National Park Service
U.S. Department of the Interior

INTERIM TECHNICAL GUIDANCE ON ASSESSING IMPACTS AND IMPAIRMENT TO NATURAL RESOURCES

National Park Service
Natural Resource Program Center
July 2003

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Interim Technical Guidance

This guidance is released for use by National Park Service staff as an "interim" technical guidance document. It is a working document that will be revisited in the future after NPS staff have the opportunity to use it and provide feedback.

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Cover photo courtesy of Johan Almblad

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ASSESSING IMPACTS AND IMPAIRMENT TO NATURAL RESOURCES

INTRODUCTION AND OVERVIEW

PURPOSE OF DOCUMENT

This paper provides general background information on approaches to assess impacts to natural resources with respect to the no-impairment mandate of the National Park Service (NPS) Organic Act. The information and examples provided will assist park managers and their staffs in evaluating and characterizing impacts as part of the environmental impact assessment and other planning processes. This should help managers prepare the written documentation that no impairment will occur, as required by the NPS Management Policies before a proposed action is approved. It will also help managers assess whether an ongoing or past activity might have led or be leading to an impairment of park resources or values. This document generally does not include prescriptive or highly quantitative methodologies. It does, however, provide some guidance so managers will know whether impacts are more or less likely to constitute an impairment. Park managers will need to use their best professional judgment when making impairment determinations, taking into account all available information, advice from multi-disciplinary technical experts, and management objectives.

It should be emphasized that while this document provides guidance on determining impairment under the NPS Organic Act, it does not establish a "bright line" for acceptable or unacceptable actions. It is clearly inappropriate to consider all actions that fail to rise to the level of impairment as being desirable or acceptable. National Parks are not "managed to" the threshold of being impaired. On-the-contrary, they are managed with the intent of being fully functional landscapes, worthy of being considered "special places" to the American people.

This document focuses on impacts on natural resources and values per se. The NPS Management Policies acknowledge that the no-impairment standard also applies to “opportunities to experience enjoyment” of park resources, “to the extent that can be done without impairing any of them.” Some of the examples listed in this document encompass aspects of public enjoyment, but there is not an exhaustive list of the many ways in which a person’s experience or enjoyment might be “impaired” because of the condition of a resource.

Cultural resource impacts are not addressed in this document, however guidance on assessing impacts on cultural resources can be found in Director’s Order 28 and the NPS “Cultural Resources Management Guideline (1997).” The Advisory Council on Historic Preservation has also published guidance on “working with section 106.” Additional guidance on cultural resource impacts and impairment may be forthcoming.

FRAMEWORK FOR DECISION-MAKING

Legal Framework

The National Park Service Organic Act of 1916 states that the NPS:

> "…shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified…by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is 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 (emphasis added)."

Congress reaffirmed this mandate in 1978 when it directed the following:

> "The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in 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."

In addition to avoiding impairment, 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 NPS the management discretion to allow certain impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, so long as the impact does not constitute impairment of the affected resources and values.

The no-impairment mandate of the Organic Act is one of many legal requirements managers must consider and comply with when authorizing activities in parks. In some cases, requirements of other environmental laws and regulations might prohibit certain impacts on natural resources or values, irrespective of whether an "impairment" might result. In other cases, impacts technically allowed under other laws might be prohibited in a park because they would be considered an impairment. Generally, the most stringent test should be applied prior to approving an activity.

The Wilderness Act of 1964 (16 U.S.C. 1131, *et seq*.) defines wilderness as

> an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain . . . an area of undeveloped Federal Land retaining its primeval character and influence . . . which is protected and managed so as to preserve its natural conditions (16 U.S.C. 1131(c)).

In many cases the specific language of the Wilderness Act may prohibit activities before an impairment determination must be made, thereby making an impairment decision unnecessary. In other cases, the Wilderness Act may provide supporting legal context which makes it easier for managers to arrive at an impairment determination.

NPS Management Policies

NPS Management Policies 2001 leave determinations of impairment to the responsible park manager and only direct that an action should be considered to constitute impairment if, in the manager's professional judgment, the action **"would harm the integrity of the park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values."** NPS policies (*Section 1.4.5*) further state that whether an impact meets this definition (i.e., would harm the integrity of the park resources or values) depends on

1) the particular resources and values that would be affected;
2) the severity, duration, and timing of the impact;
3) the direct and indirect effects of the impact; and,
4) the cumulative effects of the impact in question along with other impacts that are in existence.

The current management policies do not state what would be acceptable or not acceptable (i.e., constitute impairment) under any of these factors. It is left to the manager to assess information on each of these factors, weigh that information, and use professional judgment to decide if the integrity of the park resources or values will be harmed by the action.

An impact would be **more likely** to constitute an impairment to the extent that it affects a resource or value whose conservation is

1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park,
2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park, or
3) identified as a specific goal in the park's general management plan or other relevant NPS planning documents.

An impact would be **less likely** to constitute an impairment to the extent that it is an unavoidable result, which cannot reasonably be further mitigated, of an action necessary to preserve or restore the integrity of park resources or values.

Impairment may occur from visitor activities; NPS activities in the course of managing a park; or activities undertaken by concessionaires, contractors, and others operating in the park as well as from external actions. Impairment can occur from **inaction** as well as **action**. For example, failure to prevent the spread of a seriously disruptive alien species may impair park resources.

Linkage to NEPA

The National Environmental Policy Act (NEPA) of 1969 requires agencies, including NPS, to assess the impact of proposals on the quality of the human environment. NPS makes an impairment determination through the environmental planning and assessment process. Director's Order #12 states that environmental documents will evaluate and describe impacts that may constitute an impairment of park resources or values. In addition, the Record of Decision will summarize impacts, and whether or not such impacts may constitute an impairment of park resources or values. The NPS NEPA Handbook (January 2001) provides additional guidance on how projected impacts are to be described and characterized based on their magnitude, context, duration, and intensity. NPS Management Policies direct decision-makers to "consider any environmental assessments or environmental impact statements required by NEPA; relevant scientific studies and other sources of information; and public comments" in making impairment determinations. The NEPA Handbook indicates that the impact assessment should lay out a methodology for assessing each impact topic, including the criteria or thresholds used to draw a conclusion on the context, intensity, and duration of the impact. Based on these assessments, impacts may be characterized as "negligible," "minor," "moderate," or "major." These impact characterizations, in turn, provide a foundation for assessing whether the impact is likely or not likely to result in an impairment of park resources or values.

Not all major or significant impacts under a NEPA analysis are impairments. However, all impairments to NPS resources and values would constitute a major or significant impact under NEPA. If an impact results in impairment, the action should be modified to lessen the impact level. If the impairment cannot be avoided by modifying the proposed action, that action cannot be selected for implementation.

In order to facilitate the linkage between NEPA documents and impairment determinations, this guidance document tracks the NEPA Handbook approach by laying out methodologies, criteria, and threshold levels for characterizing impacts along a sliding scale ("negligible" to "major"). This guidance document does not provide definitive guidance on when an impact becomes an impairment, or specify the impact level that might constitute an impairment. However the guidance does indicate conditions under which an impact is more likely or less likely to be an impairment. Impact levels (also referred to as impact thresholds in Director's Order #12) are used to identify the impacts of the action to resources and may assist in making either resource specific or overall impairment determinations. These impacts need to be placed into context (e.g., the park's enabling legislation, specific laws governing endangered species, publicly reviewed planning documents, or other considerations) to make a decision as to whether or not the impacts are acceptable or unacceptable.

Conclusions regarding potential impairments come into play when impacts are examined for each topic or resource type, and when impacts are examined in an integrated manner based on all projected impacts. Generally, environmental documents should examine whether an impairment is **likely or not likely to occur** for each topic or resource type, but a conclusory statement regarding whether an impairment **will result** should only be made in a comprehensive statement at the end that considers all the anticipated impacts. It is possible that the park would consider impairment of any resource type or individual area unlikely but, on the whole, the integrity of the park would be compromised and thus an impairment would result. In some cases, there may be a relatively clear-cut case of impairment based on effects on an individual resource. In these cases, it would be prudent to discuss concerns regarding a potential impairment of a resource or value with park managers early in the process. In most of these cases, alternatives that result in such an impact would likely be removed from further consideration early in the process.

Even though NEPA documents are prepared largely by technical staff and contractors, determinations of whether an impact constitutes an impairment is a management decision. Thus, conclusions in NEPA documents that there would be an impairment to a specific resource type should only be made in consultation with the park manager or other decision-maker. Staff members and technical experts should be encouraged to offer their expertise and opinions, but staff members are not always aware of all the facts of a situation or the full context in which a decision must be made. Ultimately, park managers will need to determine whether or not the impact is the unavoidable result, which cannot reasonably be further mitigated, of an action necessary to preserve or restore the integrity of park resources or values.

NPS Management Policies also direct the NPS to demonstrate environmental leadership in all aspects of park planning. In this, the NPS is required to seek opportunities for achieving the highest standards for environmental protection and for implementing sustainable practices. Park managers should consider impacts and the potential for impairment against these benchmarks. Moreover, the environmental leadership management policy directs the NPS to comply with both the letter and the spirit of NEPA.

GENERAL APPROACHES TO IMPAIRMENT

Management Context

Impairment decisions also need to be put into context. This means considering the action within the context of the purposes for which the park was established, the management objectives, and desired future conditions. One should also consider existing conditions in the park, the relative impacts from activities within and outside the park, and the incremental and cumulative effect of potential impacts from a proposed or ongoing activity. When deciding whether impacts might constitute an impairment, park managers should remain cognizant of the effect such decisions might have on their ability to protect park resources and values from impacts caused by activities outside park boundaries. Neighboring land managers and land owners, as well as private entities farther upwind or upstream, may want the NPS to judge the acceptability of the impacts they cause within parks the same way we judge our own activities.

Lack of Information and Risk Assessment

Managers and decision-makers must have adequate information upon which to base their analysis and decisions regarding potential impacts or impairment. The appropriate level of detail needed is related to three factors commonly used in risk assessments to describe probability or likelihood of an impact: the magnitude of the action, the probability of making a wrong decision, and the consequences of the action.

> **Magnitude of the action**: Large or complex projects require more information to inform impact assessments than small simple projects.
> **Probability of a wrong decision:** There is always a possibility that a wrong decision will be made and negative unintended impacts or consequences will result. However, the better the information used for decision-making, the less likely it is that unintended or unanticipated impacts will occur.
> **Consequences of the action:** The potential impact of an activity on one or more resources may also drive the amount of information needed for analysis and decision-making. If the potential consequences of an action are irreversible, then the amount of information needed might greatly increase, because the risk would be higher.

These three factors interact in a manner that influences the amount of information needed for an impact assessment or impairment determination. For example, a small project with minimal long-term consequences may not require a lot of information, even if there is a high likelihood that we will make the wrong decision. Conversely, an action where impacts are highly predictable and the action is likely to go as planned may require much more information if that action is irreversible or has serious consequences such as potentially extirpating a species.

There is often insufficient information to determine whether or not an action or management plan may impair park resources. In this case, the first step is to identify in writing the questions one would like to have answered through the availability of additional information. If information is truly not available or easily accessible through additional research, then one must look at the risk that a wrong decision will, in fact, impair park resources. Professional scientists, technical experts, and resource managers in parks, regions, support offices, and Cooperative Ecosystem Study Units, can help parks assess available information to determine likely outcomes. Lists of technical and policy experts who helped prepare this document and park and regional subject matter experts available for assistance with impact and impairment analyses, can be found and the end of this document. It is usually helpful to assess the risk of making a wrong decision, and to examine the potential worst case scenario. If that scenario is acceptable, then a no-impairment determination is probably easily justified. If that scenario is unacceptable, then existing information should be reassessed and either additional information gathered or significant effort committed to documenting and supporting the determination.

If additional information is needed, there are a number of ways to obtain that information. In some instances, raw data are needed that may be obtained through additional surveys or studies to fill gaps in analysis or understanding. Information may also be available from sources outside the NPS (e.g., a good source of rare species location information is the state heritage program). In other instances, adequate data may be available, but interpretation of the data is controversial. A good approach for addressing these situations is to convene an expert panel (following Federal Advisory Committee Act guidelines, where applicable) to assess the data and draw conclusions as to the likely outcomes of the action. Such panels are especially useful because they not only provide well-thought-out answers, but they may also help build consensus among parties interested in the ultimate decision. Impairment decisions do not need to wait until the last shred of information is collected, analyzed, and published. To do so may only result in indefinitely postponing decisions. Additional discussion regarding information gaps can be found on page 3 of Director's Order #2, and on page 55 of the NPS NEPA Handbook.

The NPS Inventory and Monitoring (I&M) program may assist in providing resource and ecosystem related data on which impact assessments may be based, although it is anticipated that other sources of information will also be needed to do so. I&M may also provide data useful as background information for conceptual models or include information useful in making impairment decisions, however it is important to note that the I&M program is not specifically designed for this purpose.

Professional Judgment

Professional judgment of the decision-maker and staff is a critical tool in assessing impact and impairment. It is impractical to expect to have independently gathered monitoring data and analyses on every resource issue. Judgments must be made using the combined education and work experiences of professional staff. However, these judgments need to be documented so that decisions can be revisited in the future as more information is acquired or as conditions change.

Impairment Determination Considerations

Some, but not all, major impacts to natural resources may be an impairment, depending on the severity, duration, and timing of the direct, indirect, and cumulative impacts and on the park purpose, management objectives and context. Impacts determined to be negligible, minor, or moderate are not as likely to lead to impairment, but may do so in rare cases (e.g., the integrity of a park's spectacularly dark night skies might be considered harmed by a relatively small increase in artificial illumination). In practice, if a manager concludes there might be or is an impairment from an impact not characterized as "major," she or he should carefully re-examine the impact analysis to see if the impact has been characterized appropriately.

