elevated compared to that seen in free-ranging situations. Thus, it is hypothesized that increased animal density and increased animal-to-animal contact, as well as increased environmental contamination, enhance the spread of CWD. Decreasing animal densities may decrease the transmission and incidence of the disease. However, migration patterns and social behaviors may make this an ineffective management strategy if, instead of dispersing across the landscape, deer and elk stay in high-density herds in small home ranges throughout much of the year (Williams et al. 2002b). Population reduction is an aggressive and invasive approach to mitigating the CWD threat. It has immediate and potentially long-term effects on local and regional populations of deer and the associated ecosystem. This may be an appropriate response if animals are above population objectives and/or the need to know CWD prevalence with a high degree of accuracy is vital.

Coordination

Regardless of which surveillance method is used, each park should cooperate with state wildlife and agriculture agencies in monitoring CWD in park units, working within the park's management policies. CWD is not contained by political boundaries; thus, coordination with other management agencies is important.

Additionally, as stated above, the NPS Biological Resource Management Division provides assistance to parks for staff training (e.g., sample collection, recognition of clinical signs of CWD) and testing (e.g., identifying qualified/approved labs or processing samples).

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APPENDIX D: MONITORING PROTOCOLS

DEER MONITORING METHODS

National lakeshore staff would continue to use the distance sampling method to estimate the annual deer population density in the national lakeshore (NPS 2004b). Distance sampling, a reliable analytical method for estimating population densities (Buckland et al. 2001; Thompson et al. 1998), is conducted by an observer traveling along a transect and recording the distance to all detected objects of interest. The method allows for a proportion of objects within a certain distance of the line to be missed. Unbiased estimates of density can be obtained from the distance data if three assumptions are met: (1) objects on the line or point are detected with certainty; (2) objects are detected at their initial location; and (3) distance measurements are exact (Buckland et al. 2001; Thompson et al. 1998; Underwood et al. 1998).

Typically, surveys would be conducted at night, when deer are most active, and in the fall and winter, excluding the breeding season, when leaf drop allows easy viewing and deer behavior is not radically influenced by the breeding season. Surveys at the national lakeshore have been conducted since 1991.

Distance sampling surveys would be conducted for five nights over a two-week period, except when ambient conditions or personal safety (e.g., heavy traffic) required postponement. Additional surveys would be added if needed to create reliable estimates with the number of deer groups encountered.

Spotlighting equipment would be assembled and checked at least two weeks before the first survey. Laser rangefinders would also be checked for operability and battery life.

Ambient conditions would be near the seasonal average in temperature. Heavy rain or unusual weather events (such as an approaching front or high winds), as reported from the nearest official National Oceanographic and Atmospheric Administration weather data site, would cause the survey to be postponed. Visibility would be greater than the distance needed during the survey. Temperature and weather conditions would be recorded before starting the survey. Surveys would be postponed if ambient conditions would exceed minimum standards during the survey.

Surveys would begin no earlier than 30 minutes after sunset. A minimum three-person crew, consisting of a driver (data recorder) and two observers, would be required to execute each survey. Survey routes would be driven at speeds ranging from 6 to 10 miles per hour (mph). Initial starting points along the route would vary, where possible, to reduce temporal bias, and routes would be reversed from one night to the next as an option. Observers would use handheld spotlights to illuminate the survey area on both sides of the transect; each observer would focus attention on one side of the transect. On detecting a deer, the observer would direct the driver to position the vehicle such that the perpendicular distance (90° angle to the transect) could be measured. Because the transect can be curved, more than one perpendicular distance might be available; the shortest perpendicular distance should be measured (Hiby and Krishna 2001). In cases where measuring a perpendicular distance is not possible, a radial distance, using a handheld compass to obtain the bearing of the transect and the white-tailed deer location, could be measured. The radial distance would then be multiplied by the sine of the angle (the difference of the bearing measurements) to obtain the perpendicular distance. In all instances, the distance measured should be to the initial location of the deer before any movement. The distance would be measured using a laser rangefinder and should be measured to an individual deer or, in the case of a group of deer, to the deer closest to the center of a group. To detect deer directly on the transect, the driver would be required to observe groups of deer on the transect line and record the distance of the deer or group, if any, from the transect line.

Deer would be categorized by group size (e.g., an individual deer would be a group of one, and five deer would be a group of five). Deer would be partitioned into groups by using behavioral cues and the nearest neighbor criterion (LaGory 1986). For instance, deer that repeatedly looked back at other deer could be counted as part of a group. Additionally, if an individual deer were less than half the distance from the closest deer than from its next nearest neighbor, then that individual deer would be counted as part of a group. When large groups of deer were seen in open fields, group classification would be attempted before positioning the vehicle for a distance measurement so as to minimize a flight response. In cases where the deer flee, the observer would note the initial location of the group and obtain a distance measurement to the location of first detection.

Data would be recorded on a standard deer distance datasheet with an electronic data logger. Demographic classification would be collected only when bucks, does, and fawns could be clearly identified; "unknown" would be the demographic classification default.

Data would be analyzed using the distance model (Thomas et al. 2003; Underwood et al. 1998). This model provides estimates of population density (deer/mi^2) with well-defined confidence intervals. Minimum data required would include the survey dates, national lakeshore area, transect length, number in group, and distance.

INDICATOR SPECIES MONITORING METHODS

If the deer population is to be managed based on the success of herbaceous vegetation regeneration, then indicator species of herbaceous regeneration must be monitored to determine at what point browse impacts warrant the national lakeshore to implement the selected deer management alternative.

Two monitoring methods (transects and paired plots) would be used to document changes in plant response to deer browse and deer management actions. Transects would be used for sampling sweet cicely, white baneberry, and jack-in-the-pulpit groups and the *Rubus* group. The other species would be initially monitored with paired plots. After the first couple of years of data are completed, the monitoring method used for these other species could switch to transects to save time and labor in monitoring (see the "Adaptive Management" section in Chapter 2).

A *transect* is a randomly placed line along which individual plants of a species or species group are sampled. The transect would be randomly placed in the deer management zone that supports the species to be sampled. The transects should be 50 meters long with a minimum of 10 individuals of one of the three species present, because of the low abundance of individual plants within many of the units. Because the transects would be 50 meters long, the national lakeshore would establish up to 30 transects to be monitored annually (6 in each east management zone and 6 in Hobart Prairie Grove). Once a transect is located in the field, it would be staked for annual measurement. If more than 10 individuals of an indicator species are present along the transect, the mature individuals would be sampled.

A *plot* is used to monitor vegetation and consists of an area (either open or fenced) of a defined size and shape, typically a square or circle. The plot location does not change from year to year and would be marked in the field for repeated use. The plot size is typically larger than the area to be monitored. Monitoring would be conducted randomly within the plot, and monitored areas may also be marked for repeated measurements from year to year, depending on data needs.

A *paired plot* typically consists of two plots, one in an exclosure and one in a nearby open area unprotected from deer. The open area is a control, or a standard of comparison, for checking or verifying the results of vegetative growth within the exclosed area. Paired plots would be located within contiguous species populations and randomly placed within the population. Each individual plot in a pair would be separated from the other so as not to influence browsing in the open plot; a minimum of 10 feet of separation is planned. The national lakeshore previously established 15 paired plots for trillium that consist of 1-square-meter monitoring areas within 2.25-square-meter plots.

The existing 15 paired plots would continue to be monitored, and 50 more paired plots would be added to obtain a minimum of 65 paired plots. The plots would be distributed throughout the national lakeshore to cover all 11 deer management zones.

Within the paired plots, the mean plant height for each target species, as well as quality of the flowering structure for some species, would be used to determine impacts, as described in appendix B. Modification of the monitoring protocol would be based on monitoring results and close examination of the effects on action thresholds. See the “Adaptive Management” section in Chpater 2 for further description of the potential modification process.

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APPENDIX E: NPS SPECIES ABUNDANCE DEFINITIONS

Term	NPS Species Abundance Definitions
Abundant	**Animals:** May be seen daily in suitable habitat and season and counted in relatively large numbers. **Plants:** Large number of individuals; wide ecological amplitude or occurring in habitats covering a large portion of the national lakeshore.
Common	**Animals:** May be seen daily in suitable habitat and season but not in large numbers. **Plants:** Large numbers of individuals predictably occurring in commonly encountered habitats but not those covering a large portion of the national lakeshore.
Uncommon	**Animals:** Likely to be seen monthly in appropriate season/habitat. May be locally common. **Plants:** Few to moderate numbers of individuals; occurring either sporadically in commonly encountered habitats or in uncommon habitats.
Rare	**Animals:** Present but usually seen only a few times each year. **Plants:** Few individuals, usually restricted to small areas of rare habitat.
Occasional	**Animals:** Occur in the national lakeshore at least once every few years but not necessarily every year. **Plants:** Not applicable.
Unknown	Abundance unknown.
NA	Not applicable: Abundance does not apply to the scientific name in the national lakeshore. All names on a national lakeshore's list that do not have a lakeshore status of Present should have a residency of NA.

Source: NPS 2003h.

 Appendix E: NPS Species Abundance Definitions

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APPENDIX F: REVIEW OF WHITE-TAILED DEER FERTILITY CONTROL

INTRODUCTION

Managing the overabundance of certain wildlife species has become a topic of public concern (Rutberg et al. 2004). Such species as Canada geese (*Branta canadensis*), coyotes (*Canis latrans*), and white-tailed deer (*Odocoileus virginianus*) have become either locally or regionally overabundant in many areas of the United States (Fagerstone et al. 2002). Traditional wildlife management techniques, such as hunting and trapping, are unfeasible, publicly unacceptable, or illegal in many parks and urban and suburban areas, forcing wildlife managers to seek alternative management methods (Kilpatrick and Walter 1997; Muller, Warren, and Evans 1997). The use of reproductive control as a wildlife management tool has been studied for several decades.

For reproductive control agents to effectively reduce population size, treatment with an agent must decrease the reproductive rate to less than the mortality rate in a closed population with no immigration or emigration. In an open population, where there is much animal movement into and out of an area being considered for treatment, the use of fertility control agents is not likely to be successful in decreasing a population (Rudolph, Porter, and Underwood 2000). Good estimates of population emigration, immigration, and birth and survival rates are needed before predictive models can be used to approximate the effort required to successfully use contraception as a population management technique.

The purpose of this document is to provide NPS managers with: (1) a brief overview of contemporary reproductive control options as they pertain to white-tailed deer; (2) an outline of the primary advantages, disadvantages, and challenges related to the application of wildlife fertility control agents, including population management challenges, regulatory issues, potential logistical issues, and consumption issues; and (3) an evaluation of current fertility control agents against criteria established by the national lakeshore for use of a reproductive control agent. This document is not intended to be exhaustive but to provide a scientifically sound basis for understanding and evaluating deer management alternatives that include reproductive control of female deer.

It is important to note that some of the most critical elements of a successful population-level fertility control program focus on ecological and logistical questions rather than the efficacy of fertility control agents in individual animals. It should also be noted that technology and regulation are changing rapidly in this field, and updated information should be reviewed prior to implementation of a deer management program that involves fertility control.

Researchers generally agree that the logistical difficulties of treating significant numbers of deer make controlling large, open, free-ranging populations of wild ungulates solely with a contraceptive vaccine impractical and unlikely to succeed (Rutberg et al. 2004; Garrott et al. 1992; Garrott 1995; Warren et al. 2000; Rudolph, Porter, and Underwood 2000; Cowan, Pech, and Curtis 2002; Merrill, Cooch, and Curtis 2003 and 2006). There is also agreement that fertility control as an exclusive means of population management cannot reduce wildlife population size rapidly (Rutberg and Naugle 2008a; Kirkpatrick and Turner 2008). The few long-term research projects (those lasting longer than 10 years) evaluating population-level effects of PZP on long-lived species (horses and deer) support this statement. At Assateague Island National Seashore, PZP treatments were successful in reducing the wild horse population by 16 percent (from 160 to 135 individuals) between 1994 and 2009 (15 years). The park expects to reach the target population size of 135 horses in another eight to nine years (Zimmerman, Chief of Natural Resources, ASIS, pers. comm. 2009). At Fire Island

National Seashore, park managers report a 33-percent reduction in overall deer population size (from approximately 600 to 400 individuals) between 1994 and 2009 (Bilecki, Natural Resource Manager, FIIS, pers. comm. 2009). In the most intensively treated areas of the park, deer population size decreased up to 55 percent over 15 years (Rutberg and Naugle 2008a). All population-level studies have been conducted in relatively closed populations. The appropriateness of fertility control as a deer management tool is heavily dependent on specific park objectives and the purpose and need for management.

CURRENT TECHNOLOGY

The area of wildlife contraception is constantly evolving as new technologies are developed and tested. For the sake of brevity, this appendix will discuss reproductive control only as it applies to female deer. There is a general understanding in white-tailed deer biology that managing the female component of the population is more important than managing the male component. Based on the polygamous breeding behavior of white-tailed deer, treating males with reproductive control would be ineffective when the goal is population management (Warren 2000; Garrott and Siniff 1992).

Regulation of wildlife fertility control agents can be confusing. If a product is intended for use in a food-producing animal, it must be deemed safe for human consumers. Regardless of its use in food animals, a fertility control agent must be considered safe for use in the target species and not present environmental health hazards to nontarget species. Until 2006, the Food and Drug Administration (FDA) was the agency responsible for regulation of wildlife contraceptives and their potential for drug residues. Since that time, the EPA has assumed responsibility for regulating contraceptives for use in free-ranging wildlife and feral animals (Fagerstone et al. 2010). The EPA, in consultation with the contraceptive manufacturer/sponsor, will determine the safety of the product and marking requirements for free-ranging animals treated with contraceptives. Prior to EPA registration, products can be studied in free-ranging populations to gather safety and efficacy data under an experimental use permit (EUP) obtained by the product's sponsor. Until products are registered by the EPA and marking requirements are made explicit, animals treated with any fertility control product should be permanently marked.

Marking is also needed for long-term monitoring of contraceptive efficacy in individual animals, to determine which deer have been treated during implementation and for efficient retreatment, and to monitor population vital rates. Finally, while NPS units have jurisdiction for wildlife management within their borders, parks are strongly encouraged to cooperate and coordinate with state agencies to manage cross-boundary wildlife resources whenever possible (43 CFR § 24). Therefore, parks should also communicate with appropriate state agencies regarding marking of treated animals in areas where deer may cross park boundaries. The disadvantages of permanent marking are primarily related to the substantial additional labor and costs of the first year's capture and marking of treated animals, sustainability of this effort over the long-term, capture-associated stress to individual deer (compared to remote delivery), and potential social acceptance concerns. Despite these drawbacks, marking is nearly always warranted when considering a fertility control program.

There are three basic categories of reproductive control technology: (1) immunocontraceptives (vaccines), (2) nonimmunological methods (pharmaceuticals), and (3) physical sterilization.

Immunocontraceptives

Some researchers believe that immunocontraceptive vaccines offer significant promise for future wildlife management (Rutberg et al. 2004). Immunocontraception involves injecting an animal with a vaccine that stimulates its immune system to produce antibodies against a protein (antigen) involved in reproduction (Warren 2000). In order to induce sufficient antibody production, an adjuvant is combined with the antigen. An adjuvant is a product that increases the intensity and duration of the immune system's reaction to the vaccine. There are two primary types of antigens used in reproductive control vaccines in deer: porcine zona pellucida (PZP) and gonadotropin releasing hormone (GnRH).

Neither PZP nor GnRH vaccines are 100 percent effective in preventing pregnancy. Using a two-dose vaccination protocol, Curtis et al. (2002) demonstrated approximately an 85- to 90-percent decrease in the number of fawns born per female after vaccination with either GnRH or PZP immunocontraceptive vaccines in white-tailed deer. Likewise, Rutberg and Naugle (2008a) showed a 75-percent decrease in annual fawn production using PZP vaccination in two relatively closed white-tailed deer populations. With a more contemporary version of the GnRH vaccine, Gionfriddo et al. (2009) found 88 percent efficacy the first year and 47 percent efficacy the second year at preventing pregnancy in white-tailed deer after a single vaccination. The GnRH vaccine has not been evaluated at the population level. Efficacy generally decreases as antibody production wanes. Reduced pregnancy rates can usually be expected for one to two years post-treatment with immunocontraceptive vaccines, although there is the potential for longer-term or even permanent sterility (Fraker et al. 2002; Miller et al. 2008; Miller et al. 2009). Duration of infertility is strongly related to the conjugate-antigen design, the adjuvant used, how the vaccine is delivered, and the host's immune system (Miller et al. 2008; Kirkpatrick et al. 2009).

Porcine Zona Pellucida (PZP)

The majority of immunocontraceptive research in wildlife has been conducted using PZP vaccines. PZP vaccines stimulate production of antibodies directed toward specific outer-surface proteins of domestic pig ova (eggs). Pig ova are sufficiently similar to the ova of many other mammals that antibodies produced will cross-react with the vaccinated animal's own ovum. PZP antibodies prevent fertilization, presumably by blocking the sperm attachment sites on the zona that surrounds the ovum. There are currently two PZP vaccine products being developed; one is simply called PZP and the other, SpayVac®.

SpayVac® (ImmunoVaccine Technologies, Halifax) uses a liposome preparation of PZP mixed with an adjuvant to induce antibody production. This vaccine has been evaluated in a variety of species, including captive and, to a lesser extent, free-ranging white-tailed deer (Brown et al. 1997; Fraker et al. 2002; Locke et al. 2007; Rutberg and Naugle 2009). The other PZP vaccine, often referred to as "native" PZP, does not use liposome technology but does require a potent adjuvant. Native PZP vaccines have been used extensively in captive wildlife species in the course of investigating the product's effectiveness (Rutberg and Naugle 2008a; Kirkpatrick et al. 1997; Turner, Kirkpatrick, and Liu 1996; Walter et al. 2002a and 2002b).

The native PZP vaccine has also been tested at length in free-ranging white-tailed deer (Rutberg and Naugle 2008a; Naugle et al. 2002; Rudolph, Porter, and Underwood 2000; Rutberg et al. 2004; Walter et al. 2002a and 2002b; Walter, Kilpatrick, and Gregonis 2003). Potential benefits of the native vaccine include the ability to deliver the vaccine remotely, its safety in pregnant deer and nontarget species (Barber and Fayrer-Hosken 2000), and the availability of at least some long-term data on population-level effects. The currently available PZP vaccine formulation is effective for two years (Turner et al. 2007; Turner et al. 2008; Rutberg and Naugle 2009), though longer multiyear applications are also being studied. The two-year formulation has received only limited testing in free-ranging white-tailed deer.

SpayVac® offers the same advantages as native PZP but may result in infertility for up to seven years (Miller et al. 2009). Potential advantages of SpayVac® compared to the native PZP vaccine are: (1) a more rapid immune response, (2) higher antibody titers, (3) a higher proportion of antibodies that bind to target sites, and (4) longer duration of efficacy (Fraker and Bechert 2007). Although few long-term data on population-level effects exist for SpayVac®, it is assumed they are similar to those for the native PZP formulation.

Challenges to the use of both PZP vaccines include lack of regulatory approval for use in free-ranging wildlife populations, behavioral impacts (continued estrous cycling), frequency of treatment (need for booster shots), out-of-season fawning, and possible changes in body condition. PZP vaccines are not currently registered for use in free-ranging wildlife but may be in the future (see above for regulatory issues).

PZP-based vaccines often cause out-of-season breeding behavior in treated deer because reproductive hormones that are responsible for estrous cycling are not suppressed (Miller et al. 2009; McShea et al. 1997; Fraker et al. 2002; McShea and Rappole 1997). Repeated estrous cycling has the potential to extend the population breeding season and male/female rutting behaviors. Additionally, extended estrous seasons may result in late pregnancies if the vaccine fails (Fraker et al. 2002; McShea et al. 1997). Fawning later in the summer or fall may lead to higher fawn mortality as winter ensues. Any effect that extends the rut also has the potential for secondary effects to both male and female deer. Increased attempts to breed may result in increased deer movements, and it has been suggested that this may result in deer-vehicle collisions. However, the only known research evaluating this specific issue reported that deer treated with PZP were at no greater risk of being involved in a deer-vehicle collision than untreated deer (Rutberg and Naugle 2008b).

Increased activity during rut can be energetically costly for both sexes. Although this effect is likely offset by the lack of pregnancy demands in female deer, it may have cumulative effects on energy expenditures in male deer (Walter, Kilpatrick, and Gregonis 2003; McShea et al. 1997). Alternatively, PZP-treated females may experience improved body condition and a longer lifespan compared to untreated individuals as a result of reduced energetic costs of pregnancy and lactation (Warren 2000; Hone 1992). For example, at Assateague Island National Seashore, the lifespan of horses treated with PZP has been extended from an average age at death of 20 years to 26 to 30 years (Kirkpatrick and Turner 2008; Zimmerman, Chief of Natural Resources, ASIS, pers. comm. 2009). This longer lifespan may extend the time needed to observe a decline in population size (Kirkpatrick and Turner 2008). Studies in white-tailed deer investigating effects on body condition are equivocal (Walter, Kilpatrick, and Gregonis 2003; McShea et al. 1997). There are no long-term studies investigating potential extended survival in free-ranging wild deer.

Successful field application of a fertility control program requires both an effective agent and a practical delivery system (Cowan, Pech, and Curtis 2002). Although PZP vaccines may be successfully delivered remotely through darting, the native PZP vaccine that has been tested most extensively requires a series of two initial doses followed by periodic boosters in order to maintain infertility. The need for multiple doses leads to significant logistical issues when working with free-ranging white-tailed deer, particularly when the number of deer to be treated is high. New research involving controlled-release native PZP formulations incorporates primer and booster immunizations into one injection and may extend the period of infertility (Turner et al. 2008). Turner et al. (2008) provides an overview of the current status of research related to controlled-release components of native PZP contraceptive vaccines. The new native PZP formulations have not yet been delivered through a dart. SpayVac® does not require a first-year booster and may prove easier to implement because follow-up doses would be required only every three to seven years (Fraker 2009); however, there seems to be no evidence that SpayVac® has been delivered remotely.

Many studies have modeled and a few field studies have field-tested population-level effects of PZP vaccination (Rutberg et al. 2004; Nielsen, Porter, and Underwood 1997; Rudolph, Porter, and Underwood 2000; Rutberg and Naugle 2008a). Research evaluating the effectiveness of PZP in reducing the size of deer populations has focused on moderate- to high-density deer populations of relatively small size (< 300–500 individuals). Within these populations, long-term (> 10-year) data indicate that population size may be gradually reduced using PZP treatments (Kirkpatrick and Turner 2008; Rutberg and Naugle 2008a). Rutberg and Naugle (2008a) reported a 27-percent decline in the size of a small, relatively closed, suburban deer population (approximately 250 deer) between 1997 and 2002 as a result of PZP treatments and potentially other stochastic events. However, the level of success in reducing population size varies widely. For example, deer density on Fire Island National Seashore was significantly reduced in some areas but reduced very little in other areas, probably because of an inability to treat significant numbers of does in certain areas (Rutberg and Naugle 2008a; Underwood 2005). Site-specific modeling using accurate population demographic and vital rate data, as well as knowledge of local deer behavior, land access availability, and likelihood of achieving treatment application goals, is needed to determine how fast a population can be reduced and how deep a reduction can be achieved.

Additional information on PZP may be obtained at: http://www.aphis.usda.gov/wildlife_damage/nwrc/research/reproductive_control/index.shtml or http://www.pzpinfo.org.

Gonadotropin-Releasing Hormone (GnRH) Vaccines

GnRH is a small neuropeptide (a protein-like molecule made in the brain) that plays a necessary role in reproduction. It is naturally secreted by the hypothalamus (a region of the brain that regulates hormone production), which directs the pituitary gland to release hormones (luteinizing hormone and follicle-stimulating hormone) that control the function of reproductive organs (Hazum and Conn 1988). In an attempt to interrupt this process, research has focused on eliminating the ability of GnRH to trigger the release of reproductive hormones. One option is vaccination against GnRH. Antibodies produced in response to vaccination likely attach to GnRH in the hypothalamic region and prevent the hormone from binding to receptors in the pituitary gland, thus suppressing the secretion of reproductive hormones and preventing ovulation.

GnRH vaccines have been investigated in a variety of wild and domestic ungulates (hoofed mammals) (Adams and Adams 1990; Curtis et al. 2002; Miller et al. 2000c; Miller, Rhyan, and Drew 2004). One GnRH vaccine that has been developed specifically for wildlife contraception is GonaCon™. GonaCon™ is registered with the EPA as a restricted-use pesticide to control white-tailed deer fertility. The label requires marking the treated animal and giving the vaccine by hand injection to limit the potential for nontarget animal and environmental exposure to the vaccine.

Potential benefits of this vaccine include a relatively long-lasting contraceptive effect (one to two years and potentially longer) and possibly the lack of repeated estrous cycles (Curtis et al. 2002). In free-ranging white-tailed deer, GonaCon™ is estimated to be 88 percent effective in preventing pregnancy during the first year post-treatment and approximately 47 percent effective in the second year (Gionfriddo et al. 2009); however, long-term field efficacy data currently do not exist. Although the label indicates a minimum of one year efficacy, the contraceptive effect typically lasts two years and possibly longer in some individuals (Fagerstone et al. 2008). Repeated estrous cycling and other behavioral changes in white-tailed deer have not been consistently documented in association with GnRH vaccines (Curtis et al. 2008). However, Killian et al. (2008) reported that behavioral expressions of estrus were decreased for only one to two years post-treatment and increased in subsequent years despite does remaining infertile, and Curtis et al. (2002) reported sporadic and delayed estrous cycling with prolonged fawning season in GnRH-vaccinated deer as contraceptive effects waned.

GnRH vaccines have many of the same challenges associated with PZP, including the need for repeated treatment to maintain infertility and the need to mark treated animals. Additionally, as with any vaccine that uses the adjuvant AdjuVac™, immune response to the adjuvant may interfere with determination of the animal's Johne's disease status (a gastrointestinal disease of potential regulatory importance for domestic livestock) (Miller et al. 2008). Managers should be aware of this prior to vaccination if domestic livestock graze on neighboring lands.