Although there are no canned methodologies that can be applied to determine impairment, there are a number of steps that should be taken in all evaluations:

- Gather sufficient available information to adequately inform decision making (see "Information Needs" in each resource section).
- Use or develop conceptual, physical or mathematical models of resource and ecosystem relationships to help evaluate or predict potential impacts (particularly for indirect and multiple-resource effects).
- Conduct a thorough assessment following all potential impacts over time and space to their logical conclusions (e.g. consider all life stages and functions of species, consider whether an action may be irreversible).
- Quantify the impacts as much as possible (see "Impact Level" tables in each resource section to help determine what should be quantified).
- Determine if the impacts analyzed in the steps above constitute an impairment of park resources and values by evaluating the context in which each specific resource impact decision will be made (see "Laws Regulations and Policies" in each resource section of this guidance, as well as considering the uniqueness of the impacted resource, and any park specific purposes, management objectives and context).
- Document the decision and the logic that led to the decision.

Most proposed actions are not expected to have impacts to park resources that would rise to the level of "impairment." The impacts of actions will range from clear instances of no impairment, to obvious impairment, and to in-between situations where it will be difficult to determine impairment or non-impairment. A determination of impairment is not normally a blanket application to all resources within a park. It may be specific to individual resources within the park. For example, the loss of a native species like Bachman's warbler from Congaree Swamp National Monument would impair park resources. Additional impacts to the same or other resources could also constitute an impairment. For example, the loss of Ivory-billed woodpeckers from Congaree Swamp (a past event), would not preclude a determination that the future loss of Bachman's warbler would also impair park resources.

Parks need to consider impairment not only for proposed actions that may occur, but also for on-going management that may result in impairment and the effects of past actions that may already be impairing park resources. Each of these three situations needs to be addressed differently.

Proposed future actions. This is perhaps the easiest situation to address. Proposed actions can be evaluated early in the planning stages to reduce impacts to resources and avoid impairment concerns. The goal of impairment evaluations is to prevent decisions that may impair resources. If impacts are considered early enough in the planning process, resources have not been irretrievably committed and the inertia accompanying most projects does not constrain modifications. Information needed to make an impairment determination may be sparse and speculative.

On-going actions. Current actions are more difficult than future actions to address because decisions have already been made, resources have been committed, and the actions may already have a strong constituency for continuation or to resist modification. Information needed to make an impairment determination may be more abundant and less speculative because actual effects can be observed. The NPS Management Policies address situations where an ongoing activity might have led or be leading to an impairment. Park managers must investigate and determine if there is, or will be an impairment, preferably as part of a planning process undertaken for this purpose. If impairment is found, appropriate action should be taken, to the extent possible within the Service's authority and available resources, to eliminate the impairment as soon as reasonably possible.

Impairment from past actions. Remediation of past actions that have impaired park resources are very difficult to address. While there may be more information available on the actual effects of the action, the amount of restoration needed to reverse the effects can be very large. Funding required to restore past actions may easily exceed the original costs of the action that caused the impairment. The restoration of past actions presents an additional dilemma; if a project partially restores an area to desired conditions, but does not fully rectify the impairment, does the project still impair resources (and thus violate the non-impairment directive)? In almost all cases, the answer is probably "no." However, if the restoration action only partially restores park resources and it precludes future options for full restoration, then it may impair resources.

Situation	Goal	Project action	End result
Proposed actions	Avoid impairment	Approve, modify, or reject proposal	Impairment avoided
Ongoing actions	Avoid or identify and remedy impairment	Continue project and mitigate impacts to remedy impairment or stop project and remedy impairment	Impairment avoided or identified and fully/partially remedied
Past actions	Identify impairment and remedy impairment	Develop project(s) to remedy impairment	Impairment fully/partially remedied

INTEGRATING MULTIPLE RESOURCE IMPACTS

<u>Ecosystem Perspectives</u>

Parks are directed to preserve water, air, and geological resources as well as soils, biota and the various processes that created the park and continue to act upon the respective resources. These natural resources are part of natural systems such as watersheds, rivers, airsheds, mountains, floodplains, and forests. Ecosystems represent not only the combination of biological and physical elements in a system, but more importantly, the interactions of these components at different levels of time and space. These interactions result in characteristics of specific ecosystems such as the structure and processes that managers must preserve to maintain integrity of park resources and values.

Ecosystem structure includes community species composition and three-dimensional arrangement (ground level forbs and litter, understory shrubs and coarse woody debris, and canopy trees across a given area), the quantity and distribution of physical materials or resources, and the range of physical conditions. Ecosystem processes include carbon or energy flow, biogeochemical cycles, primary and secondary production, herbivory, metapopulation processes and geomorphic and hydrologic processes. Because of the controls they exert on species and biological communities, fires, floods, hurricanes, drought, and other natural disturbances are ecosystem processes. Evolutionary processes such as mutation, and the interaction of organisms with each other and their environment and resultant rare species and biodiversity of an area also are a characteristic of ecosystems. An example of the interaction of biological and physical elements of a system is the influence of slope and bedrock on a soil series which, with occasional windstorms and seasonal precipitation, controls vegetation type on the landscape.

When parks adopt an ecosystem perspective, they allow for the holistic evaluation of impairment of these resources or systems by incorporating important ecosystem characteristics beyond those evaluations of individual resources. These characteristics are as follows:

- Ecosystems are dynamic, not static, and contain many interactions resulting in indirect effects and non-linear processes. These give rise to critical ecological thresholds to which they will respond and therefore may produce unexpected responses to management actions.
- Ecosystems are open and therefore linked to the larger biophysical landscape.
- There is no single spatial or temporal scale that is appropriate for all ecosystem patterns and processes. Rather there are suites of scales, where selection of the appropriate ones depends on particular management goals, and the resource impacted.
- Ecosystems vary in their resiliency to stresses. These resiliency properties differ according to the type and scale of the stresses. Cumulative effects of small, chronic stresses can weaken resiliency properties.
- Ecosystems are driven by interactions. While impairment evaluations may be conducted on a particular resource, there may be indirect effects on other resources. The ecosystem perspective accounts for ecological hierarchy, whereby an action on a population of a single species may be linked to a broader ecosystem function and also accounts for emergent properties of the system itself (e.g., long-term fire suppression leads to altered vegetation density and composition, and results in lower base flow of water from a watershed).

The term “ecological threshold”, as used above, means a change in an ecosystem from one state or condition to a different one. That is, certain natural processes such as prolonged drought, or human disturbance may shift an aquatic or terrestrial system to a completely different association of species and structure, with a new range of nutrient fluctuations across seasons. It will represent an “alternate steady state.” The system may or may not cross back over this “threshold” to the original state once annual rains return or disturbance ceases. While some factors (severity, duration, timing, direct and indirect effects, cumulative effects) may contribute to system shifts across both ecological and impairment thresholds, impairment thresholds are always human influenced decisions based on all the factors presented in this guidance as well: (particular resources and values, severity, duration, timing, management context, impact tradeoffs). Therefore while prediction that an activity might result in crossing an ecological thresholds would make an impairment finding “more likely”, other factors would have to be considered in the final impairment determination.

The ecosystem concept does not provide for defined physical boundaries. Instead, it provides the flexibility to identify a management unit, process, or in this case an activity, and apply the ecosystem perspective for a greater depth of analysis of potential management implications. The ecosystem perspective requires the analysis of historic conditions to best evaluate the role of resources and processes and assess how past land use may affect the current state of the resource. This information can be used in the development of ecological models, and accounts for processes such as floods and fire in the dynamic nature of the system. An ecosystem perspective will include information about geomorphic and hydrologic processes, and their influence on the development and interactions with biological components of the system. Ecological models can also assist in evaluating species and their life history strategies, that is, key periods of the life of an organism related to flowering, or spawning, or migration or translocation of nutrients that make any impact at those times more potentially threatening to the long-term survival of that population in the management area.

The ecosystem perspective also requires the analysis of natural variation at different levels of ecological hierarchy. The range of ecological hierarchy encompasses genotype, sub-species, species, association (community), ecosystem, and landscape. For example, if an action were implemented to control stream flow, even though water flow conditions were projected to be within normal fluctuation within a given day, year, or even a century, there might be impacts at some level of ecological hierarchy (i.e. individual numbers of fish in a local population) that should be evaluated. Assessing the relationships of impacts to natural variation of a system requires that the relevant temporal and spatial scales and other considerations be used. An impact that is within the long-term variation but occurring at the wrong time can be just as devastating as an impact that results in perturbations outside any known natural variation for that ecosystem. Understanding the natural variation of a system provides the manager with a baseline when the system is not influenced by human action, but the timing of perturbation is often what is most important.

Tradeoffs in Making Impairment Decisions

From the broader ecosystem perspective, the need for park decision-makers to make trade-off decisions among resources may also become readily apparent. For example, park managers may be faced with several park resources in decline due to human caused disturbances. Available data may lay out a sound course of action that can improve the condition of all but one of the resources. If the action is taken the rate of decline of the affected resource may even accelerate. Scientifically sound data may substantiate that failing to take action will assure the continuing decline of all the resources. In this example, given the impairment language of the NPS Management Policies, may the superintendent authorize the remediation action? The answer to this question is a complicated one. It hinges on the interactions of several factors including the following items:

1) the resources to be affected,

2) the magnitude (severity, duration, timing) of the effect on the affected resource,
3) the likelihood for success including risk and the efficacy of the remediation action,
4) the legal status of the resource to be impacted,
5) the opportunity to undertake additional actions to mitigate adverse impacts on the affected resource, and
6) the identified desired future condition of the park.

If all the necessary parameters are addressed adequately, the answer to this question can be yes, however the resulting impacts on any of the natural resources should never rise to the level of impairment. A park superintendent can authorize an action for the betterment of the park's overall ecosystem even though the action will accelerate the decline of a particular resource in the park. This can occur if, and only if, there are no other courses of action that protect all resources. However, mitigating or compensatory actions should be enacted to minimize or prevent the impacts to the affected resource. To be a defensible course of action, the superintendent must also assure that a solid administrative record exists supporting his/her decision.

While park managers hope not to be faced with trade-off decisions among natural resources such dilemmas inevitably arise. A few examples of trade-offs are discussed in additional detail in the "Ecosystems" section of this document. Trade-off decisions may also need to be made between natural and cultural resources. Historic cultural influences can be incorporated into the evaluation process as appropriate to the park unit and ecosystem unit. The document, "Balancing Cultural and Natural Values on Federal Land," by the Advisory Council on Historic Preservation (March 2002) offers some guidance on making these decisions. As good examples of parks making such trade-off decisions emerge, they will be posted to the impairment website at http://www.nps.gov/protect/.

DETERMINING IMPACTS AND IMPAIRMENT OF NATURAL RESOURCES

Each of the following resource sections discuss background; laws, regulations, and policies; information that may be needed to determine impacts and impairment; impact levels; and general and/or specific examples where impairment is "more likely" or "less likely" for each resource area. The sections are organized by resource area because many of the laws, regulations, and policies guiding impact and impairment determinations are specific to a given resource. In reality, impacts and impairments may not fall so neatly into resource categories as discussed below. The integration of resource impacts into a broader ecosystem perspective is discussed in the last section of this chapter.

BIOLOGICAL RESOURCES (TERRESTRIAL AND AQUATIC ORGANISMS)

Background

The "wild life" mentioned in the Organic Act includes all wild plants and animals- all naturally occurring life. The material presented in this section is intended to help the park manager through the process of evaluating potential biological impacts and in making the ultimate decision with regards to impairment.

Guiding Laws, Regulations, and Policies

With respect to terrestrial and aquatic organisms, there are several regulatory programs that may make similar types of determinations. While these other determinations do not necessarily determine impairment, they can be helpful in the overall evaluation, and it is appropriate to briefly discuss those programs and how they relate to impairment.

- **Endangered Species Act (ESA):** Under the ESA, the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) assess whether federal actions are likely to "jeopardize" the continued existence of listed species or "adversely modify" critical habitats. The USFWS and NMFS must make formal determinations of whether or not projects "jeopardize" the existence of a species. For most NPS units with a mandate to preserve and protect wildlife or natural resources, a proposed project with a "jeopardy" determination on a native species is also very likely to result in a determination of "impairment." However, for those NPS units lacking a natural resources mandate, a "jeopardy" determination may not result in an impairment determination, but the project would still need to be modified in order to comply with the ESA. Because USFWS and NMFS make their jeopardy assessment on the existence of the species as a whole or the listed population as a whole, a finding of no jeopardy does not mean that the action will not impair park resources. It is very possible for a project to severely impact a species in a park – or even extirpate it from the park – and have the project be given a finding of no jeopardy by USFWS or NMFS if the species is doing well in other portions of its range. Such a situation could, however, likely lead to an impairment finding by the park. The ESA also prohibits the "take" of listed species – this means actions that harass, harm, or kill listed animal species. The USFWS and NMFS can authorize the "incidental take" of listed species – thus, allowing certain actions to go forward even if they "take" individuals of a listed species. An action that "takes" listed species is not necessarily going to impair park resources.
- **Migratory Bird Treaty Act (MBTA):** The MBTA protects migratory birds from being taken, killed, possessed, or sold. As with the discussions of take under the ESA, take under the MBTA does not necessarily constitute impairment of park resources. The recent Executive Order on Migratory Birds greatly increases the degree to which federal agencies must plan to avoid impacts to migratory birds. There is a strong likelihood that NPS will need to certify that it is complying with the Executive Order. If that occurs, the role of this certification will be similar to that done in NEPA documents.
- **Bald Eagle Protection Act:** This law provides for the protection of the bald eagle (the national emblem) and the golden eagle by prohibiting, except under certain specified conditions, the taking, possession and sale of such birds. Again, like the discussion of the ESA and MBTA, "take" does not necessarily result in impairment.