Other challenges to use of GonaCon™ include potential health effects on treated deer, lack of information related to effectiveness at the population level in free-ranging deer, and the requirement for hand injection. Killian et al. (2006a) concluded that GonaCon™ was safe for deer and that there were no adverse health impacts associated with unintentional repeated vaccination. However, granulomas and injection site abscesses have been consistently associated with vaccination (Curtis et al. 2008; Gionfriddo et al. 2009). A ganuloma is a localized inflammatory response to the vaccine that occurs at the site of injection and can persist for many years post-treatment. Overall, no debilitating, long-term impacts to health or changes in behavior have been consistently associated with GnRH vaccination in female deer.

Site-specific modeling and population data as described for PZP immunocontraception are also required for evaluating the potential for success in managing a free-ranging deer population with GonaCon™.

Additional information may be obtained at:
http://www.aphis.usda.gov/wildlife_damage/nwrc/research/reproductive_control/index.shtml.

Nonimmunological Reproductive Control Methods

Nonimmunological reproductive control agents include GnRH agonists, GnRH toxins, steroid hormones, and contragestives.

GnRH Agonists

GnRH agonists are highly active analogs of GnRH that are similar in structure and action to the endogenous hormone. These agonists attach to receptors in the pituitary gland, thereby reducing the number of binding sites available and temporarily suppressing the effect of GnRH. As a result of this suppression, reproductive hormones are not released (Aspden et al. 1996; D'Occhio, Aspden, and Whyte 1996). Continuous administration of the agonist is necessary to maintain infertility. This can be accomplished with controlled-release formulations or surgically implanted pumps in addition to daily administration.

Not all agonists have the same effects in all species. In fact, some can have an effect that is the opposite of what is intended. The wide variation in response is likely due to a combination of type of agonist, dose, treatment regime, reproductive status, sex, and species (Becker and Katz 1997). Therefore, it is important to fully understand the effects of a product on a given species. Although many GnRH agonists are used in human and veterinary medicine, only a few have been investigated in wildlife species (Becker and Katz 1997; Vickery 1986). GnRH agonists have been tested primarily in mule deer and elk and have been shown to both suppress reproductive hormones and prevent pregnancy (Baker et al. 2005; Baker et al. 2004; Baker et al. 2002; Conner et al. 2007).

Leuprolide acetate

Leuprolide is a GnRH agonist that when administered as a controlled-release formulation, results in 100 percent pregnancy prevention in treated female elk and mule deer (Baker et al. 2002 and 2004; Conner et al. 2007). In addition, the treatment is reversible, and the effects last only for a single breeding season (Baker et al. 2004; Trigg et al. 2001). Advantages of leuprolide acetate are that it is 100 percent effective in preventing pregnancy, is safe for human consumption (Baker et al. 2004), can be delivered remotely (Baker et al. 2005), does not result in physiological side effects, and causes few behavioral effects (Baker et al. 2004). Treatment did not suppress reproductive behavior during the breeding season but also did not prolong behaviors into the non-breeding season.

Leuprolide is FDA approved for use in humans and has been used experimentally in cervids. It is not currently approved for use in free-ranging wildlife as a fertility control drug. It is not known if this application will be pursued in the future. The need to deliver leuprolide subcutaneously via hand injection has traditionally been considered a significant barrier to the long-term application of this drug as a wildlife management tool. However, Baker et al. (2005) successfully applied the treatment through dart delivery, which may extend the practical application of this contraceptive.

Treatment using leuprolide differs from GnRH vaccines in that it does not require an adjuvant and does not induce an antibody reaction. Therefore, inflammatory responses to adjuvant components and other physiological effects often observed with immunocontraceptives have not been observed in association with leuprolide. Leuprolide treatment does, however, require a slow-release implant that remains under the skin or in the muscle. It is unlikely that leuprolide poses a threat to the environment or to nontarget species because the drug is not absorbed through the oral route of administration (Baker et al. 2004). Marking requirements for animals treated with leuprolide implants are currently unknown because the drug is not a registered wildlife contraceptive.

One drawback to the use of leuprolide is the need to treat animals within a short timeframe prior to the breeding season (Conner et al. 2007). If a female is not re-treated each year, then she has the same chances of becoming pregnant as an animal that was never treated. The need to treat a potentially large number of individuals within a short period of time on an annual basis reduces the feasibility of leuprolide as a wildlife management tool, particularly for large, free-ranging, open deer populations.

Histrelin acetate

Histrelin acetate is effective in suppressing a key reproductive hormone in white-tailed deer (Becker and Katz 1995). However, testing was administered using a mini-pump that was surgically implanted under the animal's skin. This is an infeasible route of administration in free-ranging animals. In the future, a delivery system with slow-release characteristics may help to make this a more feasible option for free-ranging wildlife. It is likely that histrelin acetate will also suppress ovulation and pregnancy in white-tailed deer, although this remains to be tested.

GnRH Toxins

GnRH toxins consist of a cellular toxin combined with a GnRH analog (either agonist or antagoinst). A GnRH analog is a synthetic peptide similar to the body's own gonadotropin-releasing hormone. Using the analog as a carrier, a cellular toxin can be delivered to specific cells in the pituitary that produce reproductive hormones. Internalization of the toxin leads to cell death. When this occurs, the production of reproductive hormones (leuteinizing hormone and follicle-stimulating hormone) is affected. This process has been studied in male dogs (Sabeur et al. 2003), domestic sheep (Nett et al. 1999), rats (Kovacs et al. 1997), and female mule deer (Baker et al. 1999), but the technology is still in the developmental stages and not ready for use in free-ranging wildlife.

Steroid Hormones

The field of wildlife contraception began with research examining the manipulation of reproductive steroid hormones (Matschke 1980, 1977a, and 1977b). Treatment usually entails the application of synthetic hormones, such as norgestomet and melangestrol acetate (Jacobsen, Jessup, and Kesler 1995; DeNicola, Kesler, and Swihart 1997a; Fagerstone et al. 2010). Available products are administered via slow-release implants or repeated feeding and have demonstrated variable efficacy and duration of infertility. Most currently available products are used in domestic animal or zoological veterinary medicine and have not been used widely in free-ranging wildlife. Issues related to using steroids include difficulties in treating large numbers of animals for extended periods of time, potential pathological side effects of the reproductive tract experienced by the treated animals, and concerns over the consumption of treated animals by nontarget species and humans. Although many of these hormones are used as growth promotants in domestic food animal production, they are not labeled for use in free-ranging wildlife. Currently, this method of contraception is not being pursued by the wildlife management community.

Contragestives

Contragestives are products that terminate pregnancy. Progesterone is the primary gestational hormone for maintaining pregnancy in mammals. Many contragestives act by preventing progesterone production or blocking its effect, thereby affecting pregnancy. The primary contragestive that has been researched for use in domestic animals and white-tailed deer is an analog of Prostaglandin F2α (PGF2α) (Becker and Katz 1994; DeNicola, Kesler, and Swihart 1997b; Waddell et al. 2001). Lutalyse® is a commercially available form of PGF2α. Unlike many of the other alternatives, there are no issues related to consumption of the meat when an animal has been treated with this product. Challenges with contragestives include timing of administration, efficacy, potential to rebreed if breeding season is not finished, and the potential for aborted fetuses on the landscape. These limitations make their use in free-ranging populations for fertility control purposes infeasible.

Sterilization

Surgical sterilization of females is an effective method of controlling reproduction and has been used extensively in domestic animal medicine. However, implementation requires capture, general anesthesia, and surgery performed by a veterinarian, which is generally considered labor intensive and costly and calls into question the long-term sustainability of sterilization as a wildlife management tool, except under very limited circumstances. Only in rare instances is physical sterilization reversible.

Depending on the method of sterilization, this procedure may have behavioral effects on both male and female deer. If gonads are removed, then the source of important reproductive hormones is removed. This is likely to change deer social interactions. If gonads are not removed, females will continue to ovulate and show behavioral signs of estrus; as a consequence, the breeding season may be extended.

EVALUATION OF FERTILITY CONTROL AGENTS BASED ON SELECTION CRITERIA ESTABLISHED BY INDIANA DUNES NATIONAL LAKESHORE

Five criteria were established for Indiana Dunes National Lakeshore that reflect minimum desired conditions for using a reproductive control agent. Only when these criteria are met would reproductive control be implemented. These criteria assume that the agent poses no significant health risk to deer.

1. There is a federally approved fertility control agent for application to free-ranging populations.
2. The agent provides multiple-year (three to five years) efficacy to minimize the cost and labor required to administer the drug to a large number of deer every year.
3. The agent can be administered through remote injection to avoid capturing animals and to increase the efficiency of distribution.
4. The agent would leave no hormonal residual in the meat (i.e., meat would be safe for human consumption).

5. Overall, there is substantial proof of success in a free-ranging population, based on science team review.

TABLE F-1: EVALUATION OF FERTILITY CONTROL AGENTS BASED ON SELECTION CRITERIA FOR INDIANA DUNES NATIONAL LAKESHORE

Agent	Criterion 1 Federally Approved	Criterion 2 Multiyear (3 to 5) Efficacy	Criterion 3 Capable of Remote Administration	Criterion 4 Meat Safe for Humans	Criterion 5 Success in Free-ranging Populations
Immunocontraceptives					
"Native" PZP	No	No[a]	Yes	Likely, but EPA approval would be needed	Yes, but only in closed populations with relatively high population turnover
SpayVac®	No	Possibly[b]	Unknown		
GnRH	Yes	Possibly[c]	Possibly[d]	Yes	Untested
GnRH Agonists					
Leuprolide Acetate	No	No	Yes	Likely, but EPA approval would be needed	Untested
Histrelin Acetate	No	No	No	Likely, but EPA approval would be needed	Untested
Other					
GnRH Toxins	No	Unknown	Unknown	Likely, but unknown	Untested
Steroid Hormones	No	No	Unknown	Unlikely, but regulatory guidance would be needed	Untested
Contragestives	No	No	Yes	Yes	Not likely, but untested

[a] Initial research on one-shot, multiyear PZP vaccine has demonstrated 88.3% efficacy in year 1 and 75% efficacy in the second year post-treatment (Turner et al. 2008). Research is currently ongoing to evaluate effectiveness in year 3 and beyond. Dr. Allen Rutberg has indicated that "based on the design of the vaccine and our experience with horses, it's unlikely that the vaccine would have much effect past the third year" (Rutberg 2009). However, research on this vaccine is still developing and is expected to continue into the future.

[b] SpayVac® has demonstrated 80% to 100% efficacy for up to five to seven years in horses and deer (Fraker 2009; Miller et al. 2009; Killian et al. 2008). The term "possibly" is used because long-term studies (longer than five years) have been conducted only in captive deer and with a small sample size in each treatment group (N = 5) (Miller et al. 2009).

[c] Recently published research on one-shot, multiyear GnRH vaccine in penned/captive deer indicates that GonaConTM is 88% to 100% effective in year 1, 47% to 100% effective in year 2, and 25% to 80% effective up to 5 years post-treatment (Miller et al. 2008). The term "possibly" is used because the multiyear formulation has been used only in captive deer, has been used only with small sample sizes, and lacks confidence intervals on the data.

d Recent work published in elk used dart delivery to administer the GnRH vaccine (Killian et al. 2009).

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APPENDIX G: COMMENTS AND RESPONSES ON THE DRAFT PLAN/ENVIRONMENTAL IMPACT STATEMENT

Pursuant to NEPA, its implementing regulations, and NPS guidance on meeting NEPA requirements, Indiana Dunes National Lakeshore must solicit, assess, and consider comments on the *Draft White-tailed Deer Management Plan/Environmental Impact Statement* (plan/DEIS) and respond to substantive public comments. This appendix describes how the NPS fulfilled that requirement.

On January 29, 2009, the Indiana Dunes National Lakeshore plan/DEIS was released through a Notice of Availability, opening an 85-day public comment period that closed on April 24, 2009. During this period, which was announced through the national lakeshore's website (www.nps.gov/indu), press releases, and newspapers, the plan/DEIS was accessible through the NPS's Planning, Environment, and Public Comment (PEPC) website (http://parkplanning.nps.gov). Hard copies of the plan/DEIS were available at the Dorothy Buell Memorial Visitor Center and the national lakeshore headquarters building. Copies also were mailed to interested parties, elected officials, and appropriate local and state agencies. The public was encouraged to review the plan/DEIS and submit comments through the PEPC website or by postal mail sent directly to the national lakeshore.

PUBLIC COMMENT MEETINGS

During the public comment period, NPS held an open meeting between 5:00 and 8:00 p.m. on March 12, 2009, at the Indiana Dunes National Lakeshore Visitor Center. The purpose of the meeting was to present the plan, respond to questions, and facilitate public involvement and community feedback. Release and availability of the draft plan, as well as the public meeting, were advertised as described above.

Although 42 people attended the public meeting, only 32 signed in. The meeting opened with a formal presentation by national lakeshore staff to explain the specifics of the plan and the proposed alternatives, followed by an open question period. Attendees also had the opportunity to observe displays illustrating the study area; the purpose, need, and objectives of the plan; and summaries of the alternatives. Comment sheets were available at the sign-in table. Attendees could fill out the forms and submit them at the meeting or mail them to the national lakeshore at any time during the public comment period. Meeting attendees also received a handout containing additional information about the NEPA process, a comparison of actions under each proposed alternative, and additional opportunities for comment on the project, including directing comments to the PEPC website. Public comments received are detailed in the following sections of this appendix.

METHODOLOGY

During the comment period, NPS received 74 pieces of correspondence via e-mail, mailed letter, comment sheets submitted at the public meetings, or direct entry into the PEPC website. Letters received by e-mail or postal mail, as well as comments received from the public meetings, were entered into the PEPC system for analysis. Specific comments within each piece of correspondence totaled 522.

To help categorize and address comments, each comment was coded to identify its general content and to group similar comments. If a comment addressed more than one issue or idea, the comment might be categorized under more than one code. A total of 69 codes was used to categorize all comments.

During coding, comments were also classified as substantive or non-substantive. The NPS Director's Order #12 (DO-12) Handbook, section 4.6A, defines a substantive comment as one that does one or more of the following:

- questions, with a reasonable basis, the accuracy of information presented in the EIS
- questions, with a reasonable basis, the adequacy of the environmental analysis
- presents reasonable alternatives other than those presented in the EIS
- causes changes or revisions in the proposal

In addition, substantive comments "raise, debate, or question a point of fact or policy. Comments in favor of or against the proposed action or alternatives or comments that only agree or disagree with NPS policy are not considered substantive." While all comments were read and considered and were used to help create the final plan/EIS, only those determined to be substantive led to concern statements for response from the NPS, as described below.

Under each code, all substantive comments were grouped by theme and summarized with a concern statement. For example, under the code AL2010–Alternatives Eliminated: Managed Hunt, one concern statement identified was: "Commenters urged NPS to reconsider using a managed public hunt to cull the deer population at IDNL for reasons that included its use in deer management in other similar situations, its low cost (potentially offset by a hunting fee), and its recreation value for local hunters." This one concern statement captured many comments. Following each concern statement are one or more representative quotes—taken verbatim from the correspondence to illustrate the issue, concern, or idea expressed by the comments grouped under that concern statement.

The largest number of comments fell under code AL2010, Alternatives Eliminated: Managed Hunt — Substantive (47 comments), which accounted for 8.9 percent of the total comments made. Of the comments coded PN8150, 44 (8.3 percent) argued that the deer management plan purpose and need were either not substantiated or not valid. Of the 74 pieces of correspondence, 31 (42 percent) came from Indiana; the remainder came from 13 other states. The majority of correspondence (53 of 74 items) came from unaffiliated individuals, with 9 (12 percent) coming from conservation/preservation organizations.

GUIDE TO THIS APPENDIX

This appendix is organized as follows:

- *Content Analysis Report*: This basic report was produced from PEPC and details the numbers and types of comments received, organized by code and by various demographics. The first section summarizes the following information:
- number of comments that fall under each code or topic
- percentage of comments under each code
- amount of correspondence by type
- amount received by organization type
- amount received by state

Concern Response Report: This report summarizes the substantive comments received during the public review and comment process. These comments are organized by codes and further organized into concern statements. Representative quotes and an agency response follow each concern statement.

Additional information, including the meeting sign-in sheets, correspondence list, index by organization type, index by code, and non-substantive issues report, is included in the full version of the Public Comment Analysis Report for the *Draft White-tailed Deer Management Plan/Environmental Impact Statement*, which is available on the PEPC website.

CONTENT ANALYSIS REPORT

Table G-1 is a list, by code number and name, of the comments received under each code, both substantive and non-substantive. Only the substantive comments are included in the response portion of this appendix. Table G-2 lists the count of correspondence types (e.g., letters, emails). Table G-3 lists the count of correspondence by organization or unaffiliated individuals. Table G-4 lists the count of correspondence by state of origin. The remainder of appendix G lists the coding of comment categories and the major concerns, representative quotes, and responses to those substantive concerns.

TABLE G-1: CONTENT ANALYSIS REPORT

Code	Description	Number of Comments	Percentage of Total (n=529)
AE10000	Affected Environment: Rare or Unusual Vegetation	2	0.38
AE12000	Affected Environment: Wildlife and Wildlife Habitat	2	0.38
AL1100	Elements Common to Action Alternatives: Deer-density Goal	6	1.13
AL1200	Elements Common to Action Alternatives: Indicator Plants	9	1.70
AL1300	Elements Common to Action Alternatives: Humane Treatment of Deer	8	1.51
AL2010	Alternatives Eliminated: Managed Hunt	47	8.88
AL2011	Alternatives Eliminated: Support Public Hunting	20	3.78
AL2015	Manage Deer with Public Hunt	1	0.19
AL2020	Alternatives Eliminated: Managed Hunt Using Bow Hunting	26	4.91
AL2030	Alternatives Eliminated: Surgical Sterilization of Does	3	0.57
AL2040	Alternatives Eliminated: Predator Reintroduction	2	0.38
AL2050	Alternatives Eliminated: Capture and Relocation	1	0.19
AL2300	New Alternative: Research-Oriented Alternative	2	0.38
AL2400	New Alternative: More Aggressive Nonlethal	2	0.38
AL2500	New Alternative: KC Airport Method	1	0.19
AL4000	Alternatives: New Alternatives or Elements	3	0.57
AL4100	Support No Action	6	1.13
AL4110	Oppose No Action	3	0.57
AL4120	Alternative A, No Action, Does Not Adequately Address Deer Management Needs	3	0.57
AL4210	Support Alternative B : Nonlethal Actions	4	0.76
AL4215	Reasons Alternative B, Use of Fencing and Repellents, Is Not a Viable Method	3	0.57
AL4216	Oppose Alternative B	2	0.38
AL4220	Support Fertility Control	10	1.89
AL4230	Oppose Fertility Control	7	1.32
AL4240	Reasons NPS Should Not Use Fertility Control	15	2.84
AL4250	Reasons NPS Should Use Fertility Control	15	2.84
AL4260	Reasons NPS Should Not Capture and Euthanize Deer under Alternative C	1	0.19
AL4300	Support Alternative C, Sharpshooting and Capture/Euthanize	9	1.70
AL4310	Oppose Alternative C, Sharpshooting and Capture/Euthanize	8	1.51

Code	Description	Number of Comments	Percentage of Total (n=529)
AL4320	Alternative C; Reasons NPS Should Use Sharpshooting or Capture/Euthanize	9	1.70
AL4330	Alternative C; Reasons NPS Should Not Use Sharpshooting	6	1.13
AL4400	Preferred Alternative D, Nonlethal and Lethal Control	14	2.65
AL4410	Support Alternative D	19	3.59
AL4420	Oppose Alternative D	3	0.57
AL4500	Oppose Lethal Deer Control under Alternatives C and D	23	4.35
AL4510	Support Lethal Control for Deer Management	6	1.13
AL4515	Disposal of Deer Carcasses after Lethal Control	2	0.38
AL4520	Reasons NPS Should Not Use Skilled Volunteers as Sharpshooters in Alternatives C and D	27	5.10
AL4530	Reasons NPS Should Use Skilled Volunteers as Sharpshooters in Alternatives C and D	12	2.27
AL4550	Support NPS Using Volunteers as Deer Sharpshooters	1	0.19
AL4600	Alternative D, Fencing	1	0.19
GA1100	Impact Analysis: Comparison with NEPA Tenets	2	0.38
GA3000	Impact Analysis: General Methodology for Establishing Impacts/Effects	3	0.57
GS1000	Greetings and Salutations	23	4.35
HS1000	Health and Safety of Deer Management Personnel	2	0.38
IV100	Issues: Visitor Use or Experience Issues	1	0.19
LC1000	Local Community Public Safety	10	1.89
LC2000	Coordination with Deer Managers of Adjacent Lands	18	3.40
ON1000	Other NEPA Issues: General Comments	3	0.57
ON1100	Other NEPA Issues: Public Involvement	10	1.89
ON1200	Other NEPA Issues: Lack of Data	5	0.95
PN1000	Purpose and Need: Planning Process and Policy	2	0.38
PN2000	Purpose and Need: Park Purpose and Significance	2	0.38
PN4000	Purpose and Need: Park Legislation/Authority	7	1.32
PN4100	NPS-wide Coordination of Deer Management	2	0.38
PN6100	Organic Act, Impairment, and Deer Management	11	2.08
PN7000	Purpose and Need: NEPA and CEQ	1	0.19

Code	Description	Number of Comments	Percentage of Total (n=529)
PN8000	Purpose and Need: Objectives in Taking Action	11	2.08
PN8100	Reasons the Purpose and Need Is Valid or Substantiated	26	4.91
PN8150	Reasons the Purpose and Need Is Not Substantiated or Not Valid	44	8.32
SE2000	Socioeconomics: Methodology and Assumptions	1	0.19
TE4000	Threatened and Endangered Species: Impact of Proposal and Alternatives	9	1.70
VE4000	Visitor Experience: Impact of Proposal and Alternatives	10	1.89
VR4000	Vegetation and Riparian Areas: Impact of Proposal and Alternatives	1	0.19
VS4000	Visitor Conflicts and Safety: Impact of Proposal and Alternatives	10	1.89
WH2000	Wildlife and Wildlife Habitat: Methodology and Assumptions	10	1.89
WH4000	Wildlife and Wildlife Habitat: Impact of Proposal and Alternatives	1	0.19
WH5000	Wildlife and Wildlife Habitat: Cumulative Impacts	3	0.57
WQ2000	Water Resources: Methodology and Assumptions	1	0.19
Total		529	108.35*

*Some comments were associated with more than one category; therefore, the total percentage is greater than 100 percent.

TABLE G-2: CORRESPONDENCE DISTRIBUTION BY TYPE

Type	Number
Web Form	51
Park Form	6
Letter	10
E-mail	7
Total	74

TABLE G-3: CORRESPONDENCE SIGNATURE COUNT BY ORGANIZATION TYPE

Organization Type	Number
Town or City Government	2
County Government	1
Federal Government	2
Conservation/Preservation	9
Non-Governmental	5
Recreational Groups	2
State Government	1
Unaffiliated Individual	52
Total	74

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TABLE G–4: CORRESPONDENCE DISTRIBUTION BY STATE

	Percentage	Number
AZ	1.35	1
CA	1.35	1
DC	4.05	3
GA	1.35	1
ID	1.35	1
IL	12.16	9
IN	60.81	45
LA	1.35	1
MI	2.70	2
MN	1.35	1
MS	1.35	1
NJ	5.41	4
NM	2.70	2
TN	2.70	2
Total	100	74

Indiana Dunes National Lakeshore Draft White-tailed Deer Management Plan/EIS Concern Response Report

AE10000 - Affected Environment: Rare or Unusual Vegetation

Concern ID: 21772

CONCERN STATEMENT: **One commenter stated that the description of state-listed plant species in Chapter 3: Affected Environment is inadequate because NPS fails to disclose which state-listed plant species are confirmed to occur in the national lakeshore versus those that may or may not occur in the national lakeshore. This commenter further said that NPS fails to provide information about the abundance of state-listed plant species in the national lakeshore compared to other areas adjacent to its boundaries, in the multi-county area in which the national lakeshore is located, or in the state of Indiana.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101503 **Organization Type:** Nongovernmental

Representative Quote: *The NPS states that the IDNL is home to some 123 state-listed rare or sensitive plant species. Presumably none of these species, or very few, are actually only found on the IDNL. What the NPS fails to provide, however, is information about the abundance of said state-listed species on the IDNL compared to other areas adjacent to the IDNL, in the multi-county area in which the IDNL is located, or within the entire state of Indiana. This is critical information to assess the significance of the state-listed plant species population that is found within the IDNL. If, for example, a mere fraction of all of the state-listed species of a particular plant are found on IDNL while the vast majority are found elsewhere perhaps in an area that is better protected from the myriad threats, which may or may not include deer, this is important information to disclose and for the public to consider when evaluating the impacts of the proposed action and its alternatives.*

Response: **To document the occurrence of plant species in need of protection at the national lakeshore, NPS cross-referenced the plant species listed in the 2006 NPS Species Database for Indiana Dunes National Lakeshore (NPS 2006d) and rare-plant monitoring reports of botanists and other researchers working at the national lakeshore against the IDNR Division of Nature Preserves list of sensitive plants. NPS provided information on known abundance of each species (see Final EIS Table 30: Sensitive and Rare Plants of Indiana Dunes National Lakeshore). Abundance of these plants outside the national lakeshore is not relevant to their protection within it. NPS 77: *Natural Resource Management Guideline* requires NPS to protect these plants simply because they are state-listed, regardless of their distribution or abundance outside the national lakeshore.**

AE12000 - Affected Environment: Wildlife and Wildlife Habitat

Concern ID: 21774

CONCERN STATEMENT: **One commenter stated that the EIS is inadequate because of the lack of national lakeshore–specific data on deer numbers and density, vegetation baseline conditions, and impacts of deer on vegetation. This commenter further said that the NPS analysis is flawed because it lacks data specific to the national lakeshore and relies on data from other studies in other locations and ecosystems.**

Representative **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Quote(s):

Comment ID: 101533 **Organization Type:** Nongovernmental

Representative Quote: *Adequacy of information disclosed in the DEIS and sufficiency of analysis: As previously stated one of the fundamental flaws in the DEIS is the lack of IDNL-specific data on deer numbers and density, vegetation baseline conditions, impacts of deer on veg[et]ation, etc? Chapter 3 of the DEIS in which the affected environment has a number of examples where, because the NPS doesn't have park-specific data for the IDNL, it relies on data from other studies in other locations and ecosystems. See, e.g., DEIS at 99, 112, 123. The lack of high quality information upon which to base the evaluation of environmental impacts violates NEPA. If the data exist but is not, for whatever reason, disclosed this also violates NEPA. Moreover, if the data can be obtained by the NPS to inform its analysis but the NPS selects not to obtain the data because of the cost or time involved, that too is a violation of NEPA unless the agency complies with 40 CFR 1502.22(b)91-4). This option is not applicable here since the missing information is essential to the analysis and its cost of acquisition is not exorbitant.*

Response: **Evidence from the national lakeshore and adjacent lands prompted NPS to initiate deer management planning at the national lakeshore to address growing concerns about the potential for deer damage to rare plants and habitats within its boundaries. Observations of heavy deer browsing on northern white cedar and deer spotlight surveys showing high deer numbers are examples of such evidence. NPS also monitored plants with exclosure plots and conducted other botanical surveys in various parts of the national lakeshore, which indicated that heavy deer feeding on vegetation could result in overbrowsing. In addition, adjacent residential communities and the state park had begun efforts to control deer on their property and had voiced concern to NPS that uncontrolled deer in the national lakeshore would continue to have effects outside its boundaries. These factors caused NPS to take a proactive approach to addressing the potential for deer overabundance before sensitive plants and habitats were damaged. Initially, this approach did not involve active deer control measures beyond the fencing and repellents already being used. NPS began monitoring a single sensitive plant (trillium) for deer browsing to determine whether deer were overabundant in the national lakeshore and required further control measures. Monitoring to date demonstrates that the trigger point for deer control has been reached in several management zones of the East Unit of the national lakeshore since the draft EIS was published. Therefore, if the NPS-preferred alternative is selected, deer control, including lethal control measures, will be conducted.**

These data and studies from a variety of locations and habitat types demonstrate that negative effects of deer on the natural environment depend on the deer population level. This growing body of evidence is relevant because the national lakeshore could experience these adverse effects if the deer population remains uncontrolled.

The outside studies, coupled with the monitoring data being collected at the national lakeshore, provide sufficient evidence that the national lakeshore must take action to protect native species.

AL1100 - Elements Common to Action Alternatives: Deer-Density Goal

Concern ID: 21671

CONCERN **One commenter stated that NPS had set its deer-density goal unnecessarily low**

STATEMENT: compared with studies elsewhere and was relying on adaptive management for future adjustments to the goal, after the fact, rather than basing the initial goal on national lakeshore data, which would allow the goal to be set higher.

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101508 **Organization Type:** Nongovernmental

Representative Quote: *Initial Deer-Density Goal: The NPS has established an initial deer-density goal of 15 deer/mi². DEIS at 35. While that goal can be adjusted up or down through the so-called adaptive management elements in the plan, DEIS at 69/70, initially this will be the management goal of the NPS meaning that, depending on current deer density, a large number of deer could be killed and removed from the park. The concept of adaptive management has become an oft-used, if not over-used, buzzword among federal agencies. Though few agencies actually practice adaptive management and even fewer understand what it really is, it's a term and concept that allows an agency to suggest to or to deceive the public into believing that the agency will act reasonably and rationally and though its initial proposal may seem draconian things could improve given adaptive management. Unfortunately, once an agency finalizes and implements its draconian plan it rarely exercises the process of adaptive management or waits so long to adapt the plan that the damage has already been done and animals have been killed unnecessarily. Instead, the NPS selected the goal on its own relying solely on studies of white-tailed deer impacts on vegetation conducted elsewhere. The NPS considered absolutely no study or data related to IDNL to create this deer management goal. The lack of the use of any park-specific data to establish this goal is of no surprise considering the NPS reliance on such non-IDNL studies to justify its actions throughout the DEIS and the apparent paucity of IDNL specific data. At a minimum, the NPS should endeavor to obtain the park-specific data for the IDNL and then develop a park-specific deer management goal instead of relying on studies from elsewhere to develop said management goal.*

Response: Although NPS did base its initial goal for the deer population on studies elsewhere, it is important to emphasize that NPS has not set a long-term goal because the optimum level that will protect sensitive plants and wildlife habitats, as well as allow for a sustainable deer population, is not yet known. Although this commenter recommends a higher initial level, others have recommended a lower one. As the plan is implemented, NPS's adaptive management strategy will feed back into this initial level and NPS will adjust it according to the response of the indicator plants. Thus, the adaptive management strategy is a critical, integral element of the long-term deer management plan.

Various research studies recommend a range of deer-density levels to protect the natural environment. These data and studies from a variety of locations and habitat types demonstrate that negative effects of deer on the natural environment depend on the deer population level. The science team for the EIS reviewed all the research and considered the types of habitats that exist at the national lakeshore. The team recommended a range of 10 to 20 deer/mi², with 15 as the initial goal. As the management action proceeds, the monitoring program will yield data on whether the negative effects of deer are being reduced.

Concern ID: 21915

CONCERN STATEMENT: A commenter said that the IDNR has identified levels of as few as 5 deer/mi² to sustain fragile dune habitat and rare plant species and asked if the level proposed in the EIS is low enough to provide a sustainable ecosystem.

Representative Quote(s): **Corr. ID:** 36 **Organization:** Save the Dunes Council

Comment ID: 100484 **Organization Type:** Conservation/Preservation

Representative Quote: *Indiana DNR has indicated a much lower level of deer to protect native plant and animal species. In fact they have mentioned levels of as few as 5 per square mile to sustain fragile dune habitat and rare plant species. We ask if the level proposed in the EIS is low enough to provide a sustainable ecosystem?*

Response: **According to Chad Stewart, an IDNR deer research biologist, IDNR has never made a statement claiming that much lower deer densities were needed to protect native plant species, nor has IDNR recommended a deer density of 5 deer/mi^2 to protect fragile dune habitat. NPS has not set a long-term target for deer density but will follow the principles of adaptive management and will adjust the level up or down depending on the response of sensitive plants and habitats to initial deer population reductions. NPS will manage deer on a zone-by-zone basis with control measures focused only in zones where a trigger for control has been met, rather than making decisions based on triggers for the national lakeshore in its entirety. NPS's proposed zone management is described in the Final EIS, page 34.**

AL1200 - Elements Common to Action Alternatives: Indicator Plants

Concern ID: 21672

CONCERN STATEMENT: **One commenter stated that NPS selected highly palatable plants as indicators to ensure that monitoring would trigger large deer culls and that "a more appropriate methodology to track deer impacts would have been to identify a mixture of highly palatable to non-palatable species." The commenter stated that NPS had ignored the effects of other factors on the indicator plants, including invasive plants, fire, the degree of forest canopy closure, and global warming.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101511 **Organization Type:** Nongovernmental

Representative Quote: *Indicator Species and Thresholds for Taking Action: The NPS has identified a number of indicator plant species and alternative indicator plant species that it intends to use to monitor the impact of deer on vegetation within IDNL. These so-called "indicator plants" are species that have either been documented in the literature as a deer browse indicator or have life history characteristics similar to other documented deer browse indicator species and are expected to provide similar results. Overlooking the fact that the NPS has a mandate of natural regulation and that, therefore, using indicator plant species as a trigger for lethal deer control violates that mandate, the collection of data for research purposes to assess and monitor the trends in the impact of deer on vegetation species within IDNL is certainly appropriate. While it would not be expected that the NPS would select non-palatable species to monitor the impact of deer on vegetation, the selection of only species that are palatable to deer will not only overestimate the impact of deer on vegetation in IDNL but it was likely done purposefully by the NPS to ensure that its triggers are met and that its proposed massive deer culling plan can go forward. A more appropriate methodology to track deer impacts would have been to identify a mixture of highly palatable to non-palatable species to monitor within IDNL. While the highly palatable species would likely still absorb the brunt of the browsing impacts, such a methodology would allow for the monitoring of the status of the moderately and non-palatable species along with the concurrent routine assessment of deer population size. Over time, if the highly palatable species declines in* *abundance while the moderately and non-palatable species increase followed by a decline in the estimated number of deer, this could provide evidence of nature regulating the deer population. This is not to say that such a relationship would be found but studying such a relationship over the long term is consistent with the NPS legal mandate while embarking on a deer killing spree is not.*

Response: **NPS selected trillium because it is common to the Great Lakes region and favored by deer. To include unpalatable species as part of a composite trigger would mean that many of the palatable plants would be gone or seriously depleted before action would be triggered, directly contravening NPS policy to protect sensitive plants and the health of the plant and wildlife habitats in the national lakeshore. As described in the final EIS, page 12, to maintain trillium stem heights and flowering plants in deciduous forests in northeastern Illinois, a density of 10 to 16 deer/mi^2 is recommended (Anderson 1994). High deer densities can skew trillium populations toward small plants and can lead to extirpation of trillium and other sensitive forbs (Augustine and Frelich 1998). NPS accounts for other factors besides deer affecting trillium by using exclosures that keep deer out.**

Concern ID: 21930

CONCERN STATEMENT: A commenter stated that the indicator plant deer control triggers have already been reached in the East Unit and recommended that NPS monitoring of indicator plants commence as soon as possible in the West Unit because deer densities there have increased rapidly, as indicated by observations of recent nearby deer harvest and herd size.

Representative Quote(s):

Corr. ID: 23 **Organization:** Shirley Heinze Land Trust

Comment ID: 100303 **Organization Type:** Conservation/Preservation

Representative Quote: *It is my understanding that monitoring for the indicator species, which was implemented some years ago at INDU, already indicates that the thresholds for taking action to reduce deer densities have already been reached in all 4 of the Management Zones of the park's East Unit. I trust that the NPS will decide in favor of Alternative C or D and will work to implement a sharpshooting program as soon as possible, hopefully by the coming (2009/2010) fall or winter. Finally, I recommend that vegetation monitoring of indicator species be phased in as soon as possible for all of the other Deer Management Zones of the park, especially the 3 zones of the park's West Unit. Deer densities there have risen faster than most of us could have imagined 5 or 10 years ago. There is abundant anecdotal evidence of adverse impacts. The Shirley Heinze Land Trust manages the 90+ acre Coulter Preserve that abuts the Inland Marsh area of the park. We harvested 7 deer from Coulter in 2007-2008 and 19 this past season. We have been told that the group hunting the Ewen farm property south of Stagecoach Rd. in this area harvested about 45 deer this year. Observations after the season have seen up to 150 deer at one time in those fields.*

Response: **Ongoing monitoring of trillium since the draft EIS was published has confirmed the 2006 results indicating that the deer population in the East Unit has reached the trigger level for control. If the preferred alternative is implemented, deer would be controlled expeditiously with appropriate methods. NPS will establish monitoring plots for the West Unit and, rather than using trillium as an indicator, may use lupine because the habitat is not favorable for trillium. Zones that have reached the action threshold are listed in the "Indicator Species Monitoring for 2009" section on page 40 of the final EIS.**

AL1300 - Elements Common to Action Alternatives: Humane Treatment of Deer

Concern ID: 22300

CONCERN STATEMENT: **Commenters expressed concern that NPS use humane methods of deer management. Several stated that certain deer management methods are humane, and some said that lethal control by sharpshooting or archery is humane because these are quick-kill methods. Others stated that certain nonlethal methods are humane, including: (1) PZP contraception because animals can be darted from a distance and not handled, and (2) surgical sterilization by tubal ligation because it would not cause the behavioral changes that hormonal treatment would. One commenter noted that the American Veterinary Association considers sharpshooting the most humane method of herd reduction. Another commenter recommended that lethal control should target weak deer because that is what natural predators do and that the method of kill should be sanctioned by a rabbi to ensure it is humane. Another commenter said that NPS provided no explanation of why it had chosen to use the guidelines of the American Society of Mammalogists to determine what would be "humane management actions" and recommended that NPS explicitly list the actions that it considers humane management.**

Representative Quote(s): **Corr. ID:** 26 **Organization:** Safari Club International

Comment ID: 101860 **Organization Type:** Recreational Groups

Representative Quote: *Inconsistent Approach to "Humane" Wildlife Management SCI and SCIF also question the Plan's reference to "Humane Management Actions" dictated by the American Society of Mammalogists' guidelines. The Plan offers no indication as to why the NPS has adopted these specific principles. To SCI and SCIF's knowledge, the NPS policies do not refer to these guidelines. SCI and SCIF would caution the drafters of this plan against arbitrary reliance upon guidelines that have not been subject to review by the public. At the very least, SCI and SCIF recommend that the NPS specify, in detail, the elements of the guidelines upon which the drafters intend to rely.*

Response: **In carrying out any of the alternatives, the national lakeshore would follow the recommendations of the NPS Biological Resource Management Division, which guides all units of the NPS on humane treatment of wildlife. Pursuant to this, the national lakeshore would follow the "Guidelines for the Capture, Handling, and Care of Mammals," as approved by the American Society of Mammalogists (ASM 1998), for ensuring humane handling of deer using nonlethal control methods and the "AVMA Guidelines on Euthanasia," published by the American Veterinary Medical Association (AVMA 2007), for humane lethal control methods. Lethal methods include using firearms for culling and using humane capture/euthanasia techniques, including penetrating captive bolt gun, potassium chloride, or exsanguination. The ASM "Guidelines" regarding the humane handling of animals is an accepted standard adopted by universities, federal agencies, and state and private contractors. The "AVMA Guidelines on Euthanasia" acknowledges that situations arise "involving free-ranging wildlife when euthanasia is not possible from the animal or human safety standpoint, and killing may be necessary" and that, in these situations, "The firearm and ammunition should be appropriate for the species and purpose. Personnel should be sufficiently skilled to be accurate, and they should be experienced in the proper and safe use of firearms, complying with laws and regulations governing their possession and use." As noted in the Final EIS, page 45, all actions that involving direct management of individual deer are to be conducted so as to minimize stress, pain, and suffering to the extent possible. NPS staff would minimize the degree of human contact during procedures that require handling of**

deer and use chemical immobilization drugs if needed to minimize stress. NPS has determined that compliance with the ASM and AVMA guidelines will help to ensure that all animals are treated humanely during any management actions.

0AL2010 - Alternatives Eliminated: Managed Hunt

Concern ID: 21815

CONCERN STATEMENT: **Commenters urged NPS to reconsider using a managed public hunt to cull the deer population at the national lakeshore for reasons that included its use in deer management in other, similar situations; its low cost (potentially offset by a hunting fee); and its recreation value for local hunters. These commenters pointed out the rich tradition of hunting in the area and the public service hunters would be performing to society by helping to reduce deer numbers. One commenter stated that the other solutions proposed: (1) achieve mixed results; (2) tie up valuable public funds that could and should be used for other programs; and (3) provide little or no usefulness of a renewable resource. Another commenter noted that other nearby lands had successfully conducted public hunts to control deer. Other commenters stated that public hunting was the principal management tool used by state agencies to manage free-ranging deer and that hunting was endorsed by both state and federal agencies to manage deer. One said that managed hunting was a natural solution because generations of native people were part of the ecology of deer as predators, similar to wolves and mountain lions. A commenter noted that safety concerns with hunting can be minimized by having potential hunters pass written exams and weapon proficiency tests and requiring them to hunt from elevated stands so that all shots are directed at the ground. One commenter noted that although NPS eliminated a managed hunt in part because "the possibilities of legislative acceptance may be remote and speculative," only by failing to attempt to pursue such avenues is the possibility precluded. A commenter noted that the Dunes Region Deer Study Committee consensus recommendations were to reduce deer numbers through special hunts or sharpshooting. A number of commenters stated that hunting would be low cost, far less expensive than sharpshooting, and might actually bring a monetary return to NPS. One commenter stated that a managed public hunt would be a far less costly solution than sharpshooting because public hunting would almost pay for itself, while sharpshooting would cost $500,000 over the life of the plan. Commenters also stressed that hunting would be beneficial because the meat from deer hunts could be given to low-income individuals. Commenters further stated that deer are a resource of the state and should, therefore, be harvested by the people of the state and that hunters fund state conservation programs and deserve the opportunity to hunt deer at the national lakeshore. A number of commenters stated that NPS should reevaluate a public hunting alternative that allowed bow hunting for reasons that include effectiveness, public safety, noise elimination, low cost of implementation, recreation, and provision of meat for distribution to low-income individuals.**

Representative Quote(s):

Corr. ID: 64 **Organization:** The Wildlife Society, IL Chapter

Comment ID: 101898 **Organization Type:** Conservation/Preservation

Representative Quote: *(3) long-standing policies (including hunting bans) which have contributed to deer over-abundance problems need to be addressed as part of the NPS "adaptive" deer management process. The long-standing Indiana State Park policy banning hunting was reconsidered in order to deal with overabundant deer on properties within their* *system, including Indiana Dunes State Park. Implementation of a public hunting program allowed them to achieve their deer population goal there. Perhaps it is time for the NPS to do the same. Thank you for the opportunity to comment.*

Response: **As noted in the final EIS, page 83, a public hunting alternative was not carried forward for further analysis because: (1) it would be inconsistent with existing laws, policies, regulations, and case law regarding public hunts in units of the national park system; (2) it would be inconsistent with long-standing basic policy objectives for national park system units; (3) and the likelihood that the NPS would change its long-standing servicewide policies and regulations regarding hunting in parks is remote and speculative.**

AL2030 - Alternatives Eliminated: Surgical Sterilization of Does

Concern ID: 21716

CONCERN STATEMENT: **One commenter urged NPS to consider both chemical and surgical sterilization of deer as a reasonable alternative for population control.**

Representative Quote(s): **Corr. ID:** 49 **Organization:** Humane Society of the United States

Comment ID: 101636 **Organization Type:** Nongovernmental

Representative Quote: *Based upon our offer and available research, the Final EIS must seriously re-evaluate the usefulness of both chemical and surgical sterilization to stabilize deer population density at IDNL. It behooves the Park to more closely examine these options especially in light of the social and political controversy that surrounds lethal deer management. The DEIS must also discuss how the park can justify the increased levels of reproduction that are known to occur in O. virginianus populations subjected to lethal harvest when alternatives are available.*

Response: **NPS analyzed the use of nonsurgical (chemical) reproductive control of does and included it as an element in several alternatives that were carried forward for full analysis. NPS also analyzed the use of surgical sterilization but eliminated it from detailed analysis because of concerns about its effectiveness, population stability, and genetic variability, as noted in chapter 2 of the EIS.**

Although this recommended alternative would offer the advantage of permanently sterilizing individual does, the animals would have to be captured, tagged, and surgically sterilized, usually requiring a licensed veterinarian, and then released back into the national lakeshore, as noted in the final EIS, page 86. In addition to the stress of the capture, individual animals would also be stressed by tranquilizers/anesthesia, surgical procedures, and recovery, which could increase mortality rates of sterilized individuals. Additionally, the long-term effects of this alternative on population genetics or behavior have not been well documented. Some researchers suggest that, depending on the type of sterilization used, changes in animal behavior would be expected (Warren and Warnell 2000). Removal of the ovaries, thus changing hormone production in the treated animal, would result in altered behavior. With a ligation procedure, normal hormone production would remain; however, this has been shown to result in repeated estrous cycles during the breeding season (Knox et al. 1988), extending the rut by modifying the male response behavior. The high numbers of deer needing treatment (a minimum of 523 does each year) in the national lakeshore and the actual amount of work required to manage surgical sterilization, as well as concerns about feasibility, stress to the animals, and

long-term effects on population genetics and behavior, preclude use of this alternative.

AL2040 - Alternatives Eliminated: Predator Reintroduction

Concern ID: 21822

CONCERN STATEMENT: **One commenter said that the only other option, besides lethal control, to manage deer in the national lakeshore was predator reintroduction, which the commenter supported but which the public would find unacceptable. Another said it was not practical to reintroduce predators in the national lakeshore, though this action would be preferable in terms of maintaining ecosystem health.**

Representative Quote(s):

Corr. ID: 33 **Organization:** Audubon Chicago Region

Comment ID: 101758 **Organization Type:** Conservation/Preservation

Representative Quote: *Most people also now know that the balance of nature requires predation to maintain the health of the ecosystem. If it were practical to do so, Audubon and many others would prefer the restoration of populations of wolves and mountain lions to the Dunes. Of course, this is not possible.*

Response: **NPS considered predator reintroduction as an alternative control method (final EIS, page 85). Coyotes are potential deer predators that reside throughout much of North America, including the Indiana dunes area. However, these species appear to be opportunists that capitalize on specific periods of deer vulnerability, and none of these predators has demonstrated a consistent ability to control deer populations. Although coyote populations have increased and their range has expanded in the last 20 years, in many areas, both deer and coyote populations have increased simultaneously. Biologists in some areas believe coyotes are partly responsible for declining deer numbers, but changes in deer populations in other areas appear unrelated to coyote density. Wolves and mountain lions are efficient deer predators but have been eliminated from much of the country. Lack of a suitable habitat precludes reintroducing these predators into Indiana Dunes National Lakeshore. A wolf has a home range averaging 30 square miles when deer are the primary prey, which is much larger than the national lakeshore's 20.7 square miles (Mech 1991). In addition, most of the national lakeshore area is surrounded by an urban/suburban environment; human safety issues make reintroduction of such predators inappropriate (MD DNR 1998). For the reasons described above relating to effectiveness, habitat limitations, and human safety concerns, reintroduction of predators was dismissed as a reasonable alternative.**

AL2050 - Alternatives Eliminated: Capture and Relocation

Concern ID: 21888

CONCERN STATEMENT: **One commenter suggested that if found helpful, NPS should employ relocation rather than euthanasia in considering its capture/euthanasia alternative.**

Representative Quote(s):

Corr. ID: 48 **Organization:** Not Specified

Comment ID: 100743 **Organization Type:** Unaffiliated Individual

Representative Quote: *If capture is deemed helpful, then there should be relocation rather* *than euthanasia.*

Response: **Although NPS considered capture and relocation (final EIS, page 85), capturing deer within Indiana Dunes National Lakeshore and relocating them would be a violation of NPS policy regarding translocation (NPS 2002a). Even if the policy were not in effect, relocating deer to areas a sufficient distance from the national lakeshore to ensure that they would not return would require permits, and because of concerns related to CWD testing, possible quarantine processes would be required. Given the abundance of deer in Indiana and most of the United States, recipients for such a program would be very limited. Also, live capture and relocation methods can result in high mortality rates among captured and/or relocated deer. Implementation of this alternative could result in the deaths of more than 50 percent of the deer during the first year after release (Jones and Witham 1990). In one study, only 15 percent of the relocated deer had survived one year after relocation (O'Bryan and McCullough 1985). These concerns led to dismissal of capture and release as a reasonable alternative.**

AL2300 - New Alternative: Research-Oriented Alternative

Concern ID: 21725

CONCERN STATEMENT: **One commenter urged NPS to consider a new alternative that would consist of a comprehensive monitoring study to document how vegetation, deer, and related elements change over time at the national lakeshore.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101525 **Organization Type:** Nongovernmental

Representative Quote: *A research-oriented alternative whereby the vegetation, deer, and other elements within IDNP would be subject to a comprehensive monitoring study to document how these elements change over time as conditions change, populations increase and decrease, stochastic events occur, the climate warms, etc. National parks, like IDNL, provide excellent potential research laboratories to conduct credible and comprehensive long-term natural studies.*

Response: **NPS does not believe that research alone is a viable alternative because it does not meet the principal management objectives of protecting sensitive plants and wildlife habitats while maintaining a sustainable deer population.**

AL2400 - New Alternative: More Aggressive Nonlethal

Concern ID: 21727

CONCERN STATEMENT: **One commenter urged NPS to consider a more aggressive nonlethal alternative combining teams of "shooters" to immediately begin delivering immunocontraceptives throughout the national lakeshore, with fencing and other measures employed widely to protect sensitive plants.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101527 **Organization Type:** Nongovernmental

Representative Quote: *A more aggressive non-lethal management alternative. This alternative assumes that there is, indeed, a legitimate reason or basis to justify a reduction in*

IDNL's deer population. This alternative would combine the options considered under Alternatives B and non-lethal deer management controls, including immunocontraception, in a single alternative which would entail a much more aggressive approach to the implementation of an immunocontraception, fencing, and repellent application effort within IDNL. A team of skilled and experienced persons would be assembled (paid for through a possible combination of public and private funds) to carry out this alternative over a four- to five-year period. Just like a team of sharpshooters may be used to kill deer under Alternative C, a team of shooters would be used to remotely deliver the immunocontraceptive vaccine to IDNL deer under this alternative allowing for the treatment and retreatment, if necessary, of as much of the entire deer population as is possible over a multiyear period. This approach would, during the life of this plan, result in a noticeable decline in deer numbers while avoiding a large scale slaughter operation. In addition, through the strategic use of fencing, repellents, and other non-lethal deer management tools, rare and sensitive plant species would be identified and, at least temporarily, protected until they reach a size, abundance, or density when the fences can be removed. While this alternative would require cooperation with the state wildlife agency and local communities, it is not a theoretical pipe dream but is, in fact, a viable and realistic option. Should the NPS consider exploring this type of alternative, AWI would be willing to help develop, evaluation, and seek funding to help support the plan.

Response: **No federally approved fertility control agent for application to free-ranging populations that provides multiyear efficacy for does (i.e., three to five years) is currently available (final EIS, page 50). A science team would evaluate any new product that claimed to possess those characteristics to determine whether its use would be feasible at the national lakeshore. If the science team recommended the use of the new agent, a small research project would be implemented to evaluate the new agent in the field. If such a research project were successful, only then would reproductive control be expanded and phased into the deer management program.**

Apart from the lack of a reliable reproductive control agent, with respect to the other nonlethal methods, the major expense and staffing requirements of using extensive fencing and repellents, as well as the greatly increased potential for conflicts with national lakeshore users, would make such an aggressive nonlethal approach untenable.

AL2500 - New Alternative: KC Airport Method

Concern ID: 21889

CONCERN STATEMENT: One commenter recommended that NPS consider the method used at the Kansas City airport.

Representative Quote(s): **Corr. ID:** 11 **Organization:** Not Specified

Comment ID: 100225 **Organization Type:** Unaffiliated Individual

Representative Quote: *Maybe someone should call the KC airport to ask about their very effective deer management plan that costs them nothing—a win win.*

Response: **The methods used at the Kansas City airport are not reasonable methods to use for deer management at Indiana Dunes National Lakeshore. The Kansas City airport plan, like most deer control plans at major airports, involves removal or mowing of much of the natural vegetation to degrade the habitat and reduce its attractiveness to foraging deer. The airport has no obligation or concern to maintain natural habitats; its priority is human safety, including protection from the threat of deer–aircraft collisions. In contrast, NPS's priority is to maintain a diversity of natural habitats, as**

well as a sustainable deer population. Therefore, degrading habitats is not feasible and would not meet national lakeshore objectives with respect to vegetation and deer management.