Although managers can and should use a variety of environmental and species protection laws in evaluating the acceptability of potential impacts from a proposed action, the ultimate decision to undertake an action will require consideration of the regulatory impact determinations described above, in addition to NPS non-impairment criteria.

Information Needs

Determinations of impairment or non-impairment require information. For most actions affecting biological resources, it is important for the park to have information on at least the following eight areas:

Assessment component	Information needs	Sources of information
Park purposes and values	An understanding of the specific purposes and values for which the park was established	• Organic Act • Enabling legislation
Biological resources in park planning documents	Knowledge of what biological resources are specifically identified in the park's general management plan or planning documents	• GMP • RMP • Implementation plans
Ecosystem processes and conditions	An understanding of the ecosystem processes and conditions that sustain these species	• Resource management staff • Publications • CESUs, USGS, universities, cooperators • New park research • NRID, BRMD, and WRD
Native species inventory	An inventory of all native species found in the action area (in some instances, an inventory of key non-native species will also be important)	• Resource management staff • Publications • New park or network surveys • State heritage programs • CESUs, USGS, universities, cooperators • Inventory & Monitoring program data
Species abundance and viability	An estimate of abundance (e.g., population size or distribution) and viability (self-sustainability) for key species. This information may be contained in survey or monitoring reports, population viability assessments, or reports from expert panels.	• Resource management staff • Publications • New park or network monitoring • State heritage programs • CESUs, USGS, universities, cooperators • Inventory & Monitoring program data
Impacts of action on biological resources and ecosystem processes	Knowledge of how the action may impact park biological resources and ecosystem processes	• Resource Management staff • Publications • New park, network, or DSC studies • CESUs, USGS, universities, cooperators • NRID, BRMD, and WRD
Public enjoyment of biological resources	An understanding of how the public is currently enjoying the potentially affected biological resources, including targeted surveys and elicitations of public use and enjoyment.	• Public scoping/review processes • CESUs, universities, and cooperators
Impact of action on public enjoyment of resources	Knowledge of how the action may impact public enjoyment of these resources	• New park, network, or DSC studies • Publications • CESUs, USGS, universities, cooperators • NRID, BRMD, and WRD

For endangered species, parks must work closely with the USFWS and NMFS offices in their area. In most instances, the park should ask USFWS for a list of threatened and endangered species found in the project area (or in the park for management plans). As a minimum, surveys should be conducted for listed species thought to be in the project area. Simply consulting heritage or other databases of known occurrences of species is not adequate. Surveys should be conducted to at least the species-specific standards established by USFWS and NMFS. For management plans, surveys of the entire park are not required, but may help in developing appropriate management objectives.

For migratory bird species, the Executive Order on migratory birds requires agencies to consult the list of migratory birds of special concern. This list is maintained by USFWS and can be found at its website (http://migratorybirds.fws.gov). Additional surveys for migratory birds may or may not be appropriate given the nature of the project and the amount of information already available to park staff.

For most other species, NPS management plans, staff assessments, or scoping sessions with the public can provide information on which species may be affected by the project or activity. Additional surveys may or may not be appropriate given the nature of the project and the amount of information already available to park staff. Special attention may need to be given to keystone species or species that are known to be highly sensitive to proposed or ongoing actions.

Impact Levels

It is important to insure that impact evaluations are not limited with regards to species, temporal, or spatial scales. All potentially related impacts should be considered and impacts to natural resources should be followed until effects at a further geographical distance, ecosystem, trophic level, or associated species relationship are no longer logically anticipated.

Impact levels for Biological Resources are based on three components:

- **Severity**. The degree to which resources are affected. This has two subcomponents:
    - Intensity. How much an individual unit of resource is affected (e.g., are individual animals annoyed, injured, killed, etc.)
    - Extent. How much of the resource is affected (e.g., the proportion of a species habitat that is affected or the proportion of a population that is affected).
- **Duration**. How long the resource is affected (e.g., the effect is a short-term event, long-term event, or a permanent change to the environment).
- **Timing**. When the resource is affected (e.g., plants are mowed during flowering, fruiting, or when dormant).

Impact levels in this section are based on the concept of natural variability (NV). By this we mean how some parameter that we measure varies naturally over time (or how we would expect it to vary without human influence). Examples of such parameters are population size, distribution of metapopulations, species range, age or stage structure of the population, genetic variability, seral stage of the community, pollination rate, seed set, disturbance regime, fire frequency, fire severity, fuel loads, seasonal or daily stream flows, and migration pathways. There is no set time period (e.g., since 1800 or at the time of park designation) for determining how these parameters have varied or are estimated to vary. The NV for a parameter should be evaluated on a case-by-case basis for each affected park unit.

As noted above, impacts to natural resources should be followed to logical endpoints and the NV should be considered both at those endpoints and along the impact threads. For example, a water control project could maintain average stream flows within the annual NV, but reduce the frequency of large flooding events from once every four years to once every seven years. The project would thus result in impacts outside NV.

Another example would be where population levels of a species naturally and cyclically fluctuates between X and 3X, and the park proposes to maintain population levels permanently at 3X. Because this action disrupts natural cyclic events, it would be outside NV. When the ability of park ecosystems to recover from negative events has been damaged, special care needs to be used in determining the effects of actions and in determining which parameters are important with respect to NV. For example, lethal levels of low oxygen may have periodically occurred in the past with the end result being the temporary depopulation of an aquatic organism. Today, a human produced period of low oxygen levels may be within NV, but the result may be an unnaturally long-term or permanent depopulation due to a lack of recolonization ability. In this instance, the impact threshold may more heavily weigh the long-term depopulation (which is outside NV) rather than the low oxygen levels that may be within NV.

The following discussions of impact levels use a matrix to identify how the severity, duration, and timing of effects relate to NV. Both severity and timing of effects should be placed into the context of NV (how similar impacts would be expected to occur naturally) to help determine impact levels.

Negligible. Impacts occur, but are so minute that they have no observable effects on plants and animals and the ecosystems supporting them.

Severity: Trivial effects on individual organisms or areas of habitat.
Duration: Short-term to long-term effects.
Timing: Outside of critical timing windows of key resources or ecosystems.

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term	X		
	Long-term	X		
	Permanent			

Minor. Impacts are detectable, but the severity and timing of changes to parameter measurements are not expected to be outside the natural variability (NV) and not expected to have have any long-term effects on biological resources or ecosystems. Population numbers, population structure, genetic variability, and other demographic factors for species may have small, short-term changes, but long-term characteristics remain stable. Key ecosystem processes may have short-term disruptions that are within NV, and habitat for all species remains functional.

Severity: Trivial effects on individual organisms or areas of habitat with very small proportions of organisms or habitat affected. Impacts are well within NV.
Duration: Short-term to permanent affects.
Timing: Outside of critical timing windows of key resources or ecosystems.

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term		X	
	Long-term			
	Permanent	X		

Moderate. Impacts are detectable and the severity and timing of changes to parameter measurements are expected to be outside the natural variability (NV) for short periods of time and changes within the NV may be long-term in nature. Population numbers, population structure, genetic variability, and other demographic factors for species may have small to moderate, short-term declines, but rebound to pre-impact numbers. Species are not at risk of being extirpated from the park, key ecosystem processes may have short-term disruptions that are outside NV (but return to NV), and habitat for all species remains functional.

Severity: Considerable effects on individual organisms, populations, or habitat over very limited areas or measurable small effects on most individuals or on populations over a large area. Impacts are within or outside NV.

Duration: Short-term to long-term effects.
Timing: Some impacts may occur during key time periods for individuals, populations, or ecosystems.

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term		X	X
	Long-term		X	
	Permanent			

Major. Impacts are detectable and the severity and timing of changes to parameter measurements are expected to be outside the natural variability (NV) for short to long periods of time – or even be permanent. Changes within the NV may be long-term or permanent in nature. Timing of the impacts are important with respect to species or ecosystem functioning. Population numbers, population structure, genetic variability, and other demographic factors for species may have large, short-term declines with long-term population numbers considerablely depressed. In extreme cases, species may be extirpated from the park, key ecosystem processes like dune nourishment may be disrupted, or habitat for any species is rendered not functional.

Severity: Considerable effects on individual organisms, populations, or habitat over a large area. Impacts are within or outside NV.
Duration: Short-term to long-term to permanent effects.
Timing: Considerable impacts during key time periods for species or ecosystems.

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term			X
	Long-term		X	X
	Permanent		X	X

In summary, thresholds of impact can be placed into the following table. Note that some boxes may have two potential thresholds, depending on the magnitude of the impact.

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term	Negligible	Minor/Moderate	Moderate/Major
	Long-term	Negligible	Moderate/Major	Major
	Permanent	Minor	Major	Major

Key Terms

Appropriate opportunity to enjoy: The opportunity for the public to view, use, or consume biological resources under appropriate conditions that sustain those resources. For parks established to protect natural resources, the appropriate condition is an essentially natural condition, with natural population levels, a natural distribution of animals, and natural animal behaviors within the park. For some areas (such as Wolf Trap Farm Park), the appropriate condition may be a semi-natural situation or even unnatural conditions. Regardless of the type of park unit, an acceptable opportunity to enjoy park resources does not include use to the point that it becomes unsustainable, that it results in an inappropriate visitor experience, that it requires the park to maintain population levels of charismatic species at unnaturally high levels, or that habituation of wild animals is accepted.

Considerable: Events with consequences large in extent or degree.
Ecological processes: Natural processes important to the control of, or perpetuation of, native plant and animal communities (e.g., successional, hydrologic, geologic, soil formation, and evolutionary processes). Considerable alteration of these can directly and negatively affect habitats and viability of species that often have life histories adapted to these processes.
Native species: Species are native if they naturally occur within the park's plant and animal communities.
Natural variability (NV): How a measured parameter varies naturally over time or how we would expect it to vary without human influence. Examples of such parameters are population size, distribution of metapopulations, species range, age or stage structure of the population, genetic variability, seral stage of the community, pollination rate, seed set, disturbance regime, fire frequency, fire severity, fuel loads, seasonal or daily stream flows, and migration pathways. There is no set time period for determining how these parameters have varied or are estimated to vary. The NV for a parameter should be evaluated on a case-by-case basis for each affected park unit.
Trivial: Events of such small or unimportant consequence as to warrant no concern.
Non-native species: Species are non-native if they occur within a park's plant and animal communities as a direct or indirect result of human actions. Species that naturally occur within one park community, but have expanded beyond their natural range to other communities as a result of human actions (e.g., fire suppression) would be considered non-native in the area of range expansion.
Permanent: The action results in a situation that is irreversible or policies that institutionalize management actions indefinitely into the future.
Preclude: The action effectively prevents the attainment of a condition (e.g., prevents the restoration of habitat needed to re-establish a species extirpated from the park or prevents accomplishing a goal in the General Management Plan).
Viable population: A viable population of a plant or animal is self-sustaining under natural conditions or maintained under actions in an approved land-use management plan.

Impairment Considerations and Examples

An action that eliminates a naturally occurring native plant or animal population from the park has a high likelihood of impairing park resources. Similarly, actions that ultimately preclude an extirpated species from being restored to the park or that preclude populations becoming self-sustaining are also likely to impair park resources. However, there may be instances when actions that severely impact a native species may be acceptable, with examples as follows:

- Restoration projects frequently remove non-native vegetation (e.g., tamarisk) because of their deleterious affect on individual species or entire ecosystems. In some instances, the loss of a non-native plant or animal may have a negative effect on specific native species. Examples would be the conflict between removing tamarisk (salt cedar) that provide "structure" for some migratory birds (e.g., southwest willow flycatcher) or removing feral pigs in areas where they are important prey for listed carnivores. Removal of these non-native species is desirable from long-term ecosystem protection and endangered species management perspectives. These long-term benefits, however, need to be reconciled with short-term negative impacts to some species. The conflicts between removing non-native species and protecting current habitat or prey bases are frequently conflicts of timing. It is possible that phasing out unwanted weed habitat/prey while phasing in native habitat/prey may resolve this issue (e.g., removing only a portion of the non-native weeds until replacement native habitat can grow, then replacing the remaining non-native habitat). Such actions result in a short-term loss of habitat or a temporary decline in population levels of native species, but are unlikely to result in impairment – if viable populations of the native species are maintained in the long-term.

- As a result of re-establishing more natural fire regimes, species that had previously benefited from fire suppression may, in the future, see their habitat reduced in size. This will have negative impacts on species that use fire-suppressed habitats. In general, it is better to re-establish a more natural fire regime rather than attempt to maintain unnatural fire regimes and unnatural plant communities. This generality holds even if re-established fire regimes have a negative effect on individual species – including federally listed species. However, while our long-term goal may be to re-establish natural fire regimes, we may have short-term goals that retain key habitat for native species (especially listed species) until other habitat has become suitable or until we are comfortable that the species is adequately managed. So, timing of the action, appropriate mitigation measures, and the magnitude of impacts to the species are important considerations. It is possible, for example, for the overall goal of re-establishing natural fire regimes to be non-impairment and for an aggressive series of projects to be impairment if they are timed so as to have unacceptable short-term affects on habitat and population levels that preclude viable populations of naturally occurring species in the future.
- In many instances, restoration projects seek to modify or eliminate the existing vegetative communities found in human-disturbed habitats in order to promote more natural communities. In some instances this will result in the loss of unnatural habitats that are used by both native and non-native species. The loss from the park of non-native species (see definitions) would not usually be considered impairment, unless the park was established specifically to conserve those species.