AL4000 - Alternatives: New Alternatives or Elements

Concern ID: 21824

CONCERN STATEMENT: **A commenter urged NPS to conduct its deer culling in the same way wild predators take prey—by taking the weakest animals—but the commenter recommended that the killing be done in a humane way and that a rabbi be consulted to make sure deer culling was done humanely.**

Representative Quote(s): **Corr. ID:** 44 **Organization:** Not Specified

Comment ID: 100710 **Organization Type:** Unaffiliated Individual

Representative Quote: *Predators hunt and kill the weakest. You should do the same by humane means.*

Response: **The sharpshoot culls would be done humanely, and any deer not immediately killed would be put down afterward as quickly as possible, but there would be no selection criteria for culling only sick or weak animals. The final EIS notes (page 63) that the national lakeshore's deer population, as of fall 2005, was estimated at 1,162, based on 70 deer/mi^2 in East Unit zones (covering 12.5 square miles) and 35 deer/mi^2 in West Unit and outlying zones (covering 8.2 square miles). The population has almost certainly increased since then. NPS's proposed culling operations would be designed to reduce the population within three years to one that could be sustained at about 70 to 100 deer. Sharpshooting operations would be conducted at bait stations, and deer would be culled regardless of sex or condition. Although removing does would reduce the population level more efficiently over the long term, during the first three years of treatment, both does and bucks would be removed. The culling would not necessarily take health or the apparent condition of the animals into account. Observations of the deer have indicated that the population is healthy. Culling only apparently sick or weakened animals would not accomplish the population objective, because only a small percentage of the population would likely show such condition. As a part of the monitoring program, deer that display signs of disease would be selected over other animals as a part of the targeted surveillance program. The final EIS, page 45, describes the monitoring, and Appendix C describes targeted surveillance.**

AL4100 - Support No Action

AL4110 - Oppose No Action

AL4120 - Alternative A, No Action, Does Not Adequately Address Deer Management Needs

Concern ID: 21775

CONCERN STATEMENT: **Commenters expressed concern that employing the management approach of the no-action alternative—limited use of fencing and repellents—does not reduce deer**

numbers and comes with a continuing annual cost. Commenters recommended NPS act quickly and decisively to implement an aggressive, active program to improve the health of the deer herd and minimize the negative impacts on other plant and animal species.

Representative Quote(s):

Corr. ID: 66 **Organization:** Quality Deer Management Association

Comment ID: 101560 **Organization Type:** Recreational Groups

Representative Quote: *Alternative A - No Action -- This approach does not target the deer abundance problem. The current deer population is negatively impacting the Park's native vegetation and other wildlife species. An aggressive, active deer management program should be implemented to improve the health of the deer herd and minimize the negative impacts on other plant and animal species. Alternative A will not meet those objectives.*

Response: **NPS recognizes that the no-action alternative, with deer management methods confined to limited use of fencing and repellents, would not reduce deer numbers and would involve a continuing annual cost. Although no action is not the NPS-preferred alternative, it must be analyzed in an EIS. Alternative D, with a range of lethal and nonlethal methods available for deer management, is the NPS-preferred alternative. Under alternative D, the national lakeshore would act to reduce the population to its desired level within three years of implementation.**

AL4210 - Support Alternative B, Nonlethal Actions

AL4215 - Reasons Alternative B, Use of Fencing and Repellents, Is Not a Viable Method

Concern ID: 21828

CONCERN STATEMENT: **Commenters stated that although fencing can reduce deer damage and is reliable for addressing site-specific areas, it does not address deer abundance and is prohibitively expensive for large-scale use. Fencing also moves the problem elsewhere or further increases impact in the unfenced adjacent areas.**

Representative Quote(s):

Corr. ID: 27 **Organization:** Shirley Heinze Land Trust

Comment ID: 101827 **Organization Type:** Conservation/Preservation

Representative Quote: *Limited use of fencing and repellants is of little value, does not reduce deer numbers and comes with a continual annual cost. Alternative B does not have the plausibility to reduce deer numbers in a crucial timely fashion and comes with an astronomical cost over 15 years.*

Response: **NPS agrees with the commenter. As described in the Final EIS, page 47, additional fencing and exclosures would be constructed under alternative B to protect plant species and biodiversity within localized areas of the national lakeshore. Approximately 15 small protection fences would be constructed per year and approximately 303 exclosures of 20 square meters or larger would be constructed throughout the national lakeshore. These structures would eliminate deer browsing in the exclosures and protect an estimated 936 acres, or about 7 percent, of the national lakeshore. However, the effect of browsing on vegetation in the remaining**

unprotected areas of the national lakeshore would be similar to alternative A.

AL4216 - Oppose Alternative B

AL4220 - Support Fertility Control

AL4230 - Oppose Fertility Control

AL4240 - Reasons NPS Should Not Use Fertility Control

Concern ID: 21809

CONCERN STATEMENT: **Commenters stated that fertility control is not a reliable means of deer control for reasons that include lack of efficacy when used in other locations where deer are free-ranging, high cost relative to other methods, low likelihood that a four-year or longer-term fertility agent will be developed, lack of testing on long-term fertility control agents, adverse effects to deer if they need direct handling, and the potential to transfer the agent to humans if they consume meat from a treated deer. Commenters said that a fertility control agent might stabilize but would not reduce the deer population; that if the population were reduced by a fertility agent, areas of prime habitat would be recolonized by deer; and that deer are prey animals that do not naturally control their populations but, rather, are controlled by external factors, such as predation.**

Representative Quote(s): **Corr. ID:** 66 **Organization:** Quality Deer Management Association

Comment ID: 101562 **Organization Type:** Recreational Groups

Representative Quote: *The [Alternative B] use of fertility control to limit or prevent new animals from being born into the population also does not address the current overabundance issue. Much research has been conducted over the past four decades to develop an effective contraceptive that can be used on free-ranging herds. Unfortunately much confusion surrounds the status of fertility control agents. The perception that overabundant deer herds can be controlled solely with fertility drugs is false. Successful fertility control may limit population growth but it does little to reduce the existing population. In small, isolated areas inaccessible to hunting or sharpshooting programs, this alternative may be useful at maintaining deer densities at acceptable levels following a herd reduction. However, this alternative does not reduce deer populations, it is expensive and retreatment of does is necessary. There also may be unknown long-term effects on deer behavior.*

Response: **NPS agrees that fertility control alone is not currently a reliable or effective means for controlling the deer population. As noted in the final EIS, (page 50), no federally approved fertility control agent is available for application to free-ranging populations that provides multiyear efficacy for does (i.e., three to five years).**

AL4250 - Reasons NPS Should Use Fertility Control

Concern ID: 21641

CONCERN STATEMENT: **Commenters expressed concern that NPS did not adequately acknowledge the benefits of fertility control and that the NPS proposal for its implementation was too restrictive and biased toward first using lethal methods. One commenter cited studies purported to demonstrate that fertility control could be implemented immediately and would reduce deer numbers in the national lakeshore's free-ranging herd as long as enough does were treated.**

Representative Quote(s):

Corr. ID: 49 **Organization:** Humane Society of the United States

Comment ID: 101631 **Organization Type:** Nongovernmental

Representative Quote: *Rates of free-ranging deer increase or decline during PZP vaccination programs are directly related to the proportion of deer that are treated each year (Rutberg et al. 2004). For most ungulates, populations decline when more than 60% of females are treated with a contraceptive (Garrott 1995, Rutberg et al. 2004). These studies indicate that immunocontraception can stabilize and reduce populations of wild ungulates at the landscape scale.*

Rutberg, A. T., R. E. Naugle, L. A. Thiele, and I. K. M. Liu. 2004. Effects of immunocontraception on a suburban population of white-tailed deer Odocoileus virginianus. Biological Conservation 116:243-250.
Garrott, R. A. 1995. Effective management of free-ranging ungulate populations using contraception. Wildlife Society Bulletin 23:445-452.

Response: **NPS extensively reviewed reproductive control agents, including immunocontraceptives and a variety of other agents, and found that none would be effective in the near term to substantially reduce the free-ranging deer population at the national lakeshore.**

Reproductive control agents generally decrease population levels slowly. At best, with 90 percent of the female deer treated, a 5-percent decline in the population would likely be expected after several years of treatment. Hobbs et al. described a model that suggests deer density would remain constant if 90 percent of the initial females are treated with a long-term reproductive control agent. Subsequently, 90 percent of female fawns would require treatment. This method would stabilize the population if the average mortality rate were 10 percent. However, this result does not hold for short-duration agents (i.e., those with one-year efficacy). With these agents, 90 percent of reproductively mature females would require treatment each year in order to maintain constant herd numbers (Hobbs et al. 2000). Reproductive control techniques are best suited to localized populations in which the number of breeding females to be treated is small (e.g., fewer than 100 deer) and managers are trying to maintain the population between 30 percent and 70 percent of carrying capacity (Rudolph et al. 2000).

The articles listed in the comment do not introduce any new information that was not considered when NPS and the science team for the national lakeshore deer management plan/EIS evaluated fertility control as a management option; therefore, the articles do not change any conclusions or alter any analysis completed for this plan.

AL4260 - Reasons NPS Should Not Capture and Euthanize Deer under Alternative C

Concern ID: 22018

CONCERN STATEMENT: **A commenter said that deer experience the same adverse effects from handling with capture/euthanasia as they do with trap and transfer.**

Representative Quote(s):

Corr. ID: 66 **Organization:** Quality Deer Management Association

Comment ID: 101564 **Organization Type:** Recreational Groups

Representative Quote: *The [Alternative C] trap and kill alternative is a variation of a trap and transfer program. This alternative is labor intensive, expensive, impractical and stressful to deer before they are euthanized. This alternative is not a viable option for a long-term successful deer management program.*

Response: **The capture/euthanasia method is expected to be a minor part of the program that would be used only in specific locations where sharpshooting would not be feasible. It would be retained as a possible control method because, otherwise, NPS would be limited to no action in those locations or to the use of fencing or repellents to protect sensitive plants.**

AL4300 - Support Alternative C, Sharpshooting and Capture/Euthanize

AL4310 - Oppose Alternative C, Sharpshooting and Capture/Euthanize

AL4320 - Alternative C: Reasons NPS Should Use Sharpshooting or Capture/Euthanize

Concern ID: 21848

CONCERN STATEMENT: **Commenters stated that the benefits of using sharpshooting would include the quick kill and rapid herd reduction that would immediately address NPS's need to reduce deer impacts on habitats and help reduce deer–vehicle collisions. One commenter said that sharpshooting is far more expensive compared to hunting costs than NPS estimates, but this option is preferable in areas inaccessible to hunting and should be the method used by NPS.**

Representative Quote(s):

Corr. ID: 66 **Organization:** Quality Deer Management Association

Comment ID: 101563 **Organization Type:** Recreational Groups

Representative Quote: *Alternative C - Combined Lethal Actions --*
Sharpshooting is considered the most humane method of reducing a deer herd by the American Veterinary Association. Sharpshooting programs have been successfully employed in many communities across the country by private consultants, local police authorities and federal agency personnel. This approach is proven to be successful at reducing deer populations, and the meat can be donated to food banks. Deer populations can be reduced quickly and this is the preferred removal technique in areas inaccessible to hunting. However, this approach is expensive relative to hunting, and it is a controversial technique if hunting is an option. We believe the estimated costs listed in your draft management plan/environmental impact statement grossly underestimate what the actual sharpshooting costs would be for the Lakeshore. This is a viable alternative in areas inaccessible to hunting and it should be incorporated into the Park's deer management program.

Response: **Cost was only one of many factors NPS considered in identifying and comparing deer control methods. Additional factors included efficacy, safety, and ease of implementation. NPS agrees that the benefits of sharpshooting would include a**

quick kill and rapid herd reduction that would immediately address the need to reduce deer impacts. NPS stands by its estimate of costs for sharpshooting as compared to a managed hunt, as described in the final EIS, page 83:

> **Based on the literature, costs for managed hunts generally range between $83 and $237 for each deer removed (Warren 1997). A white-tailed deer study in Minnesota that compared four lethal removal methods found that the cost of a managed hunt averaged $117 per deer removed, based on the average net cost per deer after including revenues generated by selling permits to participating hunters (Doerr et al. 2001). Even after considering permit revenue, however, the cost of a managed hunt is not necessarily lower than other removal methods, such as sharpshooting. Warren (1997) documents that costs for sharpshooting programs have ranged from $72 to $260 per deer harvested. In the Minnesota study mentioned above, the cost for sharpshooting averaged $121 per deer harvested (compared to $117 per deer harvested in the managed hunt after revenue from license sales was considered; Doerr et al. 2001). Gettysburg National Military Park reported sharpshooting costs averaged $128 per deer (Frost et al. 1997). The range of costs for sharpshooting ($72 to $260 per animal harvested) substantially overlaps the range of costs reported for managed hunts ($83 to $237per animal harvested), suggesting that minimal to no cost savings are realized by using citizen hunters.**

AL4330 - Alternative C: Reasons NPS Should Not Use Sharpshooting

Concern ID: 21850

CONCERN STATEMENT: **One commenter stated that sharpshooting was dangerous because of the buffering that is required for high-powered rifles and the difficulty of implementing those buffers in the national lakeshore. Other commenters said that the costs of sharpshooting are extremely high and may be higher than NPS estimates.**

Representative Quote(s): **Corr. ID:** 13 **Organization:** Not Specified

Comment ID: 100231 **Organization Type:** Unaffiliated Individual

Representative Quote: *Sharp shooters with rifles are dangerous because high powered rifles need a buffered area (as required in MI hunting regulations) and would be hard to control inside the park areas.*

Response: **NPS agrees that sharpshooting does pose safety risks and has disclosed this in the EIS. Every reasonable precaution would be taken to make deer removal operations safe and successful. NPS would employ buffers as necessary to protect the public. For example, sharpshooting would not occur within 100 feet of an occupied building. Use of these buffers and the numerous other safety precautions that would be employed would greatly reduce any inherent danger. Qualified federal employees or contractors trained in all aspects of sharpshooting would perform these activities. In cases where sharpshooting is deemed not feasible for safety or other reasons, capture and euthanasia would be employed for deer removal. NPS stands by its cost estimates for sharpshooting and considers them on a par with costs of a managed hunt. The range of costs for sharpshooting ($72 to $260 per animal harvested) substantially overlaps the range of costs reported for managed hunts ($83 to $237 per animal harvested), suggesting that minimal to no cost savings would be realized with the use of citizen hunters.**

AL4400 - Preferred Alternative D, Nonlethal and Lethal Control

Concern ID: 21831

CONCERN STATEMENT: **Many commenters agreed that alternative D would provide the best approach to address deer management requirements and bring the population into balance with the habitat. Others expressed concern about the high cost of implementing alternative D.**

Representative Quote(s):

Corr. ID: 37 **Organization:** U.S. Fish and Wildlife Service

Comment ID: 101734 **Organization Type:** Federal Government

Representative Quote: *We concur that Alternative D is the most appropriate alternative for INDU. Infrared imaging and spotlight surveys conducted within portions of INDU beginning in 1991 have shown recent deer densities between 50 deer per square mile (mi^2) and 150 deer/mi^2, while aerial surveys between 1998 and 2002 estimated 70 deer/mi^2 in the East Unit, where most of the deer are found. Even 50 deer/mi^2 are considerably higher than the 10 to 20 deer/mi^2 considered as the management goal for the park, based upon scientific studies from a number of sites nationwide. These studies have addressed both the health of the deer themselves and the health of the ecosystems they depend upon. Alternative D would quickly and safely reduce the very high deer population to a density that is beneficial to the deer, the ecosystem, and the public and maintain those lower numbers for the life of the plan.*

Response: **NPS agrees with the commenter that alternative D would quickly and safely reduce the high deer population to a density that is beneficial to the deer, the ecosystem, and the public and maintain those lower numbers for the life of the plan. NPS understands that some individuals might consider the estimated cost of $2.6 to $2.9 million for implementation of alternative D to be high. However, such costs are considered to be reasonable over the life of the plan. Furthermore, about two-thirds of the estimated amount ($1.9 million) represents contingent costs that would be used for reproductive control measures once deer numbers have been reduced and then only if a proven agent is found.**

AL4410 - Support Alternative D

AL4420 - Oppose Alternative D

AL4500 - Oppose Lethal Deer Control under Alternatives C and D

Concern ID: 22339

CONCERN STATEMENT: **Commenters opposed the use of lethal measures as part of the deer management plan under alternatives C and D for a number of reasons. Some stated that NPS had a bias toward lethal control and that the plan was simply a way to justify that pre-decision. Others stated that NPS is pandering to hunters and that hunting is no longer a socially acceptable practice. Some commenters stated that all nonlethal measures should be employed first and lethal measures taken only as a last resort.**

Representative **Corr. ID:** 49 **Organization:** Humane Society of the United States

Quote(s):

Comment ID: 101607 **Organization Type:** Nongovernmental

Representative Quote: *While we understand the NPS's concerns over the perceived negative impacts caused by white-tailed deer (Odocoileus virginianus), the HSUS does not believe that lethal control is either a socially acceptable practice nor, in the long-term, the most ecologically sound approach to resolving conflicts with deer. Instead, we endorse Alternative B: Combined Non - Lethal Actions - Fencing, Repellents, and Reproductive Controls that would include strategic exclusion of deer, the use of repellents and possibly long term population stabilization through reproductive controls. The HSUS asserts that this alternative will better serve the stated purposes of the National Lakeshore to "preserve, maintain, and restore the integrity and character of the natural resources and processes and protect cultural resource values" while providing "educational, inspirational, and recreational opportunities" that "inspire in the public an appreciation of and sense of personal stewardship for National Lakeshore resources."*

Response: **The only reliable methods currently available for effective control of free-ranging deer, where deer are overabundant and their population must be immediately reduced, are lethal methods. In the future, if a nonlethal method were shown to be effective, it would be integrated into the national lakeshore's deer management actions. NPS is not biased toward hunting and, in fact, rejected hunting as a reasonable alternative.**

AL4510 - Support Lethal Control for Deer Management

AL4515 - Disposal of Deer Carcasses after Lethal Control

Concern ID: 22007

CONCERN STATEMENT: **Commenters expressed concern about the use of disposal pits for deer carcasses in terms of how they might affect visitors who chance on them or other animals that might be attracted to them.**

Representative Quote(s): **Corr. ID:** 43 **Organization:** Not Specified

Comment ID: 100681 **Organization Type:** Unaffiliated Individual

Representative Quote: *No matter what Alternative is selected, a better way to dispose of deer carcasses unsuitable for human consumption must be found. The huge pits proposed in the report, even though planned for disturbed areas, will still pose a threat to restoration of disturbed sites and likely will be targets for disturbance by other animals.*

Response: **Disposal of deer in the national lakeshore would be relatively uncommon. NPS would first test deer culled by sharpshooting or by capture/euthanasia for CWD. CWD-positive deer would be disposed of following the recommended guidelines in the plan, which include incineration, alkaline digestion, or landfill. The disposal pits in the national lakeshore are not intended for disposal of CWD-positive deer. If CWD is not present, which would be the expected case, and if the animal is otherwise not sick or injured, then NPS will make efforts to donate the meat to organizations or groups that help get wild game to the needy. Disposal pits in the national lakeshore would be used only for deer that do not have CWD but that are otherwise sick or injured. There are not expected to be large numbers of these, so the likelihood of**

substantive threats to restoration or disturbance by other animals would be low.

AL4520 - Reasons NPS Should Not Use Skilled Volunteers as Sharpshooters in Alternatives C and D

Concern ID: 21384

CONCERN STATEMENT: **Commenters opposed the use of skilled volunteers in sharpshooting, claiming that this action violates the Organic Act and its implementing regulations, the Volunteers in the Parks (VIP) Act, and NEPA. Commenters said that it would also introduce serious policy and safety concerns.**

Representative Quote(s): **Corr. ID:** 59 **Organization:** Humane Society of the United States

Comment ID: 101779 **Organization Type:** Nongovernmental

Representative Quote: *As discussed more fully below, The HSUS believes the use of private hunters as volunteer "authorized agents" in the lethal reduction of the deer herd in the National Lakeshore is unlawful under the National Park Service Organic Act and its implementing regulations, the Volunteers in the Parks Act, and the National Environmental Policy Act. In addition, the decision to use volunteer hunters in this manner is imprudent and implicates serious policy and safety concerns.*

Response: **NPS will use only professional sharpshooter contractor personnel or NPS staff for the actual shooting in cull operations. NPS would not use skilled volunteers as sharpshooters. Volunteers may be used in secondary roles to assist in reduction activities that do not involve using firearms.**

AL4530 - Reasons NPS Should Use Skilled Volunteers as Sharpshooters in Alternatives C and D

Concern ID: 21811

CONCERN STATEMENT: **Commenters stated that NPS policy does not prohibit using volunteers and that there are numerous reasons to employ volunteers in sharpshooting of deer, including the low cost compared to hiring contractors and the benefit to local hunters who see the value in reducing the deer population. One commenter said that a national hunting organization had many members in the national lakeshore region who were well qualified to act as agents for NPS as volunteer sharpshooters. The same commenter urged NPS to revise the EIS to ensure that use of volunteer sharpshooters was mentioned wherever sharpshooting measures were described.**

Representative Quote(s): **Corr. ID:** 26 **Organization:** Safari Club International

Comment ID: 101856 **Organization Type:** Recreational Groups

Representative Quote: *SCI and SCIF are aware that significant research has been done on the use of qualified volunteers in deer management. For example, data collected by the New Jersey Department of Fish and Game reveals that the use of volunteers, even when compared to professional sharpshooting contractors, is an efficient and cost-effective population reduction tool. For the last 13 years, the State of New Jersey has been using volunteers from the hunting community for deer management. On Watchung Reservation in Union County, New Jersey, hunting has been prohibited since at least 1900 and the deer population has risen significantly, resulting in damage to vegetation and increased vehicle accidents on the roads* *surrounding the Reservation. In 1994, the County established a program using qualified volunteers from the hunting community to reduce the deer population. Volunteer hunters qualify for the program via a marksmanship test and are stationed in predetermined locations in the Reservation. Deer are pursued over bait. In the first year of the program, over a four-day period, 92 volunteers removed 88 deer. The program has continued in every year but 2002, with similar success. During 2006–2007, 12 qualified volunteers from the hunting community removed 70 deer during two days. The cost per deer removed in 2006–2007 was between $55 and $65. The per-deer costs are attributable almost entirely to butchering fees. The program has resulted in thousands of pounds of venison going to food banks. Volunteers who participate at least one and one half days in the program are given 20 lbs of venison in recognition of their efforts. Further information about this project and New Jersey's Community Based Deer Management Program, is available from the New Jersey Department of Fish and Game. http://www.njfishandwildlife.com/cbdmp.htm.*

Response: **NPS would not use volunteers in sharpshooting to cull deer at Indiana Dunes National Lakeshore. Only professional contractor personnel or NPS staff would be used in the actual shooting. The high cost and staff effort involved in using volunteers to do the shooting makes use of volunteers infeasible for the national lakeshore.**

AL4550 - Support NPS Using Volunteers as Deer Sharpshooters

AL4600 - Alternative D, Fencing

Concern ID: 21854

CONCERN STATEMENT: **One commenter urged NPS to consider fencing only as a short-term measure to protect sensitive plants while other measures reduce the deer population. The commenter expressed concern that fencing causes an unnatural situation where deer are excluded from habitats they would otherwise naturally occupy and that it has some level of effect on the plants, though not severe as what is seen now at the national lakeshore.**

Representative Quote(s): **Corr. ID:** 33 **Organization:** Audubon Chicago Region

Comment ID: 101765 **Organization Type:** Conservation/Preservation

Representative Quote: *Though Alternative D is the best choice, in the long run, it seems important to minimize the use of fencing to protect plants from over-abundant deer. Fencing, though temporarily very much needed, represents an admission that the surrounding ecosystem is out of balance and suffering. What's more, the complete absence of deer is not natural. For deer to browse and graze on some percentage of the vegetation, including the rare species, is part of the historical balance under which all species evolved. When over-populated deer threaten to eliminate or severely deplete some species, the fencing may be needed—especially for the protection of invertebrate animals that may be dependent on healthy populations of the plant species in question. But long-term or extensive fencing seems counter to the natural resource and educational objectives of the park.*

Response: **Some rare plants might continue to experience adverse impacts from deer even after lethal control measures have been taken; thus, despite the fact that long-term fencing does not conform to a natural ecological situation, those plants would remain fenced. The longer-term fencing would be needed to meet NPS requirements to protect rare plants.**

GA1100 - Impact Analysis: Comparison with NEPA Tenets

Concern ID: 21855

CONCERN STATEMENT: **One commenter stated that NPS had employed an unconventional and inappropriate paradigm by comparing the impacts of the alternatives against the NEPA tenets. This commenter further stated that these tenets were basically guidance for how human uses of the environment and measures to protect the environment should be judged, rather than how the impacts of more abundant or less abundant deer should be judged.**

Representative Quote(s):

Corr. ID: 51 **Organization:** Animal Welfare Institute

Comment ID: 101530 **Organization Type:** Nongovernmental

Representative Quote: *Consistency with the Purposes of the National Environmental Policy Act: In yet another example of a bizarre interpretation of NEPA, the NPS assesses each of the alternatives seriously evaluated in the DEIS, including the preferred alternative (Alternative D) in respect to the fundamental standards that are the basis for the NEPA statute. This effort is literally like trying to force a square peg through a round hole since there are no requirements that NEPA alternatives be subject to such a comparative analysis with the basic tenets of NEPA nor does such a comparison make any sense whatsoever. The basic tenets are just that, the fundamental principles underlying NEPA which establish overall guidance or direction for federal agencies when implementing NEPA. Using them as a measuring stick for alternatives simply doesn't fit or work. For example, the fifth tenet refers to a balance between population and resource use that would permit high standards of living and a wide sharing of life's amenities. The term population as used here refers to the human population, not a deer population. As such, comparing a deer management alternative to this tenet produces a rather comical result. Similarly, the third tenet refers to the need to attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences. Again, this tenet applies to beneficial uses of the environment for humans and, consequently, the reference to degradation, risk of health or safety, or other undesirable and unintended consequences pertain to those human uses of the environment not to how animals, like deer, use the landscape.*