Additional examples are provided for situations that are “less likely” or “more likely” to impair park resources. Parks need to evaluate these examples in the context of their enabling legislation to see how they apply to their specific situations.

General Examples

Action	**Affected biological resource**	**Impairment less likely**	**Impairment more likely**
Construction of a barrier fence to control entry into the park	Large ungulates	Temporarily blocking important dispersal routes for one or two generations, which may result in inbreeding or founder effects but not to the degree that park populations are threatened.	Destroying or blocking important dispersal routes permanently or to the point that natural gene flow is disrupted and park populations of a species may be threatened by deleterious genetic effects.
Construction of a visitor center	A rare native plant found along prairie edges	A very small portion of the plant’s distribution in the park is converted to non-native habitat (e.g., < 2%). Some individual plants are lost, but the species is self-sustaining within the park.	Approximately 30% of the historical habitat for the species within the park has already been lost and this project will reduce habitat by an additional 10%. The species will be reduced in numbers and there is a reasonable possibility that the species may be lost from the park.
Construction of a visitor center	A regionally rare native plant that has been extirpated from the park	Construction eliminates historical habitat for an extirpated species, but there is adequate suitable habitat available in other areas of the park to re-establish the species and for the species to maintain self-sustaining populations.	Construction eliminates a large portion of the historical habitat for the species. As a result, the action precludes the ability to restore species to the park (e.g., construction of the visitor center on the only habitat available for re-establishing a species previously lost from the park).

Action	Affected biological resource	Impairment <u>less</u> likely	Impairment <u>more</u> likely
Improved access for park visitors	Native grassland ecosystems	Expansion of non-native cultural grasslands adjacent to important native grassland ecosystems, when non-native species are actively managed to prevent significant damage to native species.	Expansion of non-native cultural grasslands when the action allows invasive species to disrupt native ecosystems or reduce the population levels of a native species to non-sustainable levels.
Control of invasive species	Native plant ecosystems	Populations of non-native ungulates are reduced to levels that allow self-sustaining native plant populations to attain natural population density and structure.	Inaction results in considerable damage to native ecosystems with some species at risk of being lost from the park.
Improvements to park transportation system	Anadromous fish	Temporarily (e.g., 2 weeks) blocking important upstream migration routes for anadromous fish, but providing alternative migration avenues (such as fish passages).	Destroying or blocking important dispersal routes permanently or to the point that reproduction is considerably disrupted and park populations of the species may be seriously depleted.
Maintenance of recreational fishing	High elevation amphibians and aquatic invertebrates.	Stocking of non-native sport fish in recreational areas where native species are not impacted and future restoration of native species is not desired.	Introduction (or maintaining non-native species) when such species threaten the viability of native species or alter ecosystem processes.
Management of forest communities	Old-growth dependent lichens and bryophytes	Maintenance of roadways and camp areas through removal of individual hazard trees.	Conversion of old-growth forests to early seral stages to the extent that the amount of old-growth forests is reduced to a level less than the natural levels expected for the area or to levels that cannot sustain lichen and bryophyte populations.
Relocation of a species	Black-tailed prairie dogs, a species under consideration for listing as threatened.	Capture and removal of individual animals that are damaging cultural resources. The species remains self-sustaining within the park and fulfills important ecological roles.	Permanent removal of this species from the park or a large portion of the park.
Regulation of water by other agencies	Aquatic resources	Water releases mimic natural water quality, quantity, and variations. Aquatic communities are self-sustaining.	Water releases vary from natural conditions and aquatic communities are negatively affected. Some species are no longer self-sustaining.
Restoration of native ecosystems	Migratory birds	Habitat restoration of a tamarisk dominated community to a native riparian community. Populations of some native birds are temporarily reduced until restoration actions produce new habitat. Populations are expected to maintain self-sufficiency during and after restoration actions.	Habitat restoration is done simultaneously throughout the park, leaving little or no opportunity for species to maintain viable populations in or adjacent to restoration areas.

Specific Examples

Action	Affected biological resource	Impairment <u>less</u> likely	Impairment <u>more</u> likely
Mechanical fuel reduction project in	Mature fire-tolerant forest (e.g.,	Fuel reduction on 3,000 of the park’s 3,500 acres of this community type will allow re-introduction of	Fuel reduction on 2,000 of the park’s 3,500 acres of this community type will convert the community to a simplified, unnatural structure

Action	Affected biological resource	Impairment <u>less</u> likely	Impairment <u>more</u> likely
Wildland urban interface (WUI): A	Ponderosa pine) The forest is heavily invaded with young pines and fire-intolerant species due to past fire suppression policies. Forest is in Condition Class 2 or 3. The historic fire frequency was 17 years and the last fire burned 79 years ago. The area harbors two T&E species.	prescribed fire onto the landscape without risk of a stand-replacing event. Action maintains a natural community type in the desired seral stage. One T&E species that favors open forests is negatively affected in the short term, but benefits from improved habitat in the long run. One T&E species that favors dense forest is negatively affected in both the short- and long-term (i.e., eliminated from the action area), but there is extensive naturally dense forest habitat in the park and the species is expected to maintain self-sustaining populations in the park.	with reduced biological diversity. Future management is intended to maintain this unnatural condition. One T&E species that favors open forests is negatively affected in the short term and long term (i.e., eliminated from the action area), but there is little remaining habitat in the park and the species is not expected to maintain self-sustaining populations in the park. One T&E species that favors dense forest is negatively affected in both the short- and long-term (i.e., eliminated from the action area), but there is extensive naturally dense forest habitat in the park and the species is expected to maintain self-sustaining populations in the park. KEY IMPAIRMENT CONCERNS: 1. Conversion of 70% of one community type to an unnatural community type. 2. Major reduction of a native species' habitat with the possible loss of the species from the park.
Mechanical fuel reduction and fuel break project in Wildland urban interface (WUI): B	Mature fire-intolerant forest (e.g., Sitka spruce or pinyon-juniper). The forest has high fuel loads. Forest is in Condition Class 1. The historic fire frequency was 425 years and the last fire burned approximately 400 years ago. Invasive species are known to rapidly colonize disturbed areas and exclude native plants. The area harbors two T&E species.	Fuel reduction will convert the community to a simplified, unnatural "savannah like" structure with reduced biological diversity. Future management is intended to maintain this unnatural condition. Fuel reduction is focused on a very limited area to protect structures and visitors. Approximately 60 acres of the 11,500 acres of this community type are affected. Fuel breaks are limited to defensible areas adjacent to developed areas. Measures are implemented to reduce the establishment of invasive species. Both T&E species lose some habitat, but both are expected to maintain self-sufficient populations. Action maintains over 99% of the park's acreage of this community type.	Fuel reduction will convert the community to a simplified, unnatural "savannah like" structure with reduced biological diversity. Future management is intended to maintain this unnatural condition. Fuel reduction is intended to protect structures and visitors and to reduce fuel loads across the landscape. Approximately 2,200 acres of the 11,500 acres of this community type are affected. Fuel breaks are placed adjacent to developed areas and along ridges to compartmentalize the park. Measures are not implemented to reduce the establishment of invasive species. Forest is fragmented due to establishment of fuel breaks. Both T&E species lose some habitat, but both are expected to maintain self-sufficient populations, though at much reduced population levels. Action maintains approximately 80% of the park's acreage of this community type. KEY IMPAIRMENT CONCERNS: 1. Conversion of 20% of one community type to an unnatural community type. 2. High potential for invasive species to have a major impact on biological resources. 3. Large reduction in population levels of native species.

WATERSHEDS

Water Quality

Background

Watersheds integrate factors that determine the natural characteristics of waters. Each natural aquatic system has evolved natural water quality characteristics that determine the nature of the dependent aquatic biological systems. Often subtle changes in water quality can result in substantial changes in dependent aquatic flora and fauna. The chemical, physical, and biological quality of ambient waters at any one point in time reflects inputs from many sources, including gases, aerosols and particulates from the atmosphere; weathering and erosion of rocks and soils; solutes and precipitants that are products biogeochemical cycles; and contaminants introduced to the hydrologic cycle from the cultural activities of man. The existence, nature, and extent of biological aquatic communities and the uses of water by man are directly related to water quality. Generally, the number and types of ecological and anthropogenic uses that can occur in a particular water body is inversely related to increasing concentrations of natural and man-caused contaminants in water. Water quality impairment may be caused when human activities contribute pollution and contamination to the degree that they threaten to eliminate natural ecological attributes or anthropogenic uses of water (e.g. recreation).

Guiding Laws, Regulations and Policies

Clean Water Act

The Clean Water Act (33 U.S.C. § 1251 et seq.) provides the basis for the legal and technical mechanisms to protect and restore the quality of natural waters through the establishment of water quality standards (Section 303(a)); the identification and restoration of quality-impaired waters (Section 303(d)); and the management of point- and non-point source pollution (Sections 402 and 319). Point-source pollution is considered to be pollutants delivered to waters of the United States through discrete conveyances. Point sources are managed through the National Pollutant Discharge Elimination System (NPDES) permit program. Examples of point sources of pollution are discharges from wastewater treatment plants, industrial discharges, and stormwater runoff from large municipalities. Non-point source pollution is considered to be all pollution that is not defined (by regulation) as a point source, and is generally contributed by runoff from diffuse sources. Non-point sources of pollution include runoff from native pasture and forest lands, stormwater runoff from small and municipalities, and most agricultural lands. Non-point sources of pollution are largely managed through voluntary programs that strive to incorporate Best Management Practices into the routine daily operation of the activity.

Water Quality Standards and the Antidegradation Policy of the Clean Water Act–

States are given a central role for the establishment of water quality standards and for the management of water quality. States administer the various provisions of the Clean Water Act in an integrated fashion under the oversight of the Environmental Protection Agency (EPA). Standards establish the statutory water quality goals that must be achieved, and they are an excellent starting point to determine if an activity will cause impairment of park water quality. Water quality standards are generally consistent with the Organic Act and park enabling legislation in that they strive to protect and preserve aquatic ecosystems and recreational uses of water. EPA regulations require that a water quality standard must consist of the following three elements: (1) designating uses to be made of the water; (2) setting minimum narrative or numeric criteria sufficient to protect the uses, and; (3) preventing degradation of water quality through antidegradation provisions. At this time, EPA has promulgated over 100 numerical ambient water quality criteria for chemical, physical, biological, and bacteriological parameters, most of which have been adopted by States in their respective water quality regulations.

The antidegradation policy is an important component of water quality standards, and has important management implications to most units of the National Park System. The antidegradation policy is set out in 40 C.F.R. Part 131.12 and consists of the following three-tiered approach for the protection of water quality (EPA Water Quality Standards Handbook 1994).

Tier 1: Includes the provisions to protect existing uses of water in the State, which constitute the absolute floor or minimum level of protection that must be provided all waters.

Tier 2: Protects the water quality in those waters whose quality is better than that necessary to protect “fishable/swimable” uses of the water body. EPA regulations require that certain procedures be followed and certain showings be made by the state before lowering water quality in high-quality waters. Many States implement this portion of the policy by promulgating more stringent numerical and narrative criteria in their standards that are reflective of existing ambient water quality. In no case may water quality on a Tier 2 water body be lowered to the level at which existing uses are impaired.

Tier 3: Protects Outstanding National Resource Waters (ONRWs) “…such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance.”(40 C.F.R. 131.12(a)(2)). While primarily a classification that protects the highest quality waters of the United States, it also offers special protection to water bodies that are important, unique or sensitive ecologically, but show water quality, as measured by the traditional parameters such as dissolved oxygen or pH, which may not be particularly high. Existing water quality in ONRWs must be “maintained and protected,” although States may allow some limited activities, which result in temporary and short-term changes in water quality. In most cases, however, new point sources of pollution will not be allowed. The National Park System encompasses many of the most sensitive, pristine, and significant aquatic resources in the United States, and many have been afforded the protection of Tier 3 ONRW status. Examples include Yellowstone National Park, Rocky Mountain National Park, and the Big South Fork National River and Recreation Area.

The three tiers of the antidegradation policy provide a basic framework from which water quality impairment determinations can be made. Antidegradation should not be interpreted to mean that “no degradation” can or will occur. Degradation may be allowed even in the most pristine Tier 3 waters for certain pollutants as long as it is temporary and short-term in nature. In most cases, human actions and activities that will introduce pollutants that threaten to impair water quality by exceeding ambient water quality standards will also be contrary to the Organic Act and a park’s enabling legislation. However, in the case of a park with management responsibility for an ONRW, it may be possible to have Clean Water Act impairment for an activity that may not be in conflict with the park’s enabling legislation. This is because of the strict mandate to “maintain and protect” existing water quality in an ONRW. Thus, an action or activity that theoretically can minutely change existing long-term water quality trends in the ONRW could be judged to be inconsistent with the classification. Conversely, it may be possible to have Organic Act impairment and not Clean Water Act impairment when water quality impacts threatens resources specifically mandated for protection by the park’s enabling legislation.

Statutory Impairment Under the Clean Water Act
Water bodies that fail to comply with standards are compiled by States into a list, commonly referred to as a "303(d) list" after the section of the CWA where the requirement is contained, for submittal to the EPA. The EPA approves the list only if it meets applicable requirements. Water bodies on an approved 303(d) list require the establishment of a total maximum daily load (TMDL). A TMDL specifies the amount of a particular pollutant that may be present in a water body, allocates allowable pollutant loads among sources, and provides the basis for attaining or maintaining water quality standards.

Information Needs

Evaluation of the potential impacts to water quality requires regulatory information from EPA, states, or tribes, regarding water standards, technical and scientific information on ambient water quality status and trends, and scientific information on the nature and behavior of the pollutants that will be discharged so that impacts may be predicted. Information needs and sources of the information are listed below.

Assessment component	Information needs	Sources of information
Regulatory and technical characterization of potentially impacted waters	• Identification and location of proposed action • Identification of whether the proposed action is a point source or nonpoint source of pollution • Identification, quantification of surface disturbance • Preliminary identification of pollutants of concern (for example sediment, organics, bacteria, hydrocarbons) • Identification of watersheds and surface and ground waters that may be affected by the proposed action • Clean Water Act designated uses and antidegradation status • Impairment status • Status and trends of ambient water quality for parameters such as total dissolved solids, dissolved oxygen, pH, metals, pesticides and hydrocarbons	• U.S. Geological Survey Topographic maps • For point source pollution: Environmental Protection Agency National Pollutant Discharge Elimination website at http://cfpub.epa.gov/npdes • For nonpoint source pollution: EPA web site at http://www.epa.gov/owow/NPS/ • General Management Plans • Park Resource Management Plan • NPS Inventory and Monitoring Program • DSC design studies and plans • EPA, Tribal, or State Water Quality Standards and regulations • Clean Water Act Section 305b reports, including 303d lists • NPS- Water Resources Division Water Quality Data Inventory and Analysis Reports • U.S. Geological Survey Water Resources Data Reports • U.S. Geological Survey National Water Quality Assessment Reports • Environmental Protection Agency Storage and Retrieval • NPS-Water Resources Division • Gallagher, L. M., and L. A. Miller. 1996. Clean Water Handbook (2nd ed.). Government Institutes, Inc., Rockville, MD • U.S. Environmental Protection Agency. 1993. Water Quality Standards Handbook. Office of Water Regulations and Standards, Washington, D.C.

Assessment component	Information needs	Sources of information
Estimating and predicting water quality impacts	• Change in water quality as compared to state and EPA water quality criteria • Potential effects on aquatic life • Potential impacts on drinking water supplies • Potential Impacts on water-based recreation	• Stressor Identification Guidance Document, EPA-822-B-00-025 • Environmental Protection Agency Water Quality Modeling web site at http://www.epa.gov/waterscience/wqm/

Impact Levels

Negligible: Impacts are effects that are not detectable, well below water quality standards, and within historical baseline water quality conditions.

Minor: Impacts are effects that are detectable but well within or below water quality standards and within historical baseline water quality conditions.

Moderate: For most waters, impacts are effects that are detectable, within or below water quality standards, but historical baseline water quality conditions are being altered on a short-term basis. However, in ONRWs, this threshold may approach the requirements for statutory impairment.

Major: For most waters, impacts are effects that are detectable and significantly and persistently alter historical baseline water quality conditions. Water quality standards are locally approached, equaled or slightly and singularly exceeded on a short-term and temporary basis. However, in ONRWs this threshold would probably constitute statutory impairment.

Impairment Considerations and Examples

Action	Affected water quality	Impairment less likely	Impairment more likely
Routine maintenance or repair of existing facilities such as roads, boat ramps, stormwater and sewage pipes and bridges, and new road and new facility construction activities. Also, new or existing land use activities such as grazing, forestry, and agricultural practices.	Sediment: Primarily originates from disturbed sites during construction activities, unpaved roads and trails, and from poorly restored disturbed sites. Also, sediment is increased by certain agricultural and silvicultural practices. May impact aquatic life by smothering habitat or restricting light penetration. Bacteria: Sources include runoff from lands that have high-intensity ungulate grazing and feeding operations, recreational activities with inadequate human-waste disposal practices, and poorly designed septic systems. Concentrations exceeding standards will impact recreational uses of the water such as swimming and fishing.	Tier 1, 2, and 3 Waters: Areas of new disturbance are kept to a minimum (one acre or less) and Appropriate Best Management Practices and stormwater pollution controls are incorporated into maintenance, construction, operations and land-use activities that will reduce quantities of sediment, hydrocarbons, pesticides nutrients and other pollutants entering surface waters. Pollution caused by maintenance activities will be short term (one year or less.) The receiving water is <u>not</u> listed on a State 303d list.	For Tier 1, 2 and 3 waters: Areas of new disturbance exceed one acre (Note: construction activities that will cause one or more acres of disturbance may be considered a point source of pollution in many states and will require an NPDES permit). Inadequate Best Management practices or stormwater controls are proposed or employed. Pollution caused by the activity will occur for one year or more. The receiving water is listed on a State 303d list and the receiving water is impaired by a pollutant that will be generated by the

Action	Affected water quality	Impairment <u>less</u> likely	Impairment <u>more</u> likely
	Nutrients: Sources are agricultural and urban areas where fertilizers are used, and areas where concentrated animal grazing occurs. Metals, hydrocarbons, and pesticides: Contained in runoff from urbanized areas and road and parking lot surfaces. Concentrations of many of these elements and compounds may cause sub-lethal to lethal effects in aquatic life. Acid-forming materials: Construction in certain geologic settings may expose natural acid-forming rocks and soils. Runoff from these areas may decrease pH in receiving waters which may impact aquatic life.		activity.
New point-source discharging facility such as municipal and industrial wastewater treatment facilities, industrial plants, and certain mining and oil and gas exploration and production activities that will require an NPDES permit.	The concentration of most pollutants allowed in the discharge will be controlled by effluent limitations in the NPDES permits. However, the impact on ambient water quality must still be analyzed. Organics: A final concentration of organics, as measured by biochemical oxygen demand, depends on the wastewater treatment technology employed. Higher concentrations of organics in ambient water will depress dissolved oxygen concentrations which could impact aquatic life. Nutrients: Most wastewater treatment facilities are a source of nitrogen and phosphorus. Potential impacts are the same as described for nonpoint sources of pollution. Pharmaceuticals and Personal Care Products: No criteria have yet been established for this class of compounds, but their presence in municipal wastewater streams is now well known, and impacts to endocrine systems of fish is increasingly being documented in the literature. Other pollutants or regulated effects that may be considered are pH, total dissolved solids or salinity, metals, hydrocarbons, and suspended solids and turbidity.	Tier 1 Waters: The discharge will <u>not</u> cause receiving waters to fall below ambient water quality standards or threaten to eliminate a designated use of the receiving water. Tier 2 Waters: The discharge will not cause a significant decline (more than 10%) from appropriate measurements of chemical, physical and biological water quality, or otherwise fall below the minimum standards for Tier 1 waters. Tier 3 Waters: Will not theoretically or measurably change the chemical, physical, or biological character of existing water quality. Tier 1, 2, and 3 Waters: The receiving water is <u>not</u> listed on a State 303d list.	Tier 1 Waters: Ambient water quality standards will not be met in the receiving water. Tier 2 Waters: A theoretical decline of more than 10% from existing chemical, physical, or biological quality of the receiving water will occur. Tier 3 Waters: Theoretical change in the chemical, physical or biological character of existing quality of the receiving water will occur. Tier 1, 2, and 3 Waters: The receiving water is listed as impaired on a State 303d list, and it is impaired by a pollutant that will be a constituent of the proposed discharge.

Water Quantity

Background

Water is an important natural resource in most landscapes within national park units. It helps shape and maintain physical features and habitats, sustains flora and fauna, and contributes to recreation and aesthetic values. All of these functions rely, in part, on continuation of an adequate quantity of water in park ecosystems and landscapes. As part of an impairment determination for a proposed or ongoing activity, parks should assess the potential for the activity to result in water quantity related impacts to park resources and values.

There are no national or regional standards that specify how much water is needed to support the functions (uses of water) listed above. In addition, there are no uniformly accepted methodologies that can be applied across all park settings to quantify how much water is needed for these functions. In evaluating an activity, parks therefore need to apply methodologies and standards that are appropriate to the resources and values of concern, and to the park setting.

Park uses of water often go beyond basic domestic and municipal water supply needs. Depending on a park unit's enabling legislation and management objectives, an adequate supply of water may be needed to protect and interpret various types of water-dependent resources and values. Questions related to how much water is needed, at what locations, and for what times of year need to be evaluated by technical specialists and park managers on a case-by-case basis.

Where applicable, water rights can influence (enhance or limit) a park's options and overall ability to manage water quantity within its boundaries. This is because water rights convey an explicit or implicit "right" to use water, subject to limitations under applicable water law.

Guiding Laws, Regulations, and Policies

NPS management policy states that the Service will perpetuate surface and ground waters as integral components of park aquatic and terrestrial ecosystems. Management policy also directs the Service to obtain and use water in accordance with legal authorities. These authorities derive from applicable state and federal laws, and legal precedents established through case law. States have the principal responsibility for allocating water, except where applicable federal law explicitly or impliedly establishes authority for protecting water quantity. Applicable federal laws include, but may not be limited to: the 1916 NPS Organic Act [16 U.S.C. 1], park-specific enabling legislation or presidential proclamations, the Wild and Scenic Rivers Act [16 U.S.C. 1271-1287], and the Wilderness Act [16 U.S.C. 1131]. Detail regarding Service policy on water rights can be found in NPS Management Policies 2001 (Section 4.6.2).

Parks need to consider the applicability of both state water rights and federal reserved water rights when evaluating activities. However, the complexities of water law and water rights do not allow for development of a concise set of guidelines that parks could use to fully assess an activity's water right implications. For state water rights, complexity is embodied in the substantial differences among states in terms of permissible water uses and procedural requirements under state law. For federal reserved water rights, complexity arises through the legal and policy issues that define when and how this type of water right can be used. Consequently, parks are generally advised to seek outside assistance to help them consider the applicability and effect of water rights for the specific activity they are evaluating. Technical assistance can be obtained through the Water Rights Branch of the NPS Water Resources Division. Legal assistance can be obtained through legal counsel in the Department of Interior's Office of the Solicitor.

Resolution of park water quantity issues often involves working with park neighbors, water administrators, and federal or state decision-makers. While preserving any legal remedies that may exist under applicable authorities, the Service is committed to work with these entities to develop and apply appropriate solutions to water quantity issues. In some cases this may lead to long-term partnerships with other water users and affected stakeholders. The Service may also need to participate in decision-making processes where NPS is not the lead.

Information Needs

The extensiveness and detail associated with information needs will depend on the scope of the project and the scale of potential impacts to park resources and values.

Assessment component	Information needs (* Specialized terminology is defined in the Water Quantity "Key Terms" section)	Sources of information
Identify general water quantity changes.	Consider potential changes in timing and magnitude of water movement through, or storage in, park surface and ground-water bodies.(*) As possible, describe potential changes in terms of: the physical mechanisms or processes (tied to the activity) that will cause a change in water quantity characteristics; the water bodies or geographic area that these changes will occur within; the relative magnitude of these changes (in absolute or percentage terms, with respect to underlying natural variability, etc.); the variability of these changes over time (seasonality, short term vs. long term changes, etc.).	Hydrology and watershed related studies, literature, and data sets Expert opinion from hydrologists with expertise in surface and ground water
Identify water-dependent resources and values of concern.	Consider whether any of the following resources or values are important to the park setting, and at risk of having their integrity compromised as a result of water quantity changes: • Water bodies • Aquatic species (or ecosystems) in streams and springs • Riparian or ground-water dependent species (or ecosystems) • Water dependent geologic processes • Water-related aesthetic and recreational values • Water-related scientific or educational values For each resource and value identified as being of concern, generally describe how/why they might be adversely affected by the water quantity changes.	For management purposes, refer to general authorizing legislation (e.g., 1916 Organic Act, Antiquities Act), enabling legislation for the park and legislative history documents. For management objectives, refer to general management plans, resource management plans, water resource management plans, other park planning and management documents. Expert opinion from hydrologists and technical specialists familiar with water-

Assessment component	Information needs (* Specialized terminology is defined in the Water Quantity "Key Terms" section)	Sources of information
		dependent resources and values.
Indicate whether resources and values currently meet desired conditions.	For resources and values identified as being of concern: • List those which presently meet desired conditions. • List those which do not meet desired conditions and generally describe the water quantity issues (if any) that may contribute to the current situation.	The above listed NPS sources for park purposes and management objectives, plus non-NPS literature and other relevant information sources. Expert opinion from hydrologists and technical specialists familiar with water-dependent resources and values.
Identify the water quantity variables that should be analyzed.	Determine which water quantity variables need to be analyzed relative to the activity: • Identify key physical characteristics(*) that, if analyzed relative to the activity, will enable assessment of adverse impacts to park resources and values of concern. • For key physical characteristics, identify any aspects of natural variability(*) that should be included in the analysis. Note: for water quantity, natural variability is often expressed as important magnitudes and their associated timing (when needed), duration (for how long needed), and/or recurrence intervals (how frequently needed). For each water quantity variable selected for analysis, describe its role in protecting the integrity of the park resources and values that are of concern.	Hydrology and watershed related studies, literature, and data sets Expert opinion from hydrologists and technical specialists familiar with water-dependent resources and values.
Consider whether the activity has any water right implications.	Develop responses to the following questions: • Does the use of water by the activity need to be supported by a state water right, and if so, has a right been obtained? • Does use of water by the activity, and the park setting, qualify for advancement of a federal reserved water right to support the water use? • Apart from water rights that support water use by the activity, do other water rights exist (either explicit or implied water rights) that may exert a legal influence on whether activity can go forward?	Park staff with specialized knowledge and experience in water rights Water right expertise from the Water Resources Division's Water Rights Branch Legal expertise from the Office of the Solicitor

Impact Levels

There is no single set of criteria that can be used to interpret levels of water quantity related impacts. For resources and values addressed in other sections of this impairment guidance, the proper criteria will generally be the ones reported in those sections. For cases where this guidance manual doesn't provide appropriate criteria, technical specialists need to identify criteria from other sources or develop suitable criteria for use in the assessment. If there are multiple resources or values of concern, each one will need to be paired with suitable criteria.