Response: **The commenter is referring to a comparison in the DEIS of the alternatives on the basis of elements listed in NEPA section 101(b). NPS is required by NEPA and its implementing regulations to compare how alternatives considered in an EIS and decisions based on an EIS will or will not achieve the requirements of NEPA sections 101 and 102(1). By doing this comparison and disclosing such to the public, the NPS is fulfilling its obligations under 40 CFR 1502.2.**

GA3000 - Impact Analysis: General Methodology for Establishing Impacts/Effects

Concern ID: 21887

CONCERN STATEMENT: **One commenter stated that the DEIS impact analysis was inadequate because NPS acted in haste in preparing the EIS and that the decision had already been made to manage deer using lethal methods without adequate scientific data or proper analysis of impacts to support the decision. Because of this, the decision-making was necessarily based largely on conjecture and best guesses.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101548 **Organization Type:** Nongovernmental

Representative Quote: *The deficiencies in the DEIS are indicative of an agency that is acting in great haste to finally initiate a project that it has likely wanted to start for many years only to be hamstrung by the NEPA planning process. As a consequence, instead of embracing the value of NEPA as a planning tool, the NPS saw it as an obstacle to a course of action that the NPS had long ago decided to pursue. Thus, in addition to the obvious bias within the NPS in favor of the deer slaughter, it had predetermined the outcome of this planning process and then crafted an analysis that achieves that outcome with virtually no site-specific scientific evidence or data. The only way to resolve these inadequacies is for the NPS to, at a minimum, suspend the current planning process pending the acquisition of new data/evidence, the analysis of that data, the supplementation/ amendment to the DEIS, and its republication for public comment.*

Response: **Rather than being hamstrung by the NEPA process with regard to deer management, NPS has been aided by the process in evaluating the science of deer management and deer effects and in identifying and analyzing a range of deer management alternative plans. NPS had made no decisions about deer management at the national lakeshore before beginning the deer management planning and impact analysis described in the EIS. In developing the draft EIS, NPS used a science team that reviewed the science base; members included Ralph Grundel, Animal Ecologist and Researcher, USGS, Indiana Dunes National Lakeshore; Noel Pavlovic, Plant Ecologist and Researcher, USGS, Indiana Dunes National Lakeshore; Peter Dratch, Endangered Species Specialist, NPS, Fort Collins; H. Brian Underwood, Ph.D., Wildlife Biologist, Leader of the Cooperative Park Studies Unit of the USGS, Patuxent Wildlife Research Center, USGS Cooperative Park Studies Unit; and William F. Porter, Ph.D., Professor of Wildlife Ecology, College of Environmental Science and Forestry, Syracuse University. The USGS research station based here has done substantial study of the national lakeshore. Therefore, NPS believes it has sufficient site-specific information and has conducted a thorough scientific evaluation that is fully adequate to make sound deer management decisions for the national lakeshore.**

GS1000 - Greetings and Salutations

HS1000 - Health and Safety of Deer Management Personnel

Concern ID: 21776

CONCERN STATEMENT: **A commenter stated that the draft EIS is inadequate because it fails to analyze the potential safety risks resulting from exposure to CWD and risks associated with the handling, processing, and transport of deer.**

Representative Quote(s): **Corr. ID:** 59 **Organization:** Humane Society of the United States

Comment ID: 101794 **Organization Type:** Nongovernmental

Representative Quote: *The Draft EIS mentions but downplays the health and safety impacts of implementing either Alternative C or D. It states "impacts would be adverse, long-term, and negligible to minor." Draft EIS at 77. The Draft EIS goes on to state "cumulative impacts would be related to...increased use of firearms in the region; these impacts would be adverse, long-term and moderate." Id. The Draft EIS entirely fails to include potential exposure to Chronic Wasting Disease ("CWD") and risks associated with the handling, processing, and* *transport of deer. It is clear that the implementation of either Alternative C or D is a "hazardous [and] dangerous occupation where the risks of injury are foreseeable," 16 U.S.C. S 18S; S. Rep. No. 1013 at 2, and involves "carrying modern firearms," Department of Interior National Park Service Reference Manual No. 7: Volunteers in Park Service 14, Final Draft, available at http://www.nps.gov/archive/ volunteer/RM7_final_draft-O-05.pdf (last accessed March 17, 2009). This use of volunteers contravenes the VIP Act, its legislative history, and NPS's rules regarding the use of volunteers.*

Response: **NPS natural resource staff and outside researchers frequently work with wildlife in parks. NPS has established guidelines to ensure the safety of personnel involved in these projects. The NPS policy Safe Work Practices for Employees Handling Wildlife will be followed to protect staff and volunteers. The purpose of this document is to provide guidance that will assist NPS staff in identifying and mitigating risks associated with handling wildlife so that important natural resource management and visitor protection tasks can be performed safely. The activities, conditions, risks, and personal protective equipment information below is excerpted from a table in Safe Work Practices for Employees Handling Wildlife and is an example of the process used to determine required safety equipment to protect employees.**

Activity—Handling dead animal for necropsy, dissection, or food processing.
Conditions—Healthy appearing animal that is collected for management or research or animal found dead with no known zoonotic disease risk.
Activity Risk—Risk is increased due to closer contact with a variety of body fluids and tissues, but no reason to suspect presence of pathogens or vectors.
PPE—Disposable gloves. Coveralls, lab coat, or dedicated clothing.

Activity—Handling dead animal for necropsy, dissection, or food processing.
Conditions—Animal found dead, animal that has been observed ill, or species with known zoonotic risk.
Activity Risk—Risk is increased due to closer contact with a variety of body fluids and tissues and unknown cause of death.
PPE—Disposable gloves, Coveralls, lab coat, or dedicated clothing, Eye and respiratory protection as appropriate to the level of disease risk, Shoe covers or boots which can be disinfected.

On the issue of CWD risk, the safety measures recommended by the Centers for Disease Control and Prevention for hunters handling animals potentially infected with CWD are straightforward and easy to follow. Persons involved in field-dressing carcasses should wear gloves, bone-out the meat from the animal, and minimize handling of the brain and spinal cord tissues. Although more research is needed regarding transmission of CWD, the article listed below indicates that a substantial species barrier to transmission of CWD exists between elk and humans. Therefore, NPS considers the risk of CWD transmission to staff or volunteers following recommended safety protocol to be negligible.

Kong, Q., S. Huang, W. Zou, et al. "Chronic Wasting Disease of Elk: Transmissibility to Humans Examined by Transgenic Mouse Models." ***Neurobiology of Disease*** **25(35):7944–9.**

IV100 - Issues: Visitor Use or Experience Issues

Concern ID: 21886

CONCERN STATEMENT: **One commenter said that NPS offered no data to demonstrate that any visitors come to the national lakeshore to watch birds or to search for rare plants or, if such data existed, that the quality of the experience of these visitors had been diminished by**

the impact of deer. This commenter said that NPS should not manufacture claims that have no basis in fact.

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101505 **Organization Type:** Nongovernmental

Representative Quote: *In regard to its discussion of visitor use and experience in the DEIS, the NPS has no evidence to suggest that the deer population has adversely impacted any user group and so it has made up such evidence by suggesting that visitors who come to IDNL to watch birds or search for rare plants may be less satisfied as deer number increase and rare plants and birds are negatively affected. DEIS at 22. The NPS offers no data to demonstrate that any visitors come to the IDNL for either of those purposes or, if such data existed, that the quality of their experience has been diminished by the deer. The NPS should stick to the data it has and not manufacture claims that have absolutely no basis in fact.*

Response: **Complaints NPS has already received from friends and neighbors of the national lakeshore who helped to identify this visitor experience issue and amateur botanists offer ample evidence that it is problematic. NPS believes it has sufficient reason to expect that certain user groups would become increasingly dissatisfied with their experience in the national lakeshore if deer management is not addressed. However, the potential for a diminishing visitor experience is not the driver for control of deer. Rather, the impetus for control is the degree to which deer affect sensitive plants and native habitats in the national lakeshore that NPS has a responsibility to protect.**

LC1000 - Local Community Public Safety

Concern ID: 21627

CONCERN STATEMENT: **Commenters expressed concern that the use of sharpshooters to cull deer would pose a hazard to people in communities adjacent to the national lakeshore.**

Representative Quote(s): **Corr. ID:** 46 **Organization:** *Not Specified*

Comment ID: 100716 **Organization Type:** Unaffiliated Individual

Representative Quote: *Ensure that weapons would be used only in locations beyond where an accidental stray bullet could potentially impact homes, public roads, trail, bike paths, etc. and that these are closed and vacated during cull times, and the public is aware of cull times to avoid the area, should a lethal alternative be selected*

Response: **The safety of visitors, nearby residents, and the general public is an extremely important consideration in implementing deer control in the national lakeshore. Deer control areas, parking lots associated with those areas, and trails that might allow access to those areas will all be closed during any shooting periods, and national lakeshore staff will enforce closures. Buffer areas will be established between the cull area and all neighboring residences. NPS will not allow recreational hunting, nor will volunteers be used for culling; cull activities will be carried out only by federal employees or professional sharpshooter contractor personnel. These professionals will fire from elevated stations or with a dune as a backstop so that the shot trajectory will be into the ground. Firing direction will be established to ensure that it is away from any residential areas.**

As described in the final EIS, page 56, high-power, small-caliber rifles would be used from close range. Every effort would be made to make the shootings as humane as possible. Noise suppression devices and night vision equipment would be used to

reduce disturbance to the public. Activities would comply with all federal laws administered by the Bureau of Alcohol, Tobacco, and Firearms. Sharpshooting would primarily occur at night (at any time between dusk and dawn) during the late fall and winter months, when deer are more visible and few if any visitors are in the national lakeshore. In some restricted areas, sharpshooting could be conducted during the day, if needed, maximizing effectiveness and minimizing overall time of visitor restrictions. In such cases, the areas would be closed to visitors. The public would be notified of any national lakeshore closures in advance. Exhibits about deer management would be displayed at visitor centers, and information would be posted on the national lakeshore's website to inform the public about deer management actions. Visitor access would be limited as necessary while reductions are taking place, and NPS rangers would patrol public areas to ensure compliance with national lakeshore closures and public safety measures. As a safety measure, sharpshooting would not occur within 100 feet of an occupied building. Qualified federal employees or contractors trained in all aspects of sharpshooting would perform these activities. Training would include safety measures to protect both visitors and NPS employees. If more than one shooting location were used, these areas would be adequately separated to ensure safety. Bait stations could be used to attract deer to safe removal locations away from public use areas to maximize the efficiency and safety of the reduction program.

LC200 - Coordination with Deer Managers of Adjacent Lands

Concern ID: 21643

CONCERN STATEMENT: **Commenters urged NPS to make sure that its deer management planning and activities were coordinated with deer management plans and actions on adjacent lands.**

Representative Quote(s):

Corr. ID: 27 **Organization:** Shirley Heinze Land Trust

Comment ID: 101833 **Organization Type:** Conservation/Preservation

Representative Quote: *Land managers, local residents, and even entire communities have come to the conclusion that deer densities are far too high. State agencies, private land owners and communities have already begun efforts to mitigate this problem. As white-tailed deer are free-ranging animals, these efforts are futile without the assistance of the largest landholder in the region, Indiana Dunes National Lakeshore.*

Response: **NPS has been coordinating and will continue to coordinate with other deer management efforts on adjacent lands. NPS participated on the Dunes Region Deer Study Committee in 1999. We continue to work with the IDNR on access issues for the special hunt in the Indiana Dunes State Park. We also continue to coordinate with the towns of Dunes Acres and Beverly Shores on their deer culling operations and have had discussions with representatives from the town of Ogden Dunes about its deer management issues. As NPS moves to implement its deer management plan at the national lakeshore, we anticipate an increase in coordination of deer management efforts with managers of adjacent lands.**

ON1000 - Other NEPA Issues: General Comments

ON1100 - Other NEPA Issues: Public Involvement

Concern ID: 21646

CONCERN STATEMENT: **One commenter expressed concern that NPS had not agreed to provide additional time for submission of comments and that NPS did not provide adequate opportunity for the public to provide input on the target deer population level. Another commenter said that NPS had provided no opportunity for the public to comment on the safety of planned sharpshooting. Still another commenter urged NPS to continue its public outreach efforts that stressed the goal of balanced, sustainable ecosystems at the national lakeshore.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101441 **Organization Type:** Nongovernmental

Representative Quote: *As a preface to comments on the DEIS, AWI again requests that the NPS reopen the comment deadline on the DEIS to provide interested stakeholders and citizens additional opportunity to carefully review the document and to prepare informed and substantive comment to aid the NPS in its decision-making process. This request is not intended to solely provide AWI or the like-minded organizations additional time to identify additional arguments to question the intent or content of the DEIS but this would benefit all parties, regardless of their position, in evaluating the DEIS and informing the NPS of their concerns. AWI and The Humane Society of the United States had previously requested a 30-day extension in the comment deadline until late May 2009. In their April letter a number of credible reasons were provided to justify this request including, but not limited to, the fact that any lethal deer control, if that was a component of the final decision, was months and more likely years away (due to the stated need to conduct two years of vegetation monitoring) and that one of the core pillars of NEPA is providing the public with a meaningful opportunity to comment on an agency's action. In response, earlier this week, IDNL submitted [a] single paragraph reply denying the request and suggesting that a 77-day comment period was sufficient. No other justification was provided by IDNL as a basis for its denial of the request. As a result of this denial, this comment letter is not as comprehensive as it could have been and, therefore the NPS and its decision-makers will not benefit from the level of review and analysis of the DEIS that could have been provided if the comment deadline extension request was granted.*

Response: **NPS made a concerted effort to involve the public throughout the scoping and review process for the draft EIS, including providing a 60-day public review and comment period. NPS believes that the draft EIS review time was adequate for interested parties to review the document and submit comments on all relevant issues.**

ON1200 - Other NEPA Issues: Lack of Data

Concern ID: 21689

CONCERN STATEMENT: **One commenter stated that NPS violated NEPA because national lakeshore–specific data on indicator plants, deer populations, and deer impact were insufficient for an adequate NEPA analysis to support deer management decisions. This commenter recommended that NPS collect the data and restart the EIS process.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101520 **Organization Type:** Nongovernmental

Representative Quote: *As evidence that the NPS has little to any IDNL-specific vegetation data, the DEIS indicates that the NPS would first monitor these indicator plants for two years before it would assess whether the triggers have been met to initiate lethal deer control actions. DEIS at 37. Not only does this provide ample evidence that the NPS could and should have extended the deadline for comments on the DEIS as requested by AWI and HSUS but, more importantly, it demonstrates that this entire planning process is, at best, premature. NEPA requires agencies to base their environmental analysis on high quality information and expert analysis or, if data relevant to the analysis does not exist, the agency must, if the information is essential to the analysis and the overall cost of obtaining it is not exorbitant, then it must be included in the analysis. Alternatively, if the required information cannot be obtained due to costs, the agency must include a statement conceding that the information is incomplete or unavailable, a statement of the relevance of the incomplete or unavailable information to evaluating the impacts, a summary of existing credible scientific evidence relevant to evaluating the adverse impacts to the quality of the human environment, and the agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community. 40 CFR 1502.22(a)(b)(1-4).*

Response: **NPS believes that the data on indicator plants, deer populations, and deer impacts used as the basis for deer management planning and evaluation of plan alternatives were fully sufficient for purposes of its analysis in the EIS.**

NPS policy is to protect sensitive plants and the health of the plant communities and wildlife habitats in park system units. NPS selected trillium as a trigger for initiating deer control because it is common to the Great Lakes region and favored by deer. To maintain trillium, a density of 10 to 16 deer/mi^2 is recommended. Higher deer densities can skew trillium populations toward small plants and can lead to extirpation of trillium and other sensitive forbs. NPS accounts for other factors affecting trillium by using deer exclosures that keep deer out but do not affect other herbivorous animals, fire, weather, or other factors. The only influence on the trigger variable is the presence of deer.

NPS has collected substantial data to show that deer densities in the national lakeshore are high. Both infrared imaging and spotlight surveys have been conducted on portions of the national lakeshore over the last several years. Spotlight surveys were conducted along a number of travel routes in the East and West Units of the national lakeshore in February or March every year between 1991 and 2006, with the exception of 1994. As of 2006, deer densities across the national lakeshore ranged from about 50 deer/mi^2 to just under 150 deer/mi^2 (Underwood and Nystrom 2008). The aerial imaging collected to date, including that for portions of the East Unit, was taken in conjunction with surveys completed by the towns of Beverly Shores and Dune Acres. The East Unit counts occurred annually between 1998 and 2002 but did not cover the entire unit in all years. Deer densities found in the aerial imaging across the national lakeshore ranged from 24 deer/mi^2 to 110 deer/mi^2. As described in chapter 2, the primary survey method used to count deer would be distance sampling. The deer population density in the national lakeshore has varied and will continue to vary over time, depending on such factors as winter temperatures, snow depth and duration, disease, habitat conditions, deer movements, hunting pressure outside the national lakeshore, acorn production, and availability of other foods (herbaceous vegetation). However, observations within the national lakeshore and trends in other units of the national park system indicate that the deer population is likely increasing. In the absence of any deer management measures, this increase is expected to continue over time, with some fluctuations because of weather and other

factors.

Finally, NPS does not depend solely on estimates of deer populations to determine whether to reduce deer numbers but, rather, relies on data collected from the trigger plants, in conjunction with the best professional judgment of its resource professionals, as a more proximate indicator of the impact deer are having on sensitive plants and habitats in general. NPS believes it is reasonable to base judgments about the relationship between deer abundance, on the one hand, and loss of sensitive plants and habitat effects in general, on the other, on the findings of numerous studies of deer effects in similar forested areas, rather than assuming that abundant deer and their relationship to sensitive plants and habitat values are uniquely different at Indiana Dunes National Lakeshore.

PN1000 - Purpose and Need: Planning Process and Policy

Concern ID: 21812

CONCERN STATEMENT: **A commenter said that NPS's stated purpose and need for lethal removal of deer at the national lakeshore was in conflict with NPS policy, because the policy allows animal removal only if animals are interfering with the use of parks by visitors, not simply because they are browsing on vegetation or harming sensitive plants, which are presumptively natural ecosystem functions.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101484 **Organization Type:** Nongovernmental

Representative Quote: *The intent of the Policies allowing active, lethal management of park wildlife was not to turn the parks into live shooting galleries but, rather, to selectively and rarely use this authority when and where there is a legitimate basis for doing so. This is reflected in NPS Policies which specify that whenever possible, natural processes will be relied upon to maintain native plant and animal species, and to influence natural fluctuations in populations of these species. DEIS at 27. Legally, as permitted in the NPS Organic Act, the only justification for the use of lethal control to remove animals from a park is provided under 16 U.S.C. 3 which gives the Secretary the authority to destroy park wildlife when those animals may be detrimental to the use of the parks. This authority is also not open ended as it is limited to killing animals whose impacts are detrimental only to the use of the park, not if they overbrowse the vegetation or harm other wildlife. The terms "the use of" clearly refers to the public's use of the park so, to exercise this authority, there must be evidence that an animal or animals are adversely affecting the public's use of a park. This authority, for example, was correctly applied years ago in Grand Canyon National Park to lethally remove some deer that had become dangerous to the public after becoming accustomed to being fed by canyon visitors. In that case, the NPS removed had the authority to lethally remove the offending animals because they were affecting public use of the park; the NPS most certainly did not have and could not have even obtained authority to engage in the massive use of lethal control simply because the deer in Grand Canyon were eating the bushes. In the case of IDNL, while there's no question the deer are eating the bushes, there is no evidence beyond mere speculation by the NPS that the deer are adversely impacting public use of the park. Indeed, there is compelling evidence that the public enjoy and benefit greatly from the deer even if, in the opinion of the NPS, they exist at a density that is too high.*

Response: **The commenter is incorrect. The NPS Organic Act authorizes the Secretary of the Interior to remove wildlife in order to protect park resources. See, generally, 16 USC § 1.**

Further authority can be found in NPS *Management Polices 2006*, section 4.4.2, which states:

> **[w]henever possible, natural processes will be relied upon to maintain native plant and animal species and influence natural fluctuations in populations of these species. The Service may intervene to manage populations or individuals of native species only when such intervention will not cause unacceptable impacts to the populations of the species or to other components and processes of the ecosystems that support them. In addition, the policy restricts management to times when certain conditions exist. One such condition is when a population occurs in an unnaturally high or low concentration as a result of human influences (such as loss of seasonal habitat, the extirpation of predators, the creation of highly productive habitat through agriculture or urban landscapes) and it is not possible to mitigate the effects of the human influences.**

Because deer populations at Indiana Dunes National Lakeshore are increasing at a rate that reflects the absence of effective predation and the presence of high-quality habitat found in the national lakeshore and surrounding areas, active management of the species is permitted.

Concern ID: 22029

CONCERN STATEMENT: **A commenter claimed that NPS's long-standing policy of prohibiting public hunting in its parks has led to the problems of overabundant deer populations that now need to be addressed. The commenter further said that this argues strongly for a change in that policy.**

Representative Quote(s):

Corr. ID: 64 **Organization:** The Wildlife Society, IL Chapter

Comment ID: 101890 **Organization Type:** Conservation/Preservation

Representative Quote: *The long-standing policy held by the court has created the deer problems identified in the plan. The plan quoted, "Holling (1978) first described the principle of adaptive management as requiring management decisions and policies to be viewed as hypotheses subject to change." Clearly, a change in policy is necessary in order to address issues as they arise elsewhere within the NPS. Many NPS protectionist policies were developed when deer numbers were extremely low. That is no longer the case, and NPS policies should adapt to meet current and/or recognize future population control needs.*

Response: **A managed public hunt was considered as a preliminary alternative to reduce the white-tailed deer population in the national lakeshore. A public hunting alternative was not carried forward for further analysis because: (1) it would be inconsistent with existing laws, policies, regulations, and case law regarding public hunts in units of the national park system; (2) it would be inconsistent with long-standing basic policy objectives for national park system units; and (3) the likelihood that the NPS would change its long-standing servicewide policies and regulations regarding hunting in parks is remote and speculative.**

PN2000 - Purpose and Need: Park Purpose and Significance

Concern ID: 21814

CONCERN STATEMENT: **A commenter argued that the stated intent of the establishing legislation to "preserve for the educational, inspirational, and recreational use of the public certain portions of the Indiana Dunes..." was not being violated simply because the deer were**

overabundant.

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101461 **Organization Type:** Nongovernmental

Representative Quote: *The NPS has also failed to fully discuss the legislative history of IDNL and the intent of Congress when officially creating the park. The NPS describes said intent as to "preserve for the educational, inspirational, and recreational use of the public certain portions of the Indiana Dunes and other areas of scenic, scientific, and historic interest and recreational value in the State of Indiana." While this "intent" would appear to apply more broadly than just to IDNL, the current situation with deer in IDNL does not violate this intent and, therefore, this language cannot be used to justify the lethal control of park deer.*

Response: **The full subsection from which the commenter took the quote is the description of the national lakeshore purpose on page 5 of the final EIS, which reads, in part, as follows:**

> **The enabling legislation further states that the "National Lakeshore shall be permanently preserved in its present state, and no development or plan for the convenience of visitors shall be undertaken therein which would be incompatible with the preservation of the unique flora and fauna or the physiographic conditions now prevailing." Therefore, the purposes of the national lakeshore were designated as the following:**
>
> - **Preserve, maintain, and restore the integrity and character of the natural resources and processes and protect cultural resource values.**
> - **Provide educational, inspirational, and recreational opportunities compatible with preserving natural and cultural resource values.**
> - **Inspire in the public an appreciation of and a sense of personal stewardship for national lakeshore resources.**
> - **Interpret, encourage, and conduct scientific research in the tradition of pioneer investigators.**

This language makes clear that NPS has a responsibility to preserve the unique flora of the national lakeshore and, in general terms, the national lakeshore's natural resource values; it is NPS's judgment that these are jeopardized by a burgeoning deer population not sufficiently kept in check by natural mortality factors.

Concern ID: 22033

CONCERN STATEMENT: **A commenter stated that NPS failed to provide support for the purpose and need based on the purpose and significance of the national lakeshore. The commenter argued that NPS failed to disclose the condition of the national lakeshore in 1966, when it was established, because its purpose was to preserve the flora and fauna in that condition and reviewers, therefore, had no context in which to judge the current condition of the national lakeshore.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101462 **Organization Type:** Nongovernmental

Representative Quote: *The enabling legislation for IDNL is reported to be that the "National Lakeshore shall be permanently preserved in its present state, and no development or plan for the convenience of visitors shall be undertaken therein which would be incompatible with the* *preservation of the unique flora and fauna or the physiographic conditions now prevailing." The NPS failed to disclose what the "present state" of the IDNL was in 1966 when the park was created. The literal interpretation of the enabling legislation is that the NPS should have preserved the park in its condition as in 1966 yet, without disclosing what that condition was, neither the NPS nor the public can understand or comment on the implications of such a directive. Presumably, the IDNL has changed significantly since 1966 both purposefully as caused by NPS actions (that could in fact violate this same enabling legislation) and as a result of factors well beyond the control of the NPS.*

Response: **NPS must proceed on the basis of the data it has and current natural resource conditions in order to fulfill the purposes of the national lakeshore. In that context, consistent with the national lakeshore's enabling legislation, NPS believes it has a responsibility to preserve the unique flora of the national lakeshore and, in general terms, its natural resource values. It is NPS's judgment that these are jeopardized by a burgeoning deer population not sufficiently kept in check by natural mortality factors.**

PN4000 - Purpose and Need: Park Legislation/Authority

Concern ID: 21857

CONCERN STATEMENT: **Commenters took issue with the NPS claim that animals can be removed from a park when there are unnaturally high concentrations as a result of human influences (including the extirpation of predators) and such influences cannot be mitigated. One commenter said that NPS has not provided sufficient data to show that there are such high concentrations at the national lakeshore. This commenter further stated that the enabling legislation requires NPS to preserve, maintain, and restore the integrity and character of the natural resources and processes in the national lakeshore and that the fluctuating size of the deer population, including the high populations that are of current concern, are part of the natural processes NPS is required to preserve.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101463 **Organization Type:** Nongovernmental

Representative Quote: *A careful review of this enabling legislation language, however, reveals that the alleged increase in the abundance of deer and their alleged, but unproven, adverse impacts on vegetation, other species, and the visitor experience is not in violation of this language and, thus, can't be used to justify the lethal slaughter of the majority of the park's deer. The enabling legislation explicitly forbids undertaking any development or plan for the convenience of visitors that would be incompatible with the preservation of the unique flora and fauna or the physiographic conditions prevailing (in 1966) in the park. While efforts undertaken by the NPS to promote and accommodate public use of IDNL may have violated its own enabling legislation, even if park deer are adversely impacting the unique flora, fauna, or physiographic conditions in the park this does not violate the enabling legislation.*

Response: **NPS disagrees that the fluctuations in deer populations that have led to the current high deer numbers are part of the natural processes that must be preserved in the national lakeshore. In fact, the major natural factors that historically controlled deer, including a variety of predators, are not in effect now because of overriding human influences; thus, the deer have been unnaturally protected from mortality factors that would otherwise have kept their numbers much lower. Peak deer populations now threaten to extirpate or deplete plant species of concern in the national lakeshore that would have been able to naturally sustain themselves were it not for**

the impact of overabundant deer feeding on them.