Determination of impact levels usually requires collaboration between hydrologists and technical specialists familiar with a park's water-dependent resources and values. Impact analysis often requires a two step approach, as follows:

1) Assess changes to water quantity variables (key physical characteristics, aspects of natural variability) as a result of water use by the activity, or as a result of the ways in which the activity affects the physical environment;
2) Evaluate whether these changes in water quantity will, in turn, result in any adverse impacts to important park resources and values.

Key Terms

Specialized terms used in water quantity assessments are as follows:

Water body **–** a general reference to surface and ground water features (e.g., rivers, creeks, springs, seeps, lakes, ponds, wetlands, aquifers). It includes water features spanning a range of environmental conditions, from those not impacted by any human activity to those managed to meet a variety of human needs, such as reservoirs and rivers below dams.

Key physical characteristics **–** for a given water body, the "water quantity related" physical attributes (e.g., flow rate, depth, volume, surface area) that have a key role in protecting the integrity of important park resources or values. Key physical characteristics will vary depending on the resource or value of concern, type of water body, and the geographic setting.

Natural variability **–** for a key physical characteristic in a given water body, its naturally occurring levels, ranges, timing, and/or patterns of change (temporal or spatial) that have a key role in protecting the integrity of park resources and values. Aspects of natural variability are often identified as critical for maintaining healthy ecosystem functions, or deemed important for protecting and interpreting other park resources and values.

Impairment Considerations

Once impact levels have been interpreted by technical specialists, park managers have the responsibility to determine whether the activity is likely to result in impairment of important park resources and values. To do this, managers must consider the results of impact analysis in the context of the park setting and other applicable considerations. If any water right implications were identified for the activity (see "Information Needs"), water rights are among the things the manager will need to consider. Because of their complex and legal nature, managers are generally advised to seek outside assistance from the NPS Water Rights Branch or the Office of the solicitor to help them consider the applicability and effect of water rights for the specific activity they are evaluating.

Watershed Processes and Conditions: Stream Channel and Riparian Resources

Background

Stream channels and associated floodplains and riparian zones are strongly interacting and dynamic landscape elements. Stream corridors integrate and reflect the attributes, conditions and processes of their watersheds, and influence the evolution of landscapes at the local, regional and watershed scales. As such the physical/morphologic properties of stream channels are influenced by altered upland watershed conditions and by activities occurring in channels and associated riparian zones. Changes in the physical attributes of stream channels, in turn, affect the aquatic habitat qualities of streams. Conversely, the health and function of riparian systems are dependent upon maintaining a proper hydrologic and morphologic relationship with the stream channel. In evaluating impairment of a stream resource, it is generally advisable to consider channel and floodplain/riparian resources and processes together. It often is difficult to determine if channels, floodplains and riparian zones are impaired or within natural variability. In all cases, channel and riparian impairment analyses require professional analysis on a site-specific basis.

Guiding Laws, Regulations, Policies

Section 4.6.6 of the NPS Management Policies 2001 (Watershed and Stream Processes) states that NPS will manage streams to protect stream processes that create habitat features such as floodplains, riparian systems, woody debris accumulations, terraces, gravel bars, riffles, and pools. Executive Order 11988 (Floodplain Management) and NPS Policy (DO-77-2) directs NPS to preserve and restore floodplain values. The Federal Clean Water Act requires a permit for dredging and filling activities in navigable waters.

Information Needs–Stream Channels

Stream channel impairment determinations require predicting responses of channels to proposed actions, then evaluating predicted channel conditions against precise definitions of desired (future) conditions. The main reason for making impairment determinations in relation to condition objectives is that the watersheds of many park streams are not entirely within parks, and there may be very real constraints on the conditions for which streams can be managed. In addition, park enabling legislation may establish specific purposes, for example preserving historic or cultural sites, which influence management of channel conditions and processes.

Defining Desired Future Conditions for Stream Channels

In parks with significant natural resources where a stream's entire watershed is contained within the park (or adjacent protected area), channels may be in near-pristine condition and existing and desired channel condition may be synonymous. In this case, channel conditions can be described from field measurement of channel physical attributes, process-based channel classification, and analysis of channel dynamics from basic hydrologic, hydraulic and fluvial geomorphic principles.

Defining desired channel condition can be more challenging for streams presently in an undesired condition and may involve measurements of the channel under pre-disturbance conditions, surveys from "reference" channels or channel reaches known to be unimpaired, or historic accounts of pre-disturbance channel conditions. Various channel classification schemes (e.g., Rosgen 1996) derived from basic hydraulic geometry, landscape position, and morphologic measurements can also be useful in describing and categorizing both unimpaired channel attributes, and those of existing or potentially impacted channels.

Complicating the analysis of channel "condition" is the fact that channels are not static landscape features, but undergo natural disturbance from floods and droughts, incremental adjustment, and evolution (including evolution following disturbance) within normal ranges of variability. Channels are also part of evolving landscapes, and channel evolution at the long-term landscape scale also should be considered in analyzing channel condition. Thus, channels can become impacted not only by changes in their morphologic attributes, but also by changes in channel process. The concept of "dynamic equilibrium" refers to the idea that channels continually experience adjustment and may be impaired when they become overly stable (as may be the case downstream from a dam when flood flows are severely reduced), or overly unstable (in which case erosion rates may be accelerated over normal erosion rates). Statements of channel condition generally should include dynamic and evolutionary attributes in addition to other descriptors.

Evaluating Channel Condition Response to Proposed Actions

Predicting channel response to proposed management actions is required to determine whether or not resulting conditions achieve management objectives (either to preserve channels that are already in their desired condition, or to restore channels that are currently in an undesired condition). While some stream channel impacts are easy to define, other impacted conditions may be very difficult to identify, diagnose or predict. Changes in channel conditions may be direct or indirect, and occur when proposed management actions result in changes in: runoff regimes (especially peak flows); sediment delivery regimes; stream bank and riparian vegetation conditions; channel alignment (and/or gradient); large organic debris loading; or base level (streambed elevation). Channel classification schemes (knowing the "type" of channel in question, and the nature of channel responses under known classes of perturbation) may be useful in evaluating potential channel response to changes in watershed or riparian conditions.

Assessment component	Information needs	Sources of information
Characterization of channel condition	• Hydraulic geometry and channel morphology including cross-section and longitudinal profiles (width, depth, bed elevation, gradient, bank geometry, pool-riffle expression), landform mapping, substrate characterization, bankfull discharge, woody debris surveys and floodplain delineations • Geomorphic/process-based channel classification • Discharge summaries, preferably from gauged data (otherwise synthesized), including mean monthly	• USGS topographic maps • Field topographic surveys • Air photos • Channel classification systems. • Channel and substrate habitat surveys. • Riparian Proper Functioning Condition Surveys • Discharge measurements • USGS stream flow records, or modeled

Assessment component	Information needs	Sources of information
	discharge, flood-frequency analysis, and low flow analysis • Summaries of discharge-hydraulic geometry relationships • Aquatic habitat condition (or suitability) analyses • Descriptions of channel dynamics (meandering, braiding, bar dynamics, etc.), and an evaluation of long-term channel evolution tendencies • Bank, floodplain and riparian vegetation conditions	or synthesized stream flows • Open Channel Hydraulic and Hydrologic Models • Rosgen, D.L., 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO
Characterization of channel response	• An analysis of the effects on watershed erosion and an evaluation of the balance between changes in sediment delivery to the channel and sediment transport capacity within the channel. Will there be a changed tendency towards sediment deposition in the channel or increased channel erosion? • An analysis of changes in channel erodibility, alignment or gradient. Depending upon channel type, current condition and stage of evolution, responses to changes in watershed, riparian or instream conditions might involve downcutting (incision), widening, aggradation (accelerated sediment deposition on the bed), changes in hydraulic roughness (e.g., substrate composition or changes in form roughness such as may occur through pool-riffle expression), changes in channel features such as bars, or changes in lateral adjustment rates (e.g., meandering). • An analysis of changes in flow hydraulics (this is particularly important when contemplating actions within the channel or floodplain, such as construction of bridge piers). • An analysis of potential changes in the interactions of the channel (and channel flows) with the floodplain. • An analysis, derived from basic principles, of long term adjustment tendencies associated with evolution towards a new dynamic equilibrium.	• Watershed erosion and sediment yield models • Sediment transport models • Open channel hydraulic models • Process-based channel classification • Professional application of basic principles • NPS Water Resources and Geologic Resources Divisions • Federal Interagency Stream Restoration Working Group, 1998. Stream Corridor Restoration Principles, Processes and Practices. This compendium is available in hardcover notebook or online at www.usda.gov/stream_restoration.com.

Information Needs–Riparian Resources

Stream riparian areas are generally defined as transition areas between in-stream aquatic systems and uplands. Riparian areas support vegetation communities that depend upon the water (including ground water) associated with the stream, for both plant water use and for the physical processes associated with flooding. Flooding can influence riparian vegetation habitats and succession. Riparian vegetation, in turn, influences stream channel morphology and flood hydraulics.

The condition and function of stream riparian systems requires consideration of hydrologic, vegetation, and erosion/deposition (soils) attributes and processes (USDI-BLM 1998). A process for assessing the Proper Functioning Condition of stream riparian systems was developed by an interagency workgroup under the coordination of the Bureau of Land Management (USDI-BLM 1998). This process establishes a consistent “framework” for evaluating the various hydrologic, vegetation and sedimentation processes influencing the condition and functioning of stream riparian areas.

According to USDI-BLM (1998) a stream riparian area is in Proper Functioning Condition when it “…is in dynamic equilibrium with the stream flow forces and channel aggradation/degradation processes producing change with vegetative, geomorphic, and structural resistance. In a healthy condition, the channel network adjusts in form and slope to handle increases in storm flow/snowmelt runoff with minimal disturbance of channel and associated riparian-wetland plant communities.”

The Proper Functioning Condition (PFC) process provides an excellent starting point and context for evaluating potential impairment from existing or proposed land uses. However, PFC is keyed to the concept that for riparian areas to support healthy riparian vegetation and associated habitats, it is necessary for the hydrologic and sedimentation systems to be sufficiently “in-tact” to support proper geomorphic function without causing significant damage to riparian vegetation. The PFC method does not define desired species composition or vegetation seral stage, and as such a riparian system in “functioning condition” may not necessarily mean that desired or “potential” vegetation and associated habitats exist – only that the physical system is adequately functioning and is capable of supporting healthy, native vegetation communities.

In evaluating potential impairment associated with land use activities, it is important to evaluate the physical functioning of the channel and riparian systems, but it may also be necessary to evaluate the species composition and seral stage of riparian vegetation. Furthermore, most applications of the PFC method have been to western U.S. streams. While the factors considered in the PFC method may be generally applicable to all streams, there may be other, more applicable (local) methods for synthesizing and evaluating information to determine overall condition.

Assessment component	Information needs	Sources of information
Evaluating stream riparian conditions and responses to land use changes	• Hydrogeomorphic: ground water tables/flows; floodplain delineation; flood modification; channel geometry; stream power; hydraulic controls; bed elevation (or incision status) • Vegetation: community types; community type distribution; surface density; canopy; community dynamics and succession; recruitment/reproduction; root density; survival • Erosion/Deposition: bank stability; bed stability; depositional features • Soils: soil type; distribution of aerobic/anaerobic soils, capillarity, annual pattern of soil water states • Water quality, including sediment transport	• Riparian condition or riparian function surveys • Vegetation surveys • Soil surveys • Channel topographic and cross-section surveys • Riparian ground water table measurements • Channel condition and channel habitat surveys • Open channel hydrologic and hydraulic models • USGS stream flow data if available, or modeled or synthesized stream flows • USDI Bureau of Land Management, 1998. Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas. Technical Reference 1737-15. Denver, CO. 126p.

Stream Channel Impairment Considerations

The extent, duration and severity of predicted channel response to proposed actions should be evaluated against the channel's desired future condition to determine if it results in channel impairment. Indirect impacts (impacts that initiate long-term adjustment processes), as well as the extent and duration of direct impacts may be particularly difficult to evaluate. This is because certain channel types may be fairly resilient to certain types of impacts, and the self-healing capabilities of the system may mitigate the duration of impact. For example, a significant but short-duration input of sediment to a high-energy bedrock stream may initially result in measurable downstream impacts to the channel bed and associated biota, but the sediment will very efficiently be transported through the system, allowing biota to recover from this short-term disturbance. Other channel impacts may be fairly minor and of limited extent initially, but set into motion long-term reach-scale or system-wide adjustments. For example, an activity such as road construction and drainage, that significantly impacts riparian vegetation on a fairly local scale may, in certain types of streams, initiate system-wide head cutting, incision, and lowering of riparian water tables. Still other activities, for example floodplain (or terrace) facilities development along laterally dynamic streams, may initially result in minor or negligible impacts to channels, but long-term channel dynamics may eventually place the channel in conflict with the facility creating the potential need for significant intervention to normal channel dynamics in order to protect infrastructure.

Channels are **more likely** to become impaired when:

- Changes in runoff, stream flow, and sediment delivery are either large or of sustained duration, requiring evolution of the channel to a new equilibrium condition. Channels that are alluvial (or otherwise erodible), or have significant depositional features, are the channel types most susceptible to a change in character stemming from changes in flow and sediment delivery.
- Land use activities result in large or sustained increases or decreases in peak flows.
- Land use activities result in large changes in the status, composition, and extent of stream bank and riparian vegetation, or large woody debris loading.
- Base levels (or base level controls) are altered in streams subject to reach-scale head cutting or aggradation.
- Channel erosion control projects, or other stream bank or floodplain projects, interfere with, or are incompatible with normal channel adjustment processes on a reach scale.
- Instream structures (e.g., bridge piers or abutments, culverts) interfere with normal channel hydraulics in streams susceptible to reach-scale adjustment through erosion and deposition of sediment.
- Channel geometry, capacity or alignment is mechanically or structurally modified, such as occurs when channels are straightened or channelized.
- Native (or desired) biologic assemblages are significantly altered at the reach-scale or greater or over long durations, affecting channel characteristics.

Channels are **less likely** to become impaired when:

- Flow regimes, including peak flow regimes, are relatively unaltered.
- Accelerated watershed (or channel) erosion is not large compared to the transport capacity of the stream, and is of short duration.
- Floodplain and riparian vegetation resources are in good condition.

- Channel and floodplain conveyance capacities are unaltered.
- Channels are unmodified mechanically or structurally.
- Structures such as bridges and culverts are designed to interfere minimally with flow hydraulics – especially during periods of high flow.
- Channel processes are essentially unconstrained by structures.
- Floodplain land uses do not modify the hydraulics of flood flows.
- Native (or desired) aquatic biologic assemblages are sustained in healthy condition.

Riparian Resource Impairment Considerations

Stream riparian areas are **more likely** to become impaired when:

- Channels incise, causing riparian ground water tables to lower and resulting in less-frequent flooding of the floodplain.
- Riparian vegetation condition is affected due to such activities as over-grazing, logging, trampling, changes in species composition, altered hydrologic regimes (including ground water regimes), or land development.
- Channels are aggraded, resulting in more frequent flooding and accelerated lateral adjustment
- Lateral channel processes (e.g., meandering) are constrained by structures such as bank riprap, bridge piers, and others.
- Upstream impoundments or diversions result in reduced flooding, changes in the season of flooding, or significantly reduced base flows.

Stream riparian areas are **less likely** to become impaired when:

- Channel geometry, planform, gradient and flow capacities are relatively unaltered, and channels are free to adjust laterally and vertically within an unimpacted, "desired" range which is in balance with the landscape setting.
- Flow regimes, especially flood and base flow regimes, are relatively unaltered.
- Riparian land uses don't significantly impact the composition, vigor or status of riparian vegetation, or interfere with fluvial processes within the channel or riparian zone.
- Riparian ground water tables are relatively unaltered.
- Woody debris loading to the channel, including beaver activities, occurs within "normal" natural variability.

Impairment Examples: Stream Channels and Riparian Areas *

Action	Affected watershed process	Impairment less likely	Impairment more likely
Bridge construction	Width or orientation of flood flow	Construction of bridge abutments adjacent to steep bedrock channels. In this case impacts are likely to be of limited extent, provided that high flow backwater effects are negligible.	Construction of bridge abutments that interact with and significantly restrict the local width or orientation of flood flows in alluvial or gravel bed channels if an analysis shows that this will likely result in substantial backwater during high flows, or

Action	Affected watershed process	Impairment <u>less</u> likely	Impairment <u>more</u> likely
			formation of upstream and downstream bars that, in turn, influence flow hydraulics on a reach scale, or otherwise interfere with reach-scale lateral or vertical channel processes.
Stream bank erosion control project	Bank erosion	Protecting an eroding bank that threatens an historic or cultural site that is fundamental to a park's enabling legislation. In this case an analysis of local and reach-scale processes should be factored into the erosion control design, and the effectiveness of alternative (soft) technologies evaluated to anticipate and mitigate impacts to natural processes.	Rip-rapping an eroding bank on an outside meander bend in a park with significant natural resources in order to protect pre-existing infrastructure if an analysis indicates riprap will interfere with long-term meandering dynamics on a reach-scale.
Upstream dam	Erosion and sedimentation	Substantial sediment input stemming from removal of a dam upstream from a park with significant natural resources when an analysis shows that downstream sediment transport capacities are capable of routing released sediments through the system over a period of years. In this case both the magnitude and extent of the impacts may be substantial, but the duration of impact is mitigated through natural healing processes, enabling restoration to desired conditions.	Development of a plan of operation for a dam upstream of a park with significant natural resources that significantly reduces the magnitude and/or frequency of historic (pre-dam) large floods. This will result in erosional (degradational) responses downstream, and could result in depositional (aggradational) responses downstream from tributaries delivering significant sediment loads. Impacts to riparian and floodplain resources also will occur downstream. (also, see water quantity impairment)
Cleared construction site.	Storm runoff	A construction site that, even utilizing best management practices, increases fine (suspended) sediment delivery to a stream on a temporary basis, provided that the finished site does not result in sustained impacts to flow or water quality, and provided that impacts to aquatic species are not sustained and that there is not risk to T&E species.	Constructing road or parking lot drainage that significantly increases storm runoff to a small channel susceptible to bed erosion. This may initiate reach or system-scale downcutting of the channel and result in isolating the riparian area from flooding (also, see water quality impairment).
Development of river recreation access facilities	Erosion	Minor excavation of a point bar on the inside of a meander bend (assuming all applicable Clean Water Act Permits are obtained) to accommodate launching of rafts during low water periods. This activity would likely be of minor severity, limited extent (the impact will not initiate upstream or downstream adjustments), and short-duration (point bars are dynamic during high flows so healing likely would occur during the subsequent annual high flow period).	Construction of river recreation access facilities (e.g., a boat launching ramp) on the outside bend of a river meander. Meandering rivers actively work outside meander bends during high flows as part of natural fluvial processes. During periods of high discharge, a locally impacted meander bank could start adjusting at rates more rapid than those associated with natural variability, eventually initiating reach-scale adjustments or requiring intervention to control erosion.
Ground water pumping	Ground water availability	Ground water pumping of a deep aquifer that is disconnected from surface streams and shallow alluvial aquifers.	Ground water pumping of a shallow alluvial aquifer that substantially and permanently reduces ground water elevations associated with a significant riparian resource. This action not only will directly impact riparian vegetation, but in certain stream types could initiate local and reach-scale channel adjustments.
Locating a road	Flood plain	Location of a road up a river valley	Location of a road up a river valley

Action	Affected watershed process	Impairment <u>less</u> likely	Impairment <u>more</u> likely
up a stream corridor	width alteration	floodplain (where no non-floodplain alternative exists), but locating the road at the very side margins of the valley bottom adjacent to the hill slopes. In this case, there will still be interactions between the road and channel migration processes, but those interactions would be more likely to be similar in nature and location that those that would occur in interactions between the channel and the hill slope, and there would be only minimal interference with normal channel adjustment processes.	floodplain (where no non-floodplain alternative exists) in a way that significantly reduces the active channel migration width or floodplain width (e.g., locating the road up the middle of the valley). The requirement to protect the road from river erosion likely will significantly interfere with normal channel adjustment processes over the reach scale.
Fire	Runoff and sediment delivery	Controlled management fires in watersheds where fire is a natural ecosystem process. In this case increased sediment delivery to the channel will be within the range of the normal variability that contributed, over geologic time, to defining channel character.	Unnaturally intense wildfire occurring in a historically fire-suppressed forest where runoff is to a fine-grained, low gradient, alluvial channel. Sediment loading is likely going to be significant compared to historic/geologic rates and compared to the transport capacity of the channel, initiating channel adjustments that may require a substantial duration of time for recovery to pre-existing conditions.
Livestock or ungulate grazing	Channel widening or downcutting	Livestock grazing in parks where grazing is authorized, provided it is conducted under grazing systems specifically and professionally designed to protect riparian vegetation resources (and associated wildlife habitat resources). This may, after professional analysis, be accomplished through such things as exclusion, or by controlling season of use, utilization, and providing for periods of rest.	Heavy grazing of riparian vegetation by livestock or ungulates at levels or during seasons that are not consistent with historic, natural grazing patterns. This could result from poor grazing management plans (livestock), trespass livestock, introduced species, or ungulate grazing in situations where the natural range has been restricted or where populations are abnormally large due to absence of predators. Over utilization of riparian species can result in lost habitat, and result in reach-scale changes in channel processes resulting in widening or downcutting, and changes to bank and cross-section geometry.
Levee construction	Flood potential	Construction of a small local levee to protect an historic or cultural site fundamental to park purposes from shallow, low velocity, infrequent floods. In this case flood protection is dictated by park purpose, there will be minimal interference with floodplain function or process, and there is no danger to human life.	Construction of a levee to protect infrastructure located on an alluvial fan feature from flooding, or to maintain channel location in relation to a downstream bridge. In this case, confining a channel to one location will result in continuing aggradation of the channel (alluvial fans are active depositional features), resulting in the channel bed becoming elevated over the elevation of the adjacent land surface. This creates a potentially dangerous flooding situation, restricts normal alluvial fan processes, and is unsustainable in the long term.

* The examples in this table are very generalized. In most all cases, channel/riparian impairment requires professional analysis on a site specific basis.

Wetlands

Background

Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Extended saturation or flooding during the growing season, and the anaerobic conditions that they create, are the dominant factors determining wetland soil characteristics and the types of plant and animal communities living in the substrate or on its surface. Frequency, duration, and depth of saturation or flooding greatly influence wetland structure and function. For example, the elevation differences between adjacent wetland plant communities such as willow thickets and wet meadows, or between wetlands and adjacent upland habitats, are typically only a few inches. Fluvial processes, fire frequency, water quality, and many other biotic and abiotic factors also strongly influence wetland characteristics.

Any of the processes and factors that create and sustain wetland ecosystems can be altered by human activities, and wetlands are often highly sensitive to such changes. For example, runoff from agricultural areas has had dramatic impacts on nutrient-poor wetlands of the Everglades, fire suppression has caused the loss of pine savanna wetland habitats in southeastern coastal plain parks, and even minor changes in hydrologic conditions brought on by road construction, drainage systems, or ground water withdrawals have altered or eliminated wetland habitats across the Service. Therefore, when NPS managers make decisions about actions in parks, impacts on wetlands and the possibility that such impacts may constitute impairment of wetland resources are often key considerations.

Many other sections of this document, including Ecosystem Perspectives, Biological Resources, Geological Resources, other Water Resources sections, and Ecosystem Integrity should be consulted when evaluating the possibility that actions will impair wetland resources or the species dependent upon them. This section will not repeat those discussions, but rather will focus on the unique characteristics of wetland habitats and wetland law and policy that may affect impairment decisions.

Guiding Laws, Regulations, and Policies

Executive Order 11990: Protection of Wetlands, NPS Management Policies (2001), Director's Order #77-1:Wetland Protection, and Procedural Manual #77-1:Wetland Protection establish NPS policies, standards, and procedures for protecting and managing wetlands. Habitats defined as wetlands in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979 U.S. Fish and Wildlife Service Report No. FWS/OBS-79/31)) are subject to these policies and procedures.

NPS wetland protection policies and procedures include a no-net-loss of wetlands provision, requiring that proposed actions with adverse impacts on wetlands follow a sequence of:

- Avoiding adverse wetland impacts to the extent practicable.
- Minimizing impacts that could not be avoided.
- Compensating for any remaining unavoidable impacts through restoration of degraded or former wetland habitats at a minimum 1:1 ratio.

The NEPA document for a proposed action that will have adverse impacts on wetlands must include a wetland "Statement of Findings." The Statement of Findings must explain why there are no practicable alternatives with less wetland impacts and must document compliance with this avoidance-minimization-compensation sequence.

Many wetlands managed by the NPS are also regulated by the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act. Anyone proposing to deposit dredged or fill material into wetlands or other "waters of the United States" must comply with Corps of Engineers 404 permit procedures, which also include an avoidance-minimization-compensation sequence. Receipt of a 404 permit for a proposed action (or a determination by the Corps that a permit is not required) does not imply compliance with the NPS wetland protection procedures.

It is recognized that some activities or facilities that are necessary to meet the NPS mission may have unavoidable impacts on wetland resources. Both the NPS wetland protection procedures and the Corps 404 permit process can allow limited wetland impacts to occur as long as certain procedural requirements are met (e.g., the avoidance-minimization-compensation sequence). However, neither process specifically addresses when a wetland impact constitutes "impairment" as defined in NPS Management Policies. Therefore, NPS managers must distinguish between impacts that may be allowable under the 404 permit process and Director's Order #77-1, and impacts that would constitute impairment of NPS wetland resources and cannot be allowed.