PN4100 - Park Service-wide Coordination of Deer Management

Concern ID: 21834

CONCERN STATEMENT: **One commenter expressed concern that NPS was pursuing lethal methods of deer management in a coordinated fashion servicewide, as evidenced by Indiana Dunes National Lakeshore and the recent Catoctin Mountain National Park, Valley Forge National Park, and Rocky Mountain National Park EISs.**

Representative Quote(s):

Corr. ID: 51 **Organization:** Animal Welfare Institute

Comment ID: 101428 **Organization Type:** Nongovernmental

Representative Quote: *AWI is concerned about a clear trend within the NPS to pursue lethal management strategies to address alleged conflicts/problem[s] attributable to White-tailed deer. Indiana Dunes National Lakeshore (IDNL) is not the first park to suggest such draconian action but, rather, simply one in a series of parks that have decided to abandon the protectionist mission and mandate of the NPS in favor of using bullets, sharpshooters, and rifles with silencers to solve a perceived problem. The fact that the environmental documents prepared in an attempt to substantiate the need for such lethal action in, for example, Catoctin Mountain National Park, Rocky Mountain National Park, Valley Forge National Park, and IDNL are identical in format and content except for the relevant park-specific information demonstrates that this decision to favor culling over conservation is a coordinated effort throughout the NPS.*

Response: **NPS has undertaken an independent deer management planning process at Indiana Dunes National Lakeshore. Each park has unique factors at issue that must be considered, and each park undergoes its own planning process.**

Concern ID: 22037

CONCERN STATEMENT: **A commenter expressed concern that Rocky Mountain National Park, Theodore Roosevelt National Park, and Catoctin Mountain National Park had different definitions of what constituted humane methods of deer control and this inconsistency could lead to arbitrary application of this principle. In particular, this commenter took issue with NPS's use of the reference to "humane management actions" in the American Society of Mammalogists' guidelines without explaining why this standard applied, thus arbitrarily relying on guidelines not reviewed by the public.**

Representative Quote(s):

Corr. ID: 26 **Organization:** Safari Club International

Comment ID: 101861 **Organization Type:** Recreational Groups

Representative Quote: *SCI and SCIF have commented recently on several different wildlife management plans for National Parks, including Catoctin Mountain National Park, Theodore Roosevelt National Park, and Rocky Mountain National Park, each of which has offered its own unique reference to "humane" lethal removal strategies. Since opinions differ on what constitutes "humane" treatment of wildlife, SCI and SCIF are concerned that the lack of specificity could make it easy for the mindset of some—potentially those who know little to nothing about wildlife or wildlife management—to dictate the manner in which the NPS reduces overpopulations of deer on IDNL lands. The inconsistency of the NPS approach makes this issue vulnerable to arbitrary application of this subjective principle for wildlife* *management.*

Response: **NPS would use the "Guidelines for the Capture, Handling, and Care of Mammals," published by the American Society of Mammalogists (1998), to ensure humane handling of deer in nonlethal control methods and the "AVMA Guidelines on Euthanasia," published by the American Veterinary Medical Association (2007), for humane lethal control methods. Lethal methods would include using firearms for culling and using capture/euthanasia with humane techniques of penetrating captive bolt gun, potassium chloride, or exsanguination. The ASM "Guidelines" for humane handling of animals is an accepted standard adopted by universities, federal agencies, and state and private contractors. The "AVMA Guidelines on Euthanasia" includes humane methods of capture/euthanasia, as well as recognition that there are "situations involving free-ranging wildlife when euthanasia is not possible from the animal or human safety standpoint, and killing may be necessary" and that in these situations, "the firearm and ammunition should be appropriate for the species and purpose. Personnel should be sufficiently skilled to be accurate, and they should be experienced in the proper and safe use of firearms, complying with laws and regulations governing their possession and use." As noted in the final EIS (page 45), all actions involving direct management of individual deer would be conducted so as to minimize stress, pain, and suffering to the extent possible. NPS staff would minimize the degree of human contact during procedures that require handling of deer and use chemical immobilization drugs if needed to minimize stress. NPS has determined that compliance with the ASM and AVMA guidelines will help to ensure that all animals are treated humanely during any management actions.**

PN6100 - Organic Act, Impairment, and Deer Management

Concern ID: 21858

CONCERN STATEMENT: **Commenters stated that NPS is in violation of the Organic Act in proposing to cull deer at Indiana Dunes National Lakeshore. One commenter stated that the court ruling NPS cites to justify sharpshooting pertained to the narrow question of whether the NPS had the authority to kill deer on park lands for research purposes without obtaining a state permit, rather than the much broader issue of allowing deer culls for management purposes. The commenter took issue with the NPS claim that the deer are damaging national lakeshore vegetation, harming other wildlife, and impairing public use by stating that NPS failed to provide sufficient data to support the claim.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101479 **Organization Type:** Nongovernmental

Representative Quote: *The impairment standard contained in the NPS Organic Act is not applicable to the impacts of any native wildlife species on the park. If it were, the NPS would have used it long ago to control any assortment of species that allegedly adversely impact the parks. This has not been done and, frankly the NPS has not, until recently, interpreted the Organic Act to apply to the management of native wildlife, because there is no legal basis for such an interpretation. The impairment language in the NPS Organic Act very clearly only applies to public use of the parks. More specifically, the first clause of the Organic Act imposes a mandate on the NPS to conserve the scenery, the wild life, and other attributes of the parks. The second clause adds to that mandate by requiring the NPS to regulate the public's enjoyment of the parks in such a manner and by such means "as will leave them unimpaired for the enjoyment of future generations." DEIS at 12. Thus, the primary mandate of the NPS is* *conservation as the courts have repeatedly held throughout the years. The secondary mandate, which is subservient to the conservation mandate, is to permit public use of the parks but only in ways that will not harm the parks. The impairment standard only applies to the public use of the parks. If a public use results in an impairment, it either must be modified so that it won't impair park resources or it can't be allowed. Applying the impairment standard to native wildlife is purely wishful thinking on the part of the NPS. Since the impairment standard cannot be applied to the impact of native deer on park vegetation or other park resources, the assessment of the impairment of each alternative in Chapter 4 of the DEIS is invalid, meaningless, and unnecessary.*

Response: **NPS has broad authority to manage wildlife and other natural resources within the boundaries of units of the national park system. The NPS Organic Act authorizes the Secretary of the Interior to remove wildlife in order to protect park resources. See, generally, 16 USC § 1.**

NPS *Management Policies 2006*, section 4.4.2.1, allows for management of native species to prevent them from interfering broadly with natural habitats, natural abundances, and natural distributions of native species and natural processes. *NPS Management Policies 2006*, section 4.4.2, also states that the NPS will rely on natural processes whenever possible but may intervene to manage wildlife or plant populations under certain conditions. One such condition is when "a population occurs in an unnaturally high or low concentration as a result of human influences (such as the extirpation of predators and the creation of highly productive habitat through urban landscapes) and it is not possible to mitigate the effects of the human influences." Because the deer population at the national lakeshore is increasing at a rate that reflects the absence of effective predation and the presence of high-quality habitat in the park and surrounding areas, active management of the species is permitted, including population reduction or lethal removal of individuals from a population.

NPS believes that the deer management plan/EIS is in compliance with the Organic Act and associated implementing regulations and policies, as well as the enabling legislation for the national lakeshore. NPS also believes that the plan/EIS fully and sufficiently discloses data that substantiate the purpose and need for action. The objectives of the plan/EIS were developed in support of the plan purpose and need for action, and NPS believes that they are fully compliant with the national lakeshore's enabling legislation, purpose, significance, and mission goals, as described in the Park's General Management Plan/EIS. All alternatives presented in the plan/EIS met the plan objectives to some degree. How well each alternative met the plan objectives is summarized in Table 13 of the plan/EIS (page 78).

PN7000 - Purpose and Need: NEPA and CEQ

PN8000 - Purpose and Need: Objectives in Taking Action

Concern ID: 21880

CONCERN STATEMENT: **One commenter stated that the NPS plan would have been very different had it framed its purpose more appropriately in terms of protecting deer and other elements of the environment without harming individual deer. The same commenter said that NPS's stated goal of allowing the perpetuation of a healthy and sustainable ecosystem while maintaining a healthy deer population was misapplied by NPS as**

requiring a static ecosystem balance rather than one that would fluctuate naturally with the size of the deer population and, therefore, one in which NPS did not have to take lethal measures to keep deer populations in check. The commenter further stated that NPS-defined desired conditions were not subject to public review but had been written simply to justify lethal deer control and that NPS had not provided sufficient evidence of current conditions in the national lakeshore to support its assessment. A second commenter said that NPS did not clearly define native plant restoration goals and objectives and, therefore, failed to demonstrate the need for lethal deer control at the national lakeshore. Another commenter said that the NPS plan would have NPS intervening, managing, and manipulating deer for the foreseeable future in the national lakeshore; challenged whether, given the NPS mandate, such actions were justified; and asked by what approaches and methodologies NPS would ever be able to determine the ecological endpoint it seeks to achieve.

Representative Quote(s):

Corr. ID: 51 **Organization:** Animal Welfare Institute

Comment ID: 101495 **Organization Type:** Nongovernmental

Representative Quote: *The NPS then goes on to define other terms as it creates this self-serving set of conditions and terms that are clearly intended to limit the options of the decision-makers to a single decision—to kill deer. First, it describes a viable deer population as "one that allows the perpetuation of a healthy and sustainable ecosystem while maintaining a healthy deer population in the National Lakeshore." DEIS at 19. A "healthy and sustainable ecosystem" is not directly defined but such a definition would include the approximation of natural conditions in an ecological community that has the ability to maintain species richness. Again, the NPS fails to define what constitutes a "healthy deer population" nor does it provide any evidence that the deer population on IDNL is not healthy. The concept of natural conditions could and should include the preservation of natural processes and the allowance for such processes to dictate the ecology of the park - which is entirely consistent with the natural regulation mandate of the NPS. If the protection of natural processes were of paramount importance, the species richness within the park would naturally vary which would be expected in such a system. The preservation of a static level of species richness is largely inconsistent with the mandate of the NPS and is more reflective of a management strategy used by the U.S. Forest Service who can legally manipulate their lands to maintain a constant state of high biodiversity by artificially creating various successional habitats. The NPS is not, nor should it be, in the business of such intentional manipulation of habitats and, therefore, its embrace of the concept of maintain species richness at a high level no matter what reflects a desire by NPS managers and not a biological reality given the legal mandates of the NPS.*

Response: **NPS believes that basing national lakeshore management on an idealized goal of allowing natural fluctuations in plant and animal communities to be the sole determinant of which species are sustained and which species are extirpated is not reasonable. Humans have radically altered the national lakeshore habitat over the years, and humans remain a major influence, both directly and indirectly. Because part of the NPS mission is to sustain sensitive plants, NPS believes it must address the risk that plants would be extirpated before the large deer populations reach an ultimate peak and eventually decrease. It is unreasonable to expect NPS to manage the national lakeshore as if it were a major wilderness area where natural factors have held and should continue to hold sway since ages past. NPS must proceed on the basis of current human-influenced natural resource conditions to fulfill the purposes of the national lakeshore. In that context, NPS believes it has a responsibility to preserve the unique flora of the national lakeshore and, in general terms, the national**

lakeshore's natural resource values; it is NPS's judgment that these are jeopardized by a burgeoning deer population not sufficiently kept in check by natural mortality factors.

Concern ID: 22061

CONCERN STATEMENT: **A commenter stated that the dominant threat to the fragile ecosystems at the national lakeshore is not deer but, rather, common reed, which continues to encroach in many of the national lakeshore's ponds.**

Representative Quote(s):

Corr. ID: 58 **Organization:** *Not Specified*

Comment ID: 101878 **Organization Type:** Unaffiliated Individual

Representative Quote: *The dominate threat to the fragile ecosystems of the dunes is "'Common Reed." There is an easy answer. The Park Service could do as they do in front of the Valpo court house. They could plant some "Common Reed" in the two ponds located by the "Refreshment Stand" that do not have any "Common Reed" in them now and take some pictures. Make huge prints of the pictures that display the tassel of "Common Reed" and declare it a dune land grass.*

Then they can go out and kill all the deer. I am not a biologist. I do not get payed for this. What I say is obvious and has been true for many years.

Response: **NPS believes that both deer and common reed are threats. Deer are a dominant threat to the uplands in the national lakeshore. NPS integrated pest management measures are undertaken to control common reed, which is a serious threat to wetlands in the national lakeshore.**

PN8100 - Reasons the Purpose and Need Is Valid or Substantiated

Concern ID: 21674

CONCERN STATEMENT: **Some commenters agreed that the national lakeshore deer populations need to be reduced because the deer are out of balance with their habitat, are damaging sensitive plants, and pose a concern for habitat impacts on adjacent lands, as well.**

Representative Quote(s):

Corr. ID: 34 **Organization:** Chicago Wilderness

Comment ID: 100456 **Organization Type:** Conservation/Preservation

Representative Quote: *IDNL's plan to cull and manage deer is also consistent with the Chicago Wilderness policy, "Conservation of Wooded Lands in the Chicago Wilderness Region" (available at http://www.chiwild.org/members/resources/index.cfm). This policy states that while white-tailed deer are native to this region and a natural part of our wooded communities, urbanization of this region has resulted in a reduction in predators of deer and an increase in deer habitat, leading to unsustainable deer population growth. Deer find certain plant species to be especially palatable, and have helped force these to the brink of local extinction.*

Response: **NPS agrees. In 2006, monitoring showed that plants in the Dune Wood zone had reached the indicator trigger for control; more recent monitoring has shown that trillium in several of the East Unit zones has reached the trigger for control. Implementation of the preferred alternative would be expected to reduce the deer population to desired levels within three years.**

PN8150 - Reasons the Purpose and Need Is Not Substantiated or Not Valid

Concern ID: 22284

CONCERN STATEMENT: **Some commenters said that NPS does not have adequate national lakeshore–specific data to substantiate the need for deer control—particularly control by lethal methods—and instead relies on information from other locations or draws inferences from sparse local data to support deer management planning.**

Representative Quote(s):

Corr. ID: 51 **Organization:** Animal Welfare Institute

Comment ID: 101451 **Organization Type:** Nongovernmental

Representative Quote: *AWI understands that there may be federally and state-protected species found on the IDNL but, considering that there are non-lethal means of protecting those populations (e.g., creation of small or large fenced plots as already practices in the park) this is not a legitimate basis for engaging in the wide-scale slaughter of park deer. Indeed, considering that IDNL was established in 1966, that no lethal deer control has occurred within the park since that date, and that IDNL remains home to over 1445 species of vascular plants of which 1135 are native species, DEIS at 4, is compelling evidence, in an of itself, that there is no "deer problem" within the park. If there was a "deer problem" surely, since the deer have been fully protected since the lakeshore was created, it would have already manifested itself on the precipitous decline in floral abundance, composition, diversity, and production within IDNL. The fact that there is no credible evidence of such a decline suggests that it doesn't exist and that, while perhaps abundant, the deer are not having the level of impact perceived by the NPS.*

Response: **Substantial data are available indicating that deer densities are high in the national lakeshore. Both infrared imaging and spotlight surveys have been conducted on portions of the national lakeshore over the last several years. Spotlight surveys occurred along a number of travel routes in the East and West Units of the national lakeshore every year between 1991 and 2006, with the exception of 1994. As of 2006, deer densities across the national lakeshore ranged from about 50 deer/mi^2 to just under 150 deer/mi^2. The aerial imaging collected to date, including that for portions of the East Unit, was taken in conjunction with surveys completed by the towns of Beverly Shores and Dune Acres. The East Unit counts occurred annually between 1998 and 2002 but did not cover the entire unit in all years. The deer densities found in the aerial imaging across the national lakeshore ranged from 24 deer/mi^2 to 110 deer mi^2. As described in chapter 2, the distance sampling method would be the primary survey method used to count deer. The deer population density in the national lakeshore has varied and will continue to vary over time, depending on such factors as winter temperatures, snow depth and duration, disease, habitat conditions, deer movements, hunting pressure outside the national lakeshore, acorn production, and availability of other foods (herbaceous vegetation). However, observations within the national lakeshore and trends in other units of the national park system indicate that the deer population is likely increasing. In the absence of any deer management measures, this increase is expected to continue over time, with some fluctuations because of weather and other factors.**

Estimates of deer populations are not the sole determinant in the question of whether to reduce deer numbers; NPS also relies on the trigger plants and the best professional judgment of its resource professionals as more proximate indicators of the impact deer are having on sensitive plants and habitats in general. NPS believes it is reasonable to base judgments about the relationship between deer abundance, on

the one hand, and loss of sensitive plants and habitat effects in general, on the other, on the findings of numerous studies of deer effects in similar forested areas, rather than assuming that abundant deer and their relationship with sensitive plants and habitat values are uniquely different at Indiana Dunes National Lakeshore.

NPS believes that the data on indicator plants, deer populations, and deer impacts used as the basis for deer management planning and evaluation of plan alternatives were fully sufficient for NEPA analyses. It is NPS policy to protect sensitive plants and the health of the plant communities and wildlife habitats in the national lakeshore. NPS selected trillium as a trigger for initiating deer control because it is common to the Great Lakes region and favored by deer. To maintain trillium, a density of 10 to 16 deer/mi^2 is recommended. NPS accounts for other factors affecting trillium by using deer exclosures to ensure that the only influence on the trigger variable is the presence of deer.

Concern ID: 22288

CONCERN STATEMENT: **Commenters stated that the NPS rationale for the proposed deer management plan that includes lethal measures is not valid because it is based on a combination of unreasonable bias toward lethal control measures and unwarranted conclusions about what impacts deer are having on sensitive plants and habitat in general at the national lakeshore.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101445 **Organization Type:** Nongovernmental

Representative Quote: *While large predators are no longer present on IDNL, it is well established in the scientific literature the predators don't control prey populations but, rather, that prey numbers and density controls predators. Thus, the elimination of the large predators did not result in uncontrolled growth in prey numbers but, rather, increased the fluctuations in prey (i.e., deer) populations over time. The deer population on IDNL is not overabundant biologically or ecologically speaking. Instead, it may be overabundant based on a measure of human tolerance (aka the cultural carrying capacity). This capacity is not static but dynamic and likely is changing constantly depending on each person's personal experience with deer, their knowledge about deer and their ecology, and how they perceive deer (i.e., beautiful woodland species that provides immense pleasure when seen in the park or in their yard or landscape damaging, disease-carrying, threat to damage my automobile or injure me four-legged villain).*

Response: **When the planning/NEPA effort began, NPS had no preconceived idea concerning what deer management measures might be implemented in the national lakeshore. NPS reviewed relevant environmental studies, sought expert opinion, and solicited the public's ideas and concerns in a broad effort to fully evaluate options for addressing what appeared to be an overabundant deer population. From scientific studies, NPS identified trillium as an indicator plant that would show effects before deer populations were so high that sensitive plants and habitat values were substantially damaged.**

SE2000 - Socioeconomics: Methodology and Assumptions

Concern ID: 21648

CONCERN STATEMENT: **One commenter stated that NPS's socioeconomic impact analysis was inadequate because it omitted positive economic impacts associated with the aesthetic beauty of**

deer; their value to national lakeshore visitors observing, photographing, or drawing them; and their value to those who never get to visit the national lakeshore but know the deer exist there.

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101506 **Organization Type:** Nongovernmental

Representative Quote: *Finally, in regard to the socioeconomic impacts associated with deer damage the NPS (and other Federal agencies) commonly examine only the alleged economic impact of, in this case, deer on landscaping, agricultural crop production, deer-vehicle accidents, etc. to calculate a socioeconomic impact. All too frequently agencies, including the NPS, only examine that economic impacts attributable to deer. This is precisely what the NPS has done in this case. Deer, of course, have positive economic impacts that are frequently overlooked and/or discounted despite their relevance and the NPS duty to objectively consider both positive and negative economic impacts attributable to deer. Such positive economic impacts are associated with the aesthetic beauty of deer, their value to park visitors who enjoy observing/photographing/drawing them, and their existence values for those who never get to visit IDNL but know (and obtain joy from) that they are present on IDNL. While the socioeconomic impact section of the DEIS needs to be substantially improved independent of the need to consider the positive economic impact of deer, at a minimum, the NPS should an economist (in house or on contract) to assess the value, intrinsic and extrinsic, of wildlife on IDNL, wildlife inhabiting national parks, and of the national park experience.*

Response: **The draft EIS analysis of impacts on socioeconomic resources focused on impacts outside the national lakeshore by evaluating the potential for deer-related crop damage and landscape plant damage to neighboring properties. In addition, neighboring land users have implemented deer reduction actions to reduce deer-browse damage, thus incurring related costs. No other actions under the alternatives considered would have more than a negligible effect on local or regional socioeconomic conditions. Therefore, the analysis for socioeconomic resources was limited to deer damage on crops and neighbors' landscape plants, as well as impacts on deer reduction activities conducted by local landowners.**

NPS believes that the economic benefit or monetary value of deer in the national lakeshore to visitors , as well as their existence value to others, is offset by their negative economic effects. Their downside costs are large in terms of plant damage and habitat impacts and the costs of continuous monitoring of these effects, maintenance of the current limited use of fencing and repellents, and whatever future control may be conducted once a plan is implemented. In light of the agency requirement to manage for a sustainable deer herd, protect sensitive plants, and maintain overall natural resource values, NPS believes it is sufficient to evaluate the costs and efficacy of alternative methods of deer control. NPS deer management is expected to sustain a deer population large enough to satisfy visitors' desire to see the animals while maintaining a diverse floristic community, which visitors also desire to see.

TE4000 - Threatened and Endangered Species: Impact of Proposal and Alternatives

Concern ID: 21878

CONCERN STATEMENT: **The USFWS stated that two and perhaps three of the federally listed species and the one candidate species extant at the national lakeshore may be affected by the current very high deer population and, therefore, would benefit from a reduced deer**

population. The specific species noted were the Karner blue butterfly (*Lycaeides melissa samuelis*), Pitcher's thistle (*Cirsium pitcheri*), the Indiana bat (*Myotis sodalis*), and the eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*). The USFWS concurred that the NPS plan, which would reduce the deer population, would not likely adversely affect these species.

Representative Quote(s): **Corr. ID:** 37 **Organization:** U.S. Fish and Wildlife Service

Comment ID: 101737 **Organization Type:** Federal Government

Representative Quote: *Two and perhaps 3 of the Federally listed species and the 1 candidate species extant at INDU may be affected by the current very high deer population at the park: Karner blue butterfly (Lycaeides melissa samuelis), Pitcher's thistle (Cirsium pitcheri), Indiana bat (Myotis sodalis), and eastern massasauga rattlesnake (Sistrurus catenatus catenatus).*

Response: **NPS appreciates the USFWS input on these species and will continue coordinating with the USFWS about threatened and endangered species in the national lakeshore.**

Concern ID: 22056

CONCERN STATEMENT: One commenter stated that despite the NPS claim that deer are overabundant in the national lakeshore and are adversely affecting vegetation and other wildlife, the blue butterfly population would appear to be secure and expanding—evidence that the deer population is not as large as predicted by NPS and/or its impacts on wild lupine have been overstated.

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101504 **Organization Type:** Nongovernmental

Representative Quote: *The sole federally listed (threatened or endangered) species that is known to permanently occupy IDNL is the Karner blue butterfly. This species relies on lupine as its sole food source which also happens to be a palatable deer plant. The NPS claims that deer consuming wild lupine could adversely impact the butterfly, DEIS at 22, yet it also claims that, through its management and restoration efforts, the butterfly population is increasing and its habitat is expanding. Clearly, despite the NPS claim that the deer on IDNL are overabundant and are adversely impacting park vegetation and other wildlife, the blue butterfly population would appear to be secure and expanding. This would be evidence, however, that the deer population is not as large as predicted by the NPS and/or its impacts on wild lupine have been overstated. Other federally listed species are also believed to occur on IDNL and/or occur on a seasonal basis.*

Response: **Trend data collected by the national lakeshore resource management staff show that the endangered Karner blue butterfly population there is not expanding but decreasing. Although wild lupine, which the butterfly depends on, is not an indicator plant for deer impacts in the national lakeshore, it may be used as one in the future in the West Unit because of the butterfly's dependence on it and because deer find the plant highly palatable. A single indicator plant, trillium, is being monitored in the zones of the East Unit. Recent trillium monitoring results have shown that the trigger level for deer control has been reached in some East Unit zones.**

The USFWS has stated:

> **[W]ild lupine, which is the sole food source of Karner blue larvae, is regularly browsed by deer, with significant loss of flower stems in some portions of INDU. This may be having an effect on lupine reproduction and its long-term survival within the park. Larvae, especially the earliest instars, may inadvertently be eaten by browsing deer, and both eggs and larvae could be trampled by browsing deer.**

Therefore, this endangered species is likely to benefit from a lower, managed white-tailed deer population at INDU.

VE4000 - Visitor Experience: Impact of Proposal and Alternatives

Concern ID: 21861

CONCERN STATEMENT: **Commenters expressed concern that NPS decisions about culling deer will adversely impact visitors' experience at the national lakeshore. Most noted that one of the main reasons they and other people come to the national lakeshore is to view wildlife, although one commenter suggested that this activity ranks far below using the beach. One commenter said that NPS had downplayed the benefits of deer at the national lakeshore, including their role in aesthetics and as "ecosystem engineers"; according to the commenter, NPS had instead stressed adverse effects, such as potential impacts to birds, even though the agency had provided no data from the national lakeshore to support this contention.**

Representative Quote(s): **Corr. ID:** 59 **Organization:** Humane Society of the United States

Comment ID: 101803 **Organization Type:** Nongovernmental

Representative Quote: *B. The NPS Has Underestimated the Impact of Lethal Reduction on Visitor Wildlife Viewing The Draft EIS has underestimated the impact to wildlife viewing opportunities that will result once hundreds of deer are permanently removed from the National Lakeshore. The Draft EIS acknowledges that "some National Lakeshore visitors may view deer sightings as an integral part of their visit," and that "seeing deer is generally a positive experience for most National Lakeshore visitors." Draft EIS at 22. In addition, the Draft EIS recognizes that "[d]eer management actions may decrease the potential for visitors to observe deer within the National Lakeshore, causing less visitor satisfaction." Id. See also id. at 251 ("Visitors who value seeing deer in the National Lakeshore would experience adverse impacts, for chances of such sightings would be diminished."). However, the Draft EIS downplays these impacts, concluding that "[a]dverse impacts on visitors would be short-term due to any required National Lakeshore closures and any negative responses to sharpshooting activities, and would range from negligible to moderate." Id. at 252.*

Response: **The goal is not to eliminate deer from the national lakeshore but to manage a sustainable deer population that depends for food on a diverse plant community without severely depleting that community. Studies in similar areas have shown that deer are keystone species; abundant populations can radically alter plant species' abundance and composition where deer feed. Monitoring of the Dune Wood zone in 2006, as well as more recent monitoring of trillium plants in the national lakeshore, indicated that these plants have reached a trigger level for control in several of the East Unit deer management zones, if the decision is made to implement the preferred alternative.**

Concern ID: 22052

CONCERN STATEMENT: **A commenter expressed concern that deer should be controlled to reduce habitat impacts, stating that as a visitor, the commenter wanted to see "healthy examples of native ecological communities, not a deer farm with rigid browse lines and diminished diversity."**

Representative Quote(s): **Corr. ID:** 32 **Organization:** *Not Specified*

Comment ID: 100435 **Organization Type:** Unaffiliated Individual

Representative Quote: *As a visitor to the Dunes I hope to see healthy examples of native ecological communities, not a deer farm with rigid browse lines and diminished diversity.*

Response: **NPS agrees with the commenter. Our goal is to manage for a sustainable deer population and a healthy forest.**

VR4000 - Vegetation and Riparian Areas: Impact of Proposal and Alternatives

Concern ID: 21862

CONCERN STATEMENT: **One commenter stated that NPS did not provide enough data to support the conclusion that rare and sensitive plant species would continue to be adversely affected if lethal deer control is not undertaken. The commenter said that the data NPS does provide are inconclusive about whether deer have had any impact on sensitive plants.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101542 **Organization Type:** Nongovernmental

Representative Quote: *Despite failing to provide data on what state-listed species actually occur on IDNL, their status on and off the IDNL (in terms of population size, production, site-specific threats), it is impossible to assess the impacts of each alternative on these species. Yet, the NPS has done so in Chapter 4 of the DEIS, confidently predicted that such rare and sensitive species will continue to be adversely impacted if lethal deer control is not implemented. DEIS at 224, 225. Without more data, such as that described above, it is impossible to make this determination unless sheer speculation is now considered an acceptable form of high quality analysis within the NPS and under NEPA.*

Response: **To document the occurrence of plant species in need of protection at the national lakeshore, NPS cross-referenced the plant species listed in the 2006 NPS Species Database for Indiana Dunes National Lakeshore (draft EIS citation NPS 2006d), as well as rare-plant monitoring reports of botanists and other researchers working at the national lakeshore, against the IDNR Division of Nature Preserves list of sensitive plants and provided information on known abundance of each species (see draft EIS Table 30: Sensitive and Rare Plants of Indiana Dunes National Lakeshore). Abundance of these plants outside the national lakeshore is not relevant to their protection within it. NPS 77: *Natural Resources Management Guidelines* requires NPS to protect these plants simply because they are state listed, without consideration of their distribution or abundance outside the national lakeshore. NPS management decisions are based on that standard alone. Impacts to these plants are inferred based on monitored effects on indicator plant species, such as trillium.**

VS4000 - Visitor Conflicts and Safety: Impact of Proposal and Alternatives

Concern ID: 21871

CONCERN STATEMENT: **Commenters were concerned about the safety of visitors, the public, and those involved in deer sharpshooting, as well as conflicts between national lakeshore managers and visitors and the public during cull activities, particularly with regard to the specifics of the culling operations and restrictions required to conduct them safely and effectively. Commenters said that NPS assurances that the culling would be conducted in the fall and winter were not reassuring because visitation is substantial during those seasons. One commenter was concerned for public safety because hunting is an activity that takes place in unpopulated**

areas and the area surrounding the national lakeshore is not unpopulated. Another argued that using lethal means in an area filled with residents, hikers, and roads was dangerous. A third commenter said that he felt at risk during deer-hunting season because he had seen hunters cruising around, drops of blood on the road, and a bow hunter reaching for a bow in a populated area. Another commenter argued that NPS erred in greatly downplaying the significant safety risks in the use of volunteer private hunters in sharpshooting, specifically in view of the fact that requirements for firearm use and the skill of the personnel involved had yet to be developed. The same commenter argued that NPS assurances that rangers would patrol public areas to ensure compliance with national lakeshore closures were not sufficient because the patrols were not adequate to close off all foot trail entries.

Commenters were also concerned about such conflicts as members of the public viewing deer gutted along roadsides, having roads closed because of culling activities, and deer cullers interfering with and potentially charging persons with engaging in an illegal activity for simply walking a dog nearby a closed area. One commenter stressed concerns about the safety of visitors, nearby residents, and NPS employees, saying that providing advance notification to residents and banning visitors from areas where sharpshooting is planned must be carefully planned and managed. A commenter claimed that NPS exaggerated the risks of national lakeshore visitors contracting Lyme disease from deer, that NPS had no data to support this assertion, and that mice were the more likely vector of the disease.

Representative Quote(s): **Corr. ID:** 59 **Organization:** Humane Society of the United States

Comment ID: 101808 **Organization Type:** Nongovernmental

Representative Quote: *Perhaps more importantly, the Draft EIS greatly downplays the significant safety risks that the use of volunteer private hunters under Alternatives C and D would pose to both visitors to and employees of the National Lakeshore. Under Alternatives C and D, the NPS would authorize private members of the public to enter the park with automatic firearms and engage in shooting activities. Despite this obvious risk to the safety of all individuals involved, the Draft EIS claims that safety "[i]mpacts on visitors would be minimal, for visitation to the National Lakeshore during late fall and winter is low," and that the "actions would occur primarily at night," Draft EIS at 253, and that risks to NPS staff involved in supporting sharpshooting operations would be offset by requiring sharpshooters to be "specifically trained in all aspects of deer reduction operations." Draft EIS at 259 -255. In addition, the NPS attempts to downplay these impacts by describing its yet-to-be-developed—and therefore not disclosed to the public for consideration and comment—requirements for firearms use and the skill of the personnel involved but provides no detail as to how safety risks would be minimized. Draft EIS at 52. Furthermore, as described more fully above, while the Draft EIS states that lethal reduction activities would take place in the fall and winter, the number of visitors the park receives during these months is certainly not negligible.*

Response: **The safety of visitors, nearby residents, and the public in general is an important consideration in implementing any deer control in the national lakeshore. Deer control areas, parking lots associated with those areas, and trails that might allow access to those areas will all be closed, and national lakeshore staff will enforce these closures. Buffer areas will be established between the cull areas and all neighbors' residences. NPS will not allow recreational hunting nor will volunteers be used for culling. NPS will employFederal e,ployees or contractors as sharpshooters only. These professionals will fire from elevated stations so the shot trajectory will be into the ground. Firing direction will be established to ensure that it is away from any residential areas.**

As described in the final EIS (page 56), high-power, small-caliber rifles would be used from close range. Every effort would be made to make the shootings as humane as possible. Deer injured during the operation would be put down as quickly as possible to minimize suffering. Noise suppression devices and night vision equipment would be used to reduce disturbance to the public. Activities would comply with all federal laws administered by the Bureau of Alcohol, Tobacco, and Firearms. Sharpshooting would primarily occur at night during the late fall and winter months when deer are more visible and few visitors are in the national lakeshore. In some restricted areas, sharpshooting could be conducted during the day, if needed, maximizing effectiveness and minimizing overall time of visitor restrictions. In such cases, the areas would be closed to visitors. The public would be notified of any national lakeshore closures in advance. Exhibits about deer management would be displayed at visitor centers, and information would be posted on the national lakeshore's website to inform the public about deer management actions. Visitor access would be limited as necessary while reductions were taking place, and NPS rangers would patrol public areas to ensure compliance with national lakeshore closures and public safety measures. As a safety measure, sharpshooting would not occur within 100 feet of an occupied building. Qualified federal employees or contractors trained in all aspects of sharpshooting would perform these activities. Training would include safety measures to protect both visitors and NPS employees. If more than one shooting location were used, these areas would be adequately separated to ensure safety. Bait stations could be used to attract deer to safe locations, away from public use areas, to maximize the efficiency and safety of the reduction program.

WH2000 -Wildlife and Wildlife Habitat: Methodology and Assumptions

Concern ID: 21863

CONCERN STATEMENT: **One commenter stated that NPS did not provide sufficient evidence of harm to other wildlife as the basis for requiring lethal deer control because the agency did not determine the abundance, density, range, and other biological/ecological characteristics of wildlife species in the national lakeshore or assess the actual impact of deer on these species. The commenter stated that NPS relied almost wholly on studies from other locations. The same commenter said that the NPS analysis was inadequate because no deer home range study, comprehensive census, or herd health check had yet been conducted at the national lakeshore, and this lack of basic information was typical of other parks that had completed deer management EISs. This commenter argued that NPS had deliberately mischaracterized the impact of deer at the national lakeshore to justify management decisions NPS had already made. According to the commenter, NPS's claims that deer were responsible for destroying the national lakeshore's floral community, adversely affecting other faunal species, and causing an array of other negative impacts were based largely on conjecture alone; further, NPS should acknowledge that the national lakeshore is a highly altered and damaged ecosystem where the concept of naturalness can't be based on what was present historically (due to the significant changes throughout the area) but, rather, must be premised on what is present there now.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101448 **Organization Type:** Nongovernmental

Representative Quote: *These are not hypothetical concerns as the NPS identifies a number of factors that, over time, have adversely impacted the natural character of IDNL. See DEIS* *at 178, 179, 180. Such factors included: logging changing the composition of the forest and resulting in dune erosion; farming resulting in the drainage of wetlands; introduction of exotic species; extirpation of predatory animals; residential development leading to additional wetland loss; construction of a large number of structures; industrial expansion leading to increases in air pollution (which can impact vegetation production and growth); suppression of naturally occurring fires leading to, in certain ecosystems, increases in canopy and understory density; increased recreational use; urban encroachment resulting in fragmented habitats; construction and use of industrial landfill; and industry and agricultural practices altering ground and surface water resources. Simply put, the IDNL is a highly altered and damaged ecosystem where the concept of naturalness can't be based on what was there historically (due to the significant changes throughout the area) but rather must be premised on what is there now.*

Response: **NPS recognizes that many influences, both natural and human-caused, have led to the current status of the natural communities in the national lakeshore. Because scientific studies and observations of nearby natural communities have shown deer to have major influence on plant species composition and habitat values, NPS believed that establishing a method of identifying the extent to which deer may be affecting the national lakeshore, in particular the plant species currently present, to be prudent.**

Concern ID: 22048

CONCERN STATEMENT: **A commenter stated that NPS exaggerated the impact of deer on wildlife habitat by not acknowledging that the national lakeshore is a secondary forest and will never achieve the level of diversity that a primary forest has, regardless of the degree of deer herbivory. This same commenter suggested that deer-caused vegetation changes should be viewed as "state transitions" rather than as negative impacts, that there are virtually no studies that examine the plant population and ecosystem-level effects of white-tailed deer herbivory, and that studies of deer effects show that, regardless of the amount of feeding, forests achieve the same climax community in the long term.**

Representative Quote(s):

Corr. ID: 49 **Organization:** Humane Society of the United States

Comment ID: 101618 **Organization Type:** Nongovernmental

Representative Quote: *Another factor which is seldom considered when assessing the plant species composition in forests with deer herbivory is the successional status of that particular forest. Research has shown that plant species diversity is higher in primary forests than in secondary forests regardless of the herbivory regime (Rooney and Dress 1997). As the forest of IDNL has probably been cleared in the past, it is secondary forest and, therefore, will not attain the levels of species diversity found in primary forests regardless of the herbivory regime.*

Rooney, T.P. and W.J. Dress. 1997. Patterns of plant diversity in overbrowsed primary and mature secondary hemlock - northern hardwood forest stands. Journal of the Torrey Botanical Society 124(1): 43 - 51.

Response: **NPS is managing the national lakeshore to sustain the diversity of the native plant and animal communities that are currently present. Protected plant species constitute a substantial part of this native community diversity, and NPS has established its monitoring system to indicate whether its growing deer population is affecting those plants.**

WH4000 - Wildlife and Wildlife Habitat: Impact of Proposal and Alternatives

WH5000 - Wildlife and Wildlife Habitat: Cumulative Impacts

Concern ID: 21670

CONCERN STATEMENT: **Commenters expressed concern that NPS did not fully account for factors other than deer affecting the habitat at the national lakeshore and, thereby, exaggerated deer impacts and the importance of controlling deer.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101546 **Organization Type:** Nongovernmental

Representative Quote: *In addition to its analysis, albeit inadequate and largely unsubstantiated, of the impacts of each of the alternatives, the NPS also includes, as required under NEPA, an analysis of the cumulative impact of each alternatives. This analysis, however, is woefully inadequate. The intent of such an analysis is to examine the impacts of the alternatives in light of the impacts of all past, present, and reasonably foreseeable future action regardless of the agency, State or Federal, responsible for the action. Instead of engaging in such a comprehensive analysis to assess how the park's vegetation, deer, other wildlife, etc., would be impacted cumulatively by all such elements, the NPS, for the most part, simply lists the past, present, and reasonably foreseeable future actions that may interact with each alternative. This deficiency represents a significant flaw in the analysis.*

Response: **NPS has sufficiently addressed cumulative impacts by analyzing the magnitude and uncertainty of activities under each alternative, along with past, present, and future activities. Cumulative impacts are analyzed for each impact topic in Table S-2 on pages ix to xiii. The cumulative analysis identifies each impact as minor, moderate, or major and determines if impairment of a resource is likely from cumulative impacts.**

WQ2000 - Water Resources: Methodology and Assumptions

Concern ID: 21649

CONCERN STATEMENT: **One commenter stated that any discussion of deer fecal matter as a threat to water quality should be removed from the analysis of impacts to water quality because water pollution from other, primarily human sources overwhelms any possible contribution from deer.**

Representative Quote(s): **Corr. ID:** 51 **Organization:** Animal Welfare Institute

Comment ID: 101498 **Organization Type:** Nongovernmental

Representative Quote: *In regard to this section of the DEIS, several issues are worth mentioning. First, the NPS inclusion of water quality as an issue and impact topic is, frankly, preposterous. The notion that deer fecal matter is compromising water quality in or around IDNL given all of the anthropogenic impacts to the quality of the water supply particularly in this region of the country and Indiana is not even comparable. The impacts of industrial development, residential construction and use, agriculture, highway, vehicles, etc., to the region's and park's water quality far exceeds any impact associated with deer pooping in the water. The primary stated concern in regard to water quality is with fecal coliform bacteria or E. coli. The NPS concedes, however, that there are a variety of potential sources of E. coli independent of deer fecal matter. For example, the NPS reports that Point and non-point sources of E. coli in the vicinity of Indiana Dunes National Lakeshore include discharges from municipal and industrial wastewater treatment plants; combined sewer overflows (overflows* *during rain events or snow melts from combined sewer systems designed to collect stormwater runoff, domestic sewage, and industrial wastewater into the same pipe); sanitary system overflows (equipment failures and other sewer overflows not related to combined systems); illicit discharges (illegal or improper connection to a storm drain or a "straight pipe" to receiving waters) stormwater runoff (including runoff from pastureland/cropland; residential septic systems; pets; wildlife; livestock; swimmer, beach sands, and algae; boaters; and contaminated sediment. DEIS at 105 citations omitted. See also, DEIS at 100, 185, and 203 for additional sources of water pollution in and outside of IDNL. While this impact topic should remain in the analysis to demonstrate that significance of the human impact in the region, any discussion of deer fecal matter as a threat to water quality should be removed.*

Response: **The increased potential for water contamination from deer fecal matter at high deer population levels was one factor that was considered in the draft EIS, but it was not the overriding concern in terms of the effects of overabundant deer in the national lakeshore and the need for deer management. Although deer fecal contamination is not the primary factor affecting water quality, it is still one of the many contributing contamination sources. To comply with NEPA, a project's impacted resources are discussed and analyzed. To omit water quality as an impact topic goes against this requirement. Other factors, principally impacts on protected plant species and on habitat diversity, were predominant.**

Original Correspondence Submitted by Government Agencies

Name: Elizabeth S McCloskey (acting for Scott E. Pruitt, Supervisor)

Organization: U.S. Fish and Wildlife Service
Organization Type: F- Federal Government
Address: Bloomington Field Office (ES)
620 South Walker Street
Bloomington, IN 47403-2121
E-mail:

Dear Sir:

The U.S. Fish and Wildlife Service has reviewed the Draft White-tailed Deer Management Plan/Environmental Impact Statement concerning the proposed management of white-tailed deer at the Indiana Dunes National Lakeshore, Lake, Porter, and LaPorte Counties, Indiana.

In addition to the No Action (continuation of current actions) Alternative A, several non-lethal and lethal alternatives are considered in detail, with Alternative D being the preferred alternative. This alternative includes the current actions (limited fencing and use of repellents, inventorying and monitoring) and a combination of specific non-lethal and lethal actions (more extensive fencing and use of repellents, phasing in nonsurgical reproductive control of does when such control becomes feasible and capable of providing multiyear efficacy, sharpshooting, and capture/euthanasia). Alternative D is preferred because it is the alternative that would best protect the biological and physical environment by ensuring an immediate reduction in deer herd numbers that could be sustained with proven methods over the life of the plan.

We concur that Alternative D is the most appropriate alternative for INDU. Infrared imaging and spotlight surveys conducted within portions of INDU beginning in 1991 have shown recent deer densities between 50 deer per square mile (mi^2) and 150 deer/mi^2, while aerial surveys between 1998 and 2002 estimated 70 deer/mi^2 in the East Unit, where most of the deer are found. Even 50 deer/mi^2 are considerably higher than the 10 to 20 deer/mi^2 considered as the management goal for the park, based upon scientific studies from a number of sites nationwide. These studies have addressed both the health of the deer themselves and the health of the ecosystems they depend upon. Alternative D would quickly and safely reduce the very high deer population to a density that is beneficial to the deer, the ecosystem, and the public and maintain those lower numbers for the life of the plan.

Of main concern to the Fish and Wildlife Service are deer impacts on Federal trust resources under our jurisdiction, which at INDU are migratory birds and threatened and endangered species. Heavy deer browsing decreases habitat availablability for bird species that use understory and ground cover levels of the forest; for example, it has been documented that as deer densities increase, the number of understory nesting bird species and their abundance decreases. Neotropical migratory birds face numerous habitat loss issues in Northwest Indiana due to human developments, and degradation of remaining habitats due to the impacts of high numbers of white-tailed deer is another stressor; however, it is one that can be addressed through adequate deer management.

Two and perhaps 3 of the Federally listed species and the 1 candidate species extant at INDU may be affected by the current very high deer population at the park: Karner blue butterfly (Lycaeides melissa samuelis), Pitcher's thistle (Cirsium pitcheri), Indiana bat (Myotis sodalis), and eastern massasauga rattlesnake (Sistrurus catenatus catenatus).

Wild lupine, which is the sole food source of Karner blue larvae, is regularly browsed by deer, with significant loss of flower stems in some portions of INDU. This may be having an effect on lupine reproduction and its long-term survival within the park. Larvae, especially the earliest instars, may inadvertently be eaten by browsing deer, and both eggs and larvae could be trampled by browsing deer. Therefore, this endangered species is likely to benefit from a lower, managed white-tailed deer population at INDU.

Pitcher's thistle is found along sand dunes close to the Lake Michigan shoreline, a habitat that generally is not conducive to high deer numbers. However, deer are known to browse on Pitcher's thistle and its seeds; deer could also trample Pitcher's thistle plants, particularly the smallest, youngest plants. Therefore, this threatened species is likely to benefit from a lower, managed white-tailed deer population at INDU.

The endangered Indiana bat is currently known from the Heron Rookery Unit of INDU along the East Branch Little Calumet River and may be present along the river further west in the Bailly Unit; it may also be present in other Units where suitable wooded habitat is available. In summer, most reproductive females occupy roost sites under the exfoliating bark of dead trees that retain large, thick slabs of peeling bark. Primary roosts usually receive direct sunlight for more than half the day. Roost trees are typically within canopy gaps in a forest, in a fenceline, or along a wooded edge. Habitats in which maternity roosts occur include riparian zones, bottomland and floodplain habitats, wooded wetlands, and upland communities. Indiana bats typically forage for insects in semi-open to closed (open understory) forested habitats, forest edges, riparian areas, and over streams. It is unknown whether or not extensive deer browse is adversely affecting Indiana bat habitat – browsing could be helping keep the understory open or it could be adversely affecting desirable native understory species and promoting less palatable and less desirable native or non-native species.

The candidate eastern massasauga rattlesnake is known from the East Unit of INDU. This species uses a variety of habitats, including seasonal wetlands, open grasslands, and forest edges. Continued or increased deer browsing could have minor, long-term adverse impacts on this species, so this species is also likely to benefit from deer management at the park.

INDU provides designated critical habitat for the endangered piping plover (Charadrius melodus) along several miles of beach between the west boundary of the Cowles Bog/Ogden Dunes Unit to Kemil Road on the east boundary of Indiana Dunes State Park. The deer management plan would not modify this critical habitat.

The U.S. Fish and Wildlife Service therefore concurs that the proposed deer management plan at the Indiana Dunes National Lakeshore is not likely to adversely affect these endangered, threatened, and candidate species.

This precludes the need for further consultation on this project as required under Section 7 of the Endangered Species Act of 1973, as amended. If, however, new information on endangered species at INDU becomes available or if the deer management plans are changed significantly, please contact our office for further consultation.

Thank you for the opportunity to review this document. We believe that it adequately addresses the expected impacts of the deer management plan as proposed at the Indiana Dunes National Lakeshore. For further discussion, please contact Elizabeth McCloskey at (219) 983-9753 or elizabeth_mccloskey@fws.gov.

Rec'd 3/19/09

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

MAR 12 2009

REPLY TO THE ATTENTION OF:
E-19J

Superintendent Constantine Dillon
United States Department of the Interior
National Park Service
Indiana Dunes National Lakeshore
1100 North Mineral Springs Road
Porter, Indiana 45304

Re: Draft White-tailed Deer Management Plan (Plan)/Draft Environmental Impact Statement (EIS), Indiana Dunes National Lakeshore, Lake, Porter, and LaPorte Counties, Indiana EIS No. 20090028

Dear Superintendent Dillon:

The U.S. Environmental Protection Agency (U.S. EPA) has reviewed the Draft EIS and Plan for proposed white-tailed deer management in the Indiana Dunes National Lakeshore (National Lakeshore). Our review and comments are pursuant to the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and Section 309 of the Clean Air Act.

The Plan/Draft EIS indicates that a management plan for white-tailed deer is needed to ensure that the local deer population does not become a dominant force within the National Lakeshore, negatively influencing ecosystem components, particularly sensitive vegetation and other wildlife. Impacts to these resources would compromise the National Lakeshore's mandate to preserve the exceptional biodiversity found within its boundaries. Preservation of biodiversity within the National Lakeshore is critical, given that public lands are increasingly important as refuges for sensitive species.

The Plan/Draft EIS identifies several negative effects on ecosystem diversity from a large deer population in the National Lakeshore. Many avian species, particularly ground and intermediate canopy nesters, and a variety of other wildlife are negatively affected by the impacts of deer browsing on herbaceous and woody vegetation of the forest understory. Numerous studies have shown that white-tailed deer browsing can negatively influence the reproductive success of plants and the long-term population stability of certain plants within a plant community. Soils are affected primarily by erosion resulting from loss of vegetative ground cover due to excessive deer browsing. Water quality is affected primarily by the associated sedimentation due to increased erosion and by increases in *E. coli* levels associated with deer scat from greater deer densities. Disturbance to vegetation from excessive deer browsing could also create opportunities for non-native invasive plant species to become established or spread across more acres of the National Lakeshore. Residential areas, resource conservation areas, and local farms also experience pressures from deer browsing. A large deer population also increases the risk of deer-vehicle accidents on roadways in and around the National Lakeshore.

In addition to the no-action alternative (Alternative A), the Plan/Draft EIS describes three action alternatives to manage deer as well as the impacts resulting from each alternative. Alternative B would include the actions currently undertaken as part of Alternative A – limited fencing, limited use of repellents, and inventorying and monitoring – and incorporate non-lethal actions to reduce deer population numbers. Alternative C would include all actions described under Alternative A as well as a direct reduction of deer through sharpshooting and capture/euthanasia, where appropriate. Alternative D would include all actions described under Alternative A with a combination of specific lethal and non-lethal actions taken from Alternatives B and C. These specific actions include sharpshooting, capture/euthanasia and phasing in of non-surgical reproductive control of does for longer-term maintenance of lower deer population numbers. The impact analysis for all alternatives is based on the principles of adaptive management, allowing the NPS to change management actions when information emerges from monitoring results and ongoing research throughout the life of the proposed
15-year plan.

The Plan/Draft EIS indicates that Alternative D is the preferred alternative to manage deer population numbers. This alternative was selected as the best measure to protect the biological and physical environment by ensuring an immediate reduction in deer population numbers. Reduced deer population numbers will allow revegetation to occur more quickly throughout the National Lakeshore because browsing pressure would be decreased. Rapid deer population decreases would provide the National Lakeshore's habitats the opportunity to recover, improving habitat for wildlife and beneficial impacts to water quality.

Based on the information contained in the Plan/Draft EIS, we believe the preferred alternative best addresses the purpose and need as stated within the document. Therefore, we rate this project as *Lack of Objections (LO)*. A summary of the rating system used in the evaluation of these documents is enclosed for your reference.

Thank you for the opportunity to review and comment on proposed management actions in the National Lakeshore. If you have any questions regarding the contents of this letter, please contact Kathleen Kowal of my staff at (312) 353-5206 or via email at kowal.kathleen@epa.gov.

Sincerely,

Kenneth A. Westlake

Kenneth A. Westlake, Supervisor
NEPA Implementation
Office of Enforcement and Compliance Assurance

DNR Indiana Department of Natural Resources

Mitchell E. Daniels, Jr., Governor
Robert E. Carter, Jr., Director

Indiana Division of Fish and Wildlife
402 W. Washington St., W273
Indianapolis, IN 46204

April 24, 2009

Superintendent
Attention: Randy Knutson, Wildlife Biologist
Indiana Dunes National Lakeshore
1100 North Mineral Springs Road
Porter, Indiana 46304-1299

Dear Mr. Knutson:

The Indiana Division of Fish and Wildlife (DFW) of the Indiana Department of Natural Resources (DNR) has reviewed the Environmental Impact Statement (EIS) prepared by Indiana Dunes National Lakeshore (IDNL). As stewards of the fish and wildlife resources of Indiana, charged with protecting and properly managing these resources for the people of Indiana, we agree that there is immediate need for action concerning the present levels of deer on the IDNL. We disagree with your proposed management plan and urge IDNL to take the necessary steps to implement a more effective and efficient program of managed public hunts.

With approximately 12,000 acres in northwest Indiana, IDNL serves as a major refuge for white-tailed deer. The presence of this refuge in a densely populated area has contributed to many negative human-wildlife interactions. As you are already well aware, the DNR has been doing its part to help reduce these negative interactions by conducting a public based hunt at Indiana Dunes State Park. You are also aware that two cities, Beverly Shores and Dune Acres, have implemented their own deer management programs.

We understand that the National Park Service (NPS) does not historically allow public hunting on its lands. However, the DFW maintains that this is the most efficient and cost effective way to control deer population numbers to date. It is mentioned under Section 4.4.2.1 in the NPS Management Policies that the "NPS may directly reduce the animal population…using techniques that include public hunting where legislatively authorized within a park". Though it is mentioned on page 79 that "allowing firearm use by the public in the park would likely limit any congressional action to allow hunting", there is no mention of the use of archery equipment, which has proven effective in removing deer from localized landscapes in Iowa, Connecticut, and Nebraska, to name a few states.

It is also apparent that sharp-shooting costs for IDNL are grossly underestimated in this EIS. The Doerr et al 2001 article citing sharp-shooting as being as cost-effective as public hunting does not include the cost of a venison donation program, which is vitally essential for public acceptance. This cost is likely significant, especially at the scale which is being discussed under the preferred alternative D. Additionally, sharp-shooting costs tend to be more cost effective in localized (suburban or exurban area) areas or within highly fragmented habitat (Gettysburg National Historical Park). IDNL covers nearly 12,000 acres and is largely forested. The DFW is confident that sharp-shooting costs will be either at the high end or exceed the estimates provided within this EIS.

The EIS also outlines the use of contraceptive drugs under the preferred alternative D when "there is a federally approved fertility control agent available". This proposal, as described, is not acceptable for several reasons. First, the DFW could not support the use of any contraceptive agent on a free ranging deer herd unless: 1) it is proven to be effective at controlling deer populations, 2) is approved by the Food and Drug Administration, and 3) substantial tests have shown there are no adverse effects of the drug on deer, scavenging wildlife, and humans. Furthermore, it is unclear whether such options would be allowable under Indiana law, even if these requirements were met. Finally, it is important to also note that the IDNL herd is not a captive or sequestered population.

No contraceptive agent has proven to adequately control free ranging wildlife. The Irondequoit, New York study that is cited in the EIS was only a 43 km2 suburban community, smaller than IDNL. The study also recommended that immunocontraception is likely only to be useful in populations where the number of females treated is less than 200. The EIS also estimates the number of does to be reproductively controlled as 142, but this number implies a closed population. Studies have shown that vacated areas of prime habitat will be recolonized by deer via immigration. Quite simply, contraception has not been proven effective for use at controlling free ranging deer in an area as broad as IDNL, and its use should be stricken from the list of management options.

The DFW does not support the preferred management plan as is currently written in the January 2009 EIS. Though not currently listed among possible management plans, we firmly believe that public hunting is the only proven and cost effective method of controlling the deer population on IDNL and the surrounding urban and suburban area. The DFW believes that managed hunts will cost significantly less than the current preferred plan of action (contrary to the EIS), and in these times, that option is worth exploring. While the possibilities of legislative acceptance may be "remote and speculative", only by completely failing to attempt to pursue such avenues is the possibility completely precluded.

The Indiana Division of Fish and Wildlife has a long history of working with the Indiana Division of State Parks and Reservoirs with their public population management hunts, and have worked with National Wildlife Refuges and military bases in providing hunting opportunities for the public. These programs have proven not only to help control and stabilize the deer population in their respective areas, but also and more importantly, have an unblemished record of safety. We would welcome the opportunity to help the IDNL in initiating a public hunt within their property boundaries.

Sincerely,

Glen Salmon, Director
IN Division of Fish and Wildlife

DNR Indiana Department of Natural Resources

Mitchell E. Daniels, Jr., Governor
Robert E. Carter, Jr., Director

Division of Historic Preservation & Archaeology•402 W. Washington Street, W274 · Indianapolis, IN 46204-2739
Phone 317-232-1646•Fax 317-232-0693 · dhpa@dnr.IN.gov

HISTORIC PRESERVATION AND ARCHAEOLOGY

January 13, 2011

Constantine J. Dillon
National Park Service
Indiana Dunes National Lakeshore
1100 North Mineral Springs Road
Porter, Indiana 46304-1299

Federal Agency: National Park Service

Re: Draft environmental impact statement and notification of the National Park Service's finding of "no adverse effect" regarding the white-tailed deer management plan for Indiana Dunes National Lakeshore (DHPA #11126; H4217(INDU))

Dear Mr. Dillon:

Pursuant to Section 106 of the National Historic Preservation Act (16 U.S.C. § 470f) and 36 C.F.R. Part 800, the staff of the Indiana State Historic Preservation Officer ("Indiana SHPO") has conducted an analysis of the materials dated December 17, 2010 and received on December 20, 2010 for the above indicated project in Lake, Porter & LaPorte Counties, Indiana.

We concur with the National Park Service's December 17, 2010 finding that there are no historic buildings, structures, districts, objects, or archaeological resources within the area of potential effects that will be adversely affected by the above indicated project provided that all proposed ground disturbance (fencing and disposal pits) will be in areas previously disturbed or in areas subjected to archaeological reconnaissance or archaeological monitoring to avoid currently known and previously unrecorded archaeological resources.

If any archaeological artifacts or human remains are uncovered during construction, demolition, or earthmoving activities, state law (Indiana Code 14-21-1-27 and 29) requires that the discovery must be reported to the Department of Natural Resources within two (2) business days. In that event, please call (317) 232-1646. Be advised that adherence to Indiana Code 14-21-1-27 and 29 does not obviate the need to adhere to applicable federal statutes and regulations.

If you have questions about archaeological issues please contact Cathy Draeger-Williams at (317) 234-3791 or cdraeger-williams@dnr.IN.gov. If you have questions about buildings or structures please contact Miriam Widenhofer at (317) 233-3883 or mwidenhofer@dnr.IN.gov.

Very truly yours,

James A. Glass, Ph.D.
Deputy State Historic Preservation Officer

JAG:MLW:CDW:cdw

cc: Judy Collins, National Park Service
Jay Sturdevant, National Park Service

www.DNR.IN.gov

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Forest Preserve District of DuPage County

3 S. 580 Naperville Road • Wheaton, IL 60187-8761 • 630.933.7200 • Fax 630.933.7204 • TTY 800.526.0857

April 13, 2009

Mr. Randy Knutson
Indiana Dunes National Lakeshore
1100 North Mineral Springs Rd.
Porter, IN 46304-1299

Dear Mr. Knutson:

Thank you for allowing the Forest Preserve District of DuPage County to comment on the *Draft White-Tailed Deer Management Plan / Environmental Impact Statement*. This document not only has importance for the Indiana Dunes National Lakeshore, but is of regional significance as well.

We concur that "Alternative D: Combined Lethal and Non-Lethal Actions" is the preferred alternative and most appropriate in this situation. With high reproductive rates and few natural predators, white-tailed deer have the ability to quickly become overabundant to the degree of compromising the integrity of the surrounding natural resources. All the resources at the Indiana Dunes National Lakeshore, including both biotic and abiotic factors, are held in public trust and must be managed to maintain balance and stability for the benefit of all. Maintaining the white-tailed deer population at a density compatible with this balance is imperative.

As you know, deer do not recognize political boundaries and frequently move in and out of various jurisdictions. As more agencies in the region conduct deer management, it is essential that surrounding agencies also practice sound ecosystem management to ensure that efforts within one jurisdiction are not compromised by their neighbor's inaction.

Within the Forest Preserve District of DuPage County, we have been conducting deer management for 17 years. During this time, we have maintained deer densities near 20 deer/mi^2 at some locations. At those locations, we have witnessed the recovery of many plant species and together with other ecosystem management have provided high-quality habitat for many endangered and threatened species.

As an agency dedicated to protecting all floral and faunal species, the Forest Preserve District of DuPage County is encouraged that the National Park Service recognizes the need to conduct deer management at the Indiana Dunes National Lakeshore and supports the Service in this endeavor.

Sincerely,

Brent Manning

Brent Manning
Executive Director

CC: Director Oldenburg

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References, Glossary, Acronyms

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The following abbreviations are used for bibliographic references in the text:

ASM	American Society of Mammalogists
CEQ	Council on Environmental Quality
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
FHWA	Federal Highway Administration, U.S. Department of Transportation
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
MASS	Maryland Agriculture Statistics Service
MD	Maryland
MDNR	Maryland Department of Natural Resources
NASS	National Agricultural Statistics Service
NIPSCO	Northern Indiana Regional Planning Commission
NPS	National Park Service, U.S. Department of the Interior
NRA	National Rifle Association
NRCS	National Resource Conservation Service
NTSB	National Transportation Safety Board
ODNR	Ohio Department of Natural Resources
URS	URS Corporation
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of the Interior
US EPA	U.S. Environmental Protection Agency
USFS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WDNR	Wisconsin Department of Natural Resources
WHO	World Health Organization

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GLOSSARY AND ACRONYMS

GLOSSARY

Action Alternative – An alternative that proposes a different management action or actions to address the purpose, need, and objectives of the plan; one that proposes changes to the current management. Alternatives B, C, and D are the action alternatives in this planning process. See also: "No-Action Alternative."

Adaptive Management – Williams et al. (2007) define adaptive management as a decision process that:

promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a "trial and error" process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

Affected Environment – A description of the existing environment that may be affected by the proposed action (40 CFR 1502.15).

Antibody – An immunoprotein that is produced by lymphoid cells in response to a foreign substance (antigen), with which it specifically reacts.

Antigen – A foreign substance, usually a protein or polysaccharide, that stimulates an immune response upon introduction into a vertebrate animal.

Biobullet – A single-dose, biodegradable projectile composed of an outer methylcellulose casing containing a solid, semisolid, or liquid product (usually a vaccine or chemical contraceptive), propelled by a compressed-air gun.

Browse Line – A visible delineation at approximately 6 feet, below which most or all vegetation has been uniformly browsed.

Carnivore – An animal that eats a diet consisting solely or mostly of meat.

Carrying Capacity – The maximum number of organisms that can be supported in a given area or habitat.

Cervid – A member of the deer family, such as white-tailed deer, mule deer, elk, moose, and caribou.

Chronic Wasting Disease (CWD) – A slowly progressive, infectious, self-propagating neurological disease of captive and free-ranging deer, elk, and moose. CWD belongs to the transmissible spongiform encephalopathy (TSE) group of diseases and is characterized by accumulations of abnormal prion proteins in neural and lymphoid tissue.

Contractor – For the purposes of this plan, a contractor is a fully insured business entity, nonprofit group, or other governmental agency engaged in wildlife management activities that include trapping, immobilization, and lethal removal through sharpshooting. The contractor must possess all necessary permits and be able to pass any needed security clearances.

Contragestive – A product that terminates pregnancy.

Cultural Landscape – A geographic area (including both cultural and natural resources and the wildlife or domestic animals therein) associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values.

Cumulative Effects – Those effects on the environment that result from the incremental effect of an action when added to past, present, and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Deer Herd – The group of deer living within Indiana Dunes National Lakeshore that have common characteristics and interbreed among themselves. For the purposes of this plan, this term is synonymous with "deer population."

Deer Population – See "Deer Herd."

Demographic – Referring to the intrinsic factors that contribute to a population's growth or decline: birth, death, immigration, and emigration. The sex ratio of the breeding population and the age structure (the proportion of the population found in each age class) are also considered demographic factors because they contribute to birth and death rates.

Depredation – Damage or loss.

Direct Reduction – Lethal removal of deer; includes both sharpshooting and hunting.

Distance Sampling – An analytical method to estimate population density that involves an observer traveling along a transect and recording the distance to objects of interest.

Ecosystem – An ecological system; the interaction of living organisms and the nonliving environment producing an exchange of materials between the living and nonliving.

Endemic – Native to or confined to a particular region.

Environment – The sum of all biological, chemical, and physical factors to which organisms are exposed; the surroundings of a plant or animal.

Environmental Assessment (EA) – A concise public document, prepared in compliance with NEPA, that briefly discusses the purposes and need for an action and provides sufficient evidence and analysis of impacts to determine whether to prepare an environmental impact statement or finding of no significant impact (40 CFR 1508.9).

Environmental Consequences – Environmental effects of project alternatives, including the proposed action, any adverse environmental effects that cannot be avoided, the relationship between short-term uses of the human environment, and any irreversible or irretrievable commitments of resources that would be involved if the proposal should be implemented (40 CFR 1502.16).

Environmental Impact Statement (EIS) – A detailed written statement required by Section 102(2)(C) of NEPA, analyzing the environmental impacts of a proposed action, adverse effects of the project that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitment of resources (40 CFR 1508.11).

Epizootic Hemorrhagic Disease – An insect-borne viral disease of ruminants that causes widespread hemorrhages in mucous membranes, skin, and visceral organs.

Ethnographic Resource – Any site, structure, object, landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it.

Euthanasia – Ending the life of an animal by humane means.

Exclosure – An area enclosed by a barrier, such as a fence, to protect vegetation and prevent browsing by animals.

Exotic Species – Any introduced plant, animal, or protist species that is not native to the area and may be considered a nuisance; also called nonnative or alien species.

Exsanguination – The action or process of draining blood.

Extirpated Species – A species that is no longer present in an area where it once lived.

Genetic Variability – The amount of genetic difference among individuals in a population.

Habitat – The environment in which a plant or animal lives (includes vegetation, soil, water, and other factors).

Habitat Fragmentation – The breaking up of large, contiguous blocks of habitat into small, discontinuous areas that are surrounded by altered or disturbed lands.

Hectare – A metric unit of area equal to 2.471 acres.

Herbaceous Plants – Non-woody plants; includes grasses, wildflowers, and sedges and rushes (grass-like plants).

Herbivore – An animal that eats a diet consisting primarily of plant material.

Hibernaculum – The shelter of a hibernating animal.

Histopathology – The study of the microscopic anatomical changes in diseased tissue.

Home Range – The geographic area to which an animal normally confines its activity.

Hypothesis – A tentative explanation for an observation or phenomenon that can be tested by further investigation.

Immunocontraception – The induction of contraception by injecting an animal with a compound that produces an immune response that precludes pregnancy.

Immunocontraceptive – A contraceptive agent that causes an animal to produce antibodies against some protein or peptide involved in reproduction. The antibodies hinder or prevent some aspect of the reproductive process.

Immunohistochemistry – Identification of specific antigens in tissues by staining them with antibodies that are labeled with fluorescent or colored material.

Impairment – As used in NPS *Management Policies 2006* (NPS 2006b), "impairment" means an adverse impact on one or more park resources or values that interferes with the integrity of the park's resources or values, or the opportunities that otherwise would exist for the enjoyment of them, by the present or a future generation. Impairment may occur from visitor activities, NPS activities in managing a park, or activities undertaken by concessioners, contractors, and others operating in a park. As used here, the impairment of park resources and values has the same meaning as the phrase "derogation of the values and purposes for which these various areas have been established," as used in the General Authorities Act.

Infrared – The range of invisible radiation wavelength just longer than the red in the visible spectrum.

Irretrievable – A term that applies to the loss of production, harvest, and consumptive or nonconsumptive use of natural resources. For example, recreation experiences are lost irretrievably when an area is closed to human use. The loss is irretrievable, but the action is not irreversible. Reopening the area would allow a resumption of the experience.

Irreversible – A term that describes the loss of future options. Applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time.

Leuprolide – A reproductive control agent that prevents secondary hormone secretion, which stops the formation of eggs and ovulation. Leuprolide is a GnRH agonist (see appendix F for additional details).

Lumbar – Of, near, or situated in the part of the back and sides between the lowest ribs and the pelvis.

Macroinvertebrate – A relatively large, generally soft-bodied organism that lacks a backbone.

Meat Withdrawal Period – Period during which meat should not be consumed.

Mesic Species – Species that are adapted to an environment having a balanced supply of moisture.

Monitoring – A process of collecting information to evaluate whether or not an objective and/or anticipated or assumed results of a management plan are being realized (effectiveness monitoring) or whether implementation is proceeding as planned (implementation monitoring).

National Environmental Policy Act of 1969 (NEPA) – A law that requires all federal agencies to examine the environmental impacts of their actions, incorporate environmental information, and utilize public participation in the planning and implementation of all actions. Federal agencies must integrate NEPA with other planning requirements and prepare appropriate NEPA documents to facilitate better environmental decisionmaking. NEPA requires federal agencies to review and comment on federal agency environmental plans/documents when the agency has jurisdiction by law or special expertise with respect to any environmental impacts involved (42 U.S.C. 4321-4327) (40 CFR 1500-1508).

Naturally Regenerating and Sustainable Forest – A forest community that has the ability to maintain plant and animal diversity and density by natural (nonhuman-facilitated) tree replacement.

Nephelometric Turbidity Unit (NTU) – A unit of measure for turbidity.

No-Action Alternative – The alternative in which baseline conditions and trends are projected into the future without any substantive changes in management (40 CFR 1502.14(d)). Alternative A is the no-action alternative in this planning process.

Omentum – One of the folds of the peritoneum that connect the stomach with other abdominal organs.

Opportunistic Surveillance – Taking diagnostic samples for CWD testing from deer found dead or harvested through a management activity within a national park unit.

Paired Plot – A paired plot typically consists of two nearby plots, one located in an exclosure (fenced area to keep deer out) and one located in an open area (not protected from deer). The open area is used as a control, or a standard of comparison, for checking or verifying the results of vegetative growth within the exclosed area. Paired plots should be located within contiguous species populations and randomly placed within the population. Each individual plot within a pair should be separated from the other so as to not influence browsing in the open plot; a minimum of 10 feet of separation is planned for paired plots in the national lakeshore. The national lakeshore previously established 15 paired plots for trillium, consisting of 1-square-meter monitoring areas within 2.25-square-meter plots.

Palatability – The property of being acceptable to the taste or sufficiently agreeable in flavor to be eaten.

Paleontological Resource – A resource related to the forms of life existing in prehistoric or geologic times, such as fossils of plants, animals, and other organisms.

Parasitism – A symbiotic relationship in which one species, the parasite, benefits at the expense of the other, the host.

Penetrating Captive Bolt Gun – A gun with a steel bolt that is powered by either compressed air or a blank cartridge. When fired, the bolt is driven into the animal's brain and renders it instantly unconscious without causing pain.

Pericardial – Around or surrounding the heart.

Pheromone – A chemical secreted by an animal that influences the behavior or development of others of the same species, often functioning as an attractant of the opposite sex.

Plot – A plot is used to monitor vegetation and consists of an area (either open or fenced) of a defined size and shape, typically a square or circle. The plot location does not change from year to year and would be marked in the field for repeated use. The plot size is typically larger than the area to be monitored. Monitoring would be conducted randomly within the plot, and monitored areas may also be marked for repeated measurements from year to year, depending on data needs.

Population (or Species Population) – A group of individual plants or animals that have common characteristics and interbreed among themselves and not with other similar groups.

Prion – Protinaceous infectious particle; a microscopic particle similar to a virus but lacking nucleic acid, thought to be the infectious agent for certain degenerative diseases of the nervous system, such as CWD.

Radial Distance – A straight-line distance measured along a radius.

Record of Decision (ROD) – A concise public record of decision prepared by a federal agency, pursuant to NEPA, that contains a statement of the decision, identification of all alternatives, a statement as to whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted (and if not, why they were not), and a summary of monitoring and enforcement where applicable for any mitigation (40 CFR 1505.2).

Recruitment – Number of organisms surviving and being added to a population at a certain point in time.

Refugia – An area that has escaped ecological changes occurring elsewhere and thus provides a suitable habitat for relict (remnant or survivor) species.

Reproductive Control – A method or methods used to limit the numbers of animals in a population by affecting the reproductive success of the animals, such as contraception or sterilization.

Ruminant – An even-toed, hoofed mammal (such as sheep, oxen, and deer) that chew the cud and have a complex three- or four-chambered stomach.

Rut – An annually recurring condition or period of sexual excitement and reproductive activity in deer; the breeding season.

Sapling – A young tree, generally not over 4 inches in diameter at breast height.

Scoping – An early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.7).

Seedling – A young plant grown from seed; a young tree before it becomes a sapling.

Seral – A phase in the sequential development of a climax community.

Sex Ratio – The proportion of males to females (or vice versa), in a population. A sex ratio of 50:50 would mean an equal number of does and bucks in a deer population.

Sharpshooting – Lethal control of deer by shooting under controlled conditions in limited areas of the national lakeshore, using qualified federal employees or contractors.

Slag – The vitreous mass left as a residue by the smelting of metallic ore.

Species Diversity – The variety of different species present in a given area; species diversity takes into account both species richness and the relative abundance of species.

Species Richness – The number of species present in a community.

Spotlight Survey – A method used to estimate deer numbers in an area by shining spotlights at night and counting the number of deer observed. This technique provides an estimate of deer numbers but not density.

Subcutaneous – Under the skin.

Targeted Surveillance – Lethal removal of deer that exhibit clinical signs of CWD, such as changes in behavior and body condition, and testing to determine whether CWD is present.

Total Maximum Daily Loads (TMDLs) – The total pollutant load from point and non-point sources that can be assimilated by a water body while maintaining the designated use.

Transect – A randomly placed line along which individual plants of a species or species group are sampled.

Transmissible Spongiform Encephalopathies (TSEs) – A group of diseases characterized by accumulations of abnormal prion proteins in neural and lymphoid tissues, which cause distinctive lesions in the brain and result in death.

Turbidity – Visible, undissolved, solid material suspended in water.

Ungulate – A hoofed, typically herbivorous animal; includes horses, cows, deer, elk, and bison.

Vaccine – A suspension of killed or attenuated microorganisms that, when introduced into the body, stimulates an immune response against that microorganism.

Vascular Plant – A plant that contains a specialized conducting system consisting of phloem (food-conducting tissue) and xylem (water-conducting tissue). Ferns, trees, and flowering plants are all vascular plants.

Viable White-Tailed Deer Population – A population of deer that allows the forest to naturally regenerate while maintaining a healthy deer population in the national lakeshore.

Woody Plants – Plants containing wood fibers, such as trees and shrubs (see "Herbaceous Plants").

Acronyms and Abbreviations

APHIS	Animal and Plant Health Inspection Service, U.S. Department of Agriculture
ASM	American Society of Mammologists
ATV	all-terrain vechicle
AVMA	American Veterinary Medical Association
BP	before present
BSE	bovine spongiform encephalopathy
Bt	*Bacillus thuringienis*
CAA	Clean Air Act
CAS	cranial abscessation syndrome
CDC	Centers for Disease Control and Protection
CEQ	Council on Environmental Quality
cfu	colony-forming unit
CITES	Convention on International Trade in Endangered Species
CJD	Creutzfeldt-Jakob disease
CWD	chronic wasting disease
DARE	Drug Awareness and Resistance Education
dB	decibel
dBA	A-weighted decibel
DDE	dichlorodiphenyldichloroethylene
DDT	dichloro-diphenyl-trichloroethane
DNL	day-night average sound level
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FDA	Food and Drug Administration
FY	fiscal year
GAO	General Accounting Office
GCIV	GonaCon™ immunocontraceptive vaccine
GnRH	gonadotropin releasing hormone (reproductive control hormone)
HSUS	Humane Society of the United States
IDELC	Indiana Dunes Environmental Learning Center
IDEM	Indiana Department of Environmental Management

IDNR	Indiana Department of Natural Resources
IHC	immunohistochemistry
INAD	Investigational New Animal Drug (classification by the Food and Drug Administration)
INDU	Indiana Dunes National Lakeshore
MBTA	Migratory Bird Treaty Act
NASS	National Agricultural Statistics Service
NEPA	National Environmental Policy Act
NIPSCO	Northern Indiana Public Service Company
NIRPC	Northwestern Indiana Regional Planning Commission
NIST	National Institute of Standards and Technology
NPS	National Park Service, U.S. Department of the Interior
NPS-PHP	National Park Service Public Health Program
NTU	nephelometric turbidity units
NWR	National Wildlife Refuge
ORV	off-road vehicle
PCB	polychlorinated biphenyl
PZP	porcine zona pellucida
SCWDS	Southeastern Cooperative Wildlife Disease Study
TB	bovine tuberculosis
TSE	transmissible spongiform encephalopathy
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USDA-NRCS	U.S. Department of Agriculture National Resources Conservation Services
USFWS	U.S. Fish and Wildlife Service
WHO	World Health Organization

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As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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