Information Needs

Assessment component	Information needs	Sources of information
Location and types of wetlands	Maps showing boundaries and classifications of wetland habitats.	Site-specific wetland delineations; National Wetland Inventory maps (U.S. Fish and Wildlife Service); special mapping studies (e.g., park-specific mapping projects involving greater ground truthing and/or higher resolution source data and products than NWI maps); vegetation maps; soils maps
Wetland-dependent flora and fauna	Inventories of flora and fauna present within the wetland or that are otherwise dependent upon the wetland habitat (may include predominantly upland faunal species that use wetlands as sources of food, water, etc.)	NPS flora and fauna databases; State Natural Heritage Program or Dept. of Natural Resources databases; U.S. Fish and Wildlife Service; National Marine Fisheries Service; site-specific studies; literature reviews
Wetland conditions and processes	Understanding of the conditions and processes that created and sustain the wetland habitat (e.g., successional processes, fire, fluvial processes, water table depths and durations, water sources, water quality)	Site-specific studies; literature reviews; aerial photography; USGS topographic maps; USGS, Corps of Engineers, state, or local agency data on water levels, stream flows, or water quality
Ecological functions	Understanding of other ecological functions provided by the wetlands and their relationships to other park resources (e.g., flood attenuation, stream flow maintenance, sediment retention, export of detritus to downstream ecosystems)	Site-specific studies; literature reviews; wetland functional assessment methods such as the Corps of Engineers Hydrogeomorphic Method (HGM) or Evaluation for Planned Wetlands (Environmental Concern, Inc.)
Sensitivities and thresholds	Understanding of the sensitivities/thresholds that could cause	Site-specific studies; literature reviews; professional judgment

Assessment component	Information needs	Sources of information
	unacceptable change in wetland conditions, processes, and functions and the species that depend on them	
Degree of change to wetland	Understanding of the degree to which proposed actions could change these conditions, processes, and functions or directly affect the wetland flora and fauna	Site-specific studies; literature reviews; professional judgment
Social functions of wetlands	Understanding of how the public experiences and values the "social functions" of wetlands (e.g., enjoyment of scenic vistas, photography, historic or cultural significance) and how these may be impacted by the proposed action	Site-specific surveys; literature reviews; professional judgment
Regional or national significance	Understanding of the regional or national significance of wetland types that may be threatened or in decline, and the role that preserving these resources plays in contributing to the value and integrity of the park	U.S. Fish and Wildlife Service; National Marine Fisheries Service; State Natural Heritage Program or Dept. of Natural Resources offices; site-specific studies; literature reviews; park enabling legislation and planning documents
Specific purposes and values of the park	Understanding of the specific purposes and values for which the park was established and whether the wetland resources to be impacted are necessary to fulfill those purposes	Park enabling legislation; General Management Plan (GMP), Resource Management Plan (RMP); other park documentation
Wetlands as a conservation goal	Knowledge of what wetland resources are specifically identified as a conservation goal in the park's general management plan or planning documents and the extent to which those resources will be impacted by the proposed action.	Park GMP, RMP and other park planning documents

Impairment Considerations and Examples

Wetlands tend to be highly sensitive to changes in many of the underlying conditions and processes that sustain them, and can change dramatically even as a result of seemingly minor levels of disturbance. For example:

- Nutrient-poor Everglades marshes undergo significant algal community shifts, with resultant changes in marsh food webs and habitat structure, if agricultural runoff increases phosphorus concentrations by only a few parts per billion.
- Dams that shift the timing of spring runoff events in many western river systems by as little as 2-3 weeks can hinder native cottonwood or willow establishment and favor invasion of non-native tamarisk.
- Changes in mean water table elevations by only a few inches in many wetland systems can cause significant shifts in plant community composition and structure or cause the oxidation (loss) of organic soils.

- Reduction in fire frequencies by only a few years can cause pine savanna wetlands of the southeastern coastal plain to shift toward bottomland hardwood forests.
- Salinity increases of only a few parts per thousand can destroy freshwater marsh vegetation, fish, and invertebrates.

Therefore, the severity, duration, and timing of such impacts from a proposed action must be understood and compared to the sensitivity of the wetland resource in question in order to help make an impairment determination. For example, temporarily lowering water levels in a wetland to repair a dam or outlet structure may have short term adverse effects on certain wetland biota, but would be less likely to be considered impairment if the affected biota were expected to recover to pre-impact levels in a reasonably short time period. On the other hand, longer-term or more severe impacts of the types described in the list above may be cause for an impairment determination.

Action	**Affected wetland characteristic or function**	**Impairment <u>less</u> likely**	**Impairment <u>more</u> likely**
Road widening to improve public safety (wetland impacts have been avoided and minimized to the extent practicable in accordance with D.O. #77-1).	Very small portions (< 0.1 acre each) of 13 wetlands will be lost by filling for road project.	Wetland habitats affected are common in the park/region and have no special designations or status (including no T&E species). Loss of natural/cultural wetland functions is minor and can be mitigated through proposed compensation. Action does not reduce public enjoyment of wetland resources, affect integrity of key resource values for which park was established, or run counter to an established goal in the park GMP.	Wetland habitats affected are very uncommon and increasingly rare or threatened in the park/region, are designated as critically rare/threatened by state Heritage Program, or have comparable state, national, or international designations. Loss of wetland habitats reduces public enjoyment of wetland resources, adversely affects integrity of key resource values for which park was established, or runs counter to established goals in park GMP.
Ground water pumping adjacent to coastal NPS unit that includes key wetland (shorebird/wading bird habitat with public viewing area).	Water withdrawals could lower the water table in the vicinity; potential to change surface water depth/duration in wetland habitat.	Technically sound groundwater studies indicate that potential impacts on wetland hydrology would be negligible (not measurable). Monitoring plan is in effect to detect impacts, and pumping would stop if effect on wetland hydrology is detected.	Technically sound groundwater study indicates that wetland area is clearly within the cone of depression; water table will be reduced, resulting in changes in plant or animal species composition.
Special use permits are to be issued for row crop agriculture in a National Recreation Area. GMP allows for agricultural uses, but also lists protection of aquatic resources as a management goal.	Isolated wetlands and streams are found throughout the special use area, providing important habitat for songbirds, wading birds, beaver, and amphibians.	Wetlands and streams will be excluded from agricultural uses. Buffer areas will be established with widths sufficient to protect wetland/stream resources from sediment/nutrients impacts and loss of natural functions and values.	Wetlands and riparian areas will be plowed and planted, or they will be excluded from agriculture but protective buffers will not be established. Wetland or stream characteristics, functions, or processes will be degraded by agricultural runoff, and biota dependent upon these resources will be measurably impacted.
Build visitor center and museum on an upland site adjacent to a wetland that provides rare	0.2 acre of wetland located immediately down gradient from the construction site and susceptible to	Construction techniques are designed to minimize offsite movement of sediment, and state-of-the-art erosion control technology is utilized such that	Construction methods and inadequate erosion controls allow sediment movement down gradient and into the wetland, resulting in degraded water quality, habitat

Action	Affected wetland characteristic or function	Impairment <u>less</u> likely	Impairment <u>more</u> likely
amphibian habitat.	sedimentation.	sediment deposition in the wetland is prevented.	alteration, and/or disruption of amphibian life cycles.

AIR RESOURCES

Background

Air pollutants emitted in and near parks might be those that affect visibility (nitrogen oxides, sulfur oxides, and particulates), those that affect human health (hydrocarbons, ozone precursors, nitrogen oxides, sulfur dioxide, particulates, and air toxics); and those that affect ecosystems (ozone, acidic deposition of nitrogen and sulfur, nitrogen nutrient enrichment and air toxics). When air pollution concentrations and effects from a project are quantified and assessed, it is important early on to identify mitigation measures, and assess strategies for potential emissions reductions. This is consistent with NPS Policy to "seek to perpetuate the best possible air quality in parks," and consistent with the way NPS addresses impacts of sources located outside park boundaries by insisting that they use the "best available control technology" (BACT) or the most effective emissions reductions feasible.

Because point (industrial) and area (vehicles, agricultural, urban) and mobile (on and off road vehicles) air pollution emissions from hundreds of miles away can be transported into parks, air pollution effects on resources, visitor enjoyment, and human health almost always have cumulative, as well as project-specific, impacts to consider. The amount of existing impact of air pollutants on parks will have bearing on an impairment finding from a proposed project in several ways: (1) If the air quality is very clean, the characteristics of visibility are such that it would only take a very small amount of pollution to create visibility degradation perceptible to the human eye; (2) If acidic deposition impacts have been occurring for several years, ecosystem tolerances may be at or above critical load levels resulting in even small amounts of additional emissions producing significant ecosystem changes; (3) Where air pollution concentrations in parks are at or near human health standards, federal law (and NPS policy) may prohibit additional emissions that would increase these pollution concentrations.

Guiding Laws, Regulations, and Policies

Clean Air Act

National Ambient Air Quality Standards (NAAQS)

NPS air resource management policy has been developed in conjunction with requirements in the Clean Air Act (CAA) and EPA's regulations. The level of protection afforded some park resources and values by the CAA may be the determining factor when deciding whether air quality impacts are acceptable. Air pollution sources within park boundaries, must, by law, comply with all federal, state, and local regulations. Air pollution sources outside park boundaries are subject to varying federal, state and local regulations depending upon the land ownership and type and size of pollution source. The CAA established National Ambient Air Quality Standards (NAAQS) to protect the public health and welfare from air pollution. Impairment determinations are not necessarily linked to exceeding the NAAQS, but mitigation measures would likely be required under the CAA if emissions from an activity caused or contributed to a NAAQS violation. This issue is discussed further under the "conformity requirements" section below.

Prevention of Significant Deterioration (PSD) Program

The CAA also established the Prevention of Significant Deterioration (PSD) of Air Quality program to protect the air in relatively clean areas. One purpose of the PSD program is to protect public health and welfare, including natural resources, from adverse effects that might occur even though NAAQS are not violated. Another purpose is to preserve, protect, and **enhance** the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic or historic value (42 U.S.C. 7401 et seq.). The PSD program includes a classification approach for controlling air pollution. Class I areas are afforded the greatest degree of air quality protection. Very little deterioration of air quality is allowed in these areas. Class I areas include international parks, national wilderness areas and national memorial parks in excess of 5,000 acres, and national parks in excess of 6,000 acres that were in existence as of August 7, 1977, when the CAA was amended. Currently, there are 48 areas in the NPS system designated as Class I. NPS areas that are not designated Class I are Class II, and the CAA allows only moderate air quality deterioration in these areas. In no case, however, may pollution increases cause violation of any of the NAAQS. Most of the regulatory authority under PSD applies to large sources of air pollution which would be located outside of park boundaries.

Under the PSD program, the park superintendent is given an affirmative responsibility to protect visibility and all other Class I area air quality related values (AQRVs) from the adverse effects of air pollution. A new pollution source proposing to locate near a Class I area must apply for a PSD permit from the state air pollution control agency. The park superintendent, with technical assistance from the NPS Air Resources Division, then reviews the permit proposal for potential adverse impacts to park resources and provides comments to the state regarding permit conditions and approval of air pollution emissions from that source. Given the CAA goal and NPS resource protection objectives, the NPS may object to permits being issued for construction of new pollution sources outside park boundaries if there will be perceptible or otherwise adverse impacts within parks. Note that, regardless of classification for PSD permit review purposes into Class I or Class II areas, all parks enjoy the same level of Organic Act protection, and the impact levels for NEPA project review listed below should be applied equally and consistently regardless of Class I or Class II area designation.

Protection of Visibility

Beyond the NAAQS and PSD programs, the CAA established a national goal of preventing any future, and remedying any existing, human-made visibility impairment in Class I areas. "Visibility impairment" under the CAA visibility protection regulations is defined as "any humanly perceptible change in visibility." Here it is important to note that "visibility impairment" carries a specific regulatory meaning which does not necessarily correspond to the meaning of "impairment" under the Organic Act. When visibility impairment interferes with the management, protection, preservation, or enjoyment of visitor's visual experience in a Class I or Class II area, it may constitute an adverse impact that is unacceptable under the Organic Act. While the CAA impairment definition may be considered by some to be more stringent than the impairment prohibited by the Organic Act, NPS must ensure that emissions generated on park lands are compatible with CAA goals. This low threshold for what constitutes an adverse effect under the CAA also is warranted because visibility degradation occurring in parks has resulted from the cumulative effect of multiple external and internal sources, large and small, nearby and far away. NPS air pollution emissions sources should adhere to the same "no degradation" criteria as the NPS demands for external emissions sources.

In 1990 EPA finalized the regional haze regulations which require states to develop plans for making reasonable progress toward eliminating visibility impairment in Class I areas, including strategies for steadily reducing emissions along a 60-year timeframe leading to natural conditions. Through these collaborative regional and state planning processes, park managers can ensure that park emissions are accounted for in plans now being developed and that activities inside parks do not compromise or delay progress toward eliminating visibility impairment. Additional details about federal requirements and management policies affecting air quality and air pollution sources are discussed briefly below.

Clean Air Act Conformity Requirements for Non-Attainment Areas

Areas that do not meet the NAAQS for any pollutant are designated as "non-attainment areas." Areas that were once designated non-attainment, but are now achieving the NAAQS are termed "maintenance areas." In non-attainment areas, states must develop plans to reduce emissions and bring the area back into attainment of the NAAQS. There are stringent requirements for activities conducted by federal agencies in non-attainment areas, to ensure that proposed pollution increases from new activities are offset by pollution reductions. Therefore when parks are assessing project emissions for potential impacts or impairment, it is important for a park to first determine whether or not it located in a non-attainment or maintenance area.

Parks located in areas that exceed the NAAQS (non-attainment areas) or whose resources are already being adversely affected by current ambient air quality levels require a greater degree of consideration and scrutiny when management actions are considered by NPS managers.

Section 176 of the CAA states:

> No department, agency, or instrumentality of the Federal Government shall engage in, support in any way or provide financial assistance for, license or permit, or approve, any activity which does not conform to an [State] implementation plan…[T]he assurance of conformity to such a plan shall be an affirmative responsibility of the head of such department, agency or instrumentality.

Essentially, federal agencies must by law ensure that any federal action taken does not interfere with a State's plan (i.e. State Implementation Plan) to attain and maintain the NAAQS in designated nonattainment areas. In making decisions regarding activities or projects within a designated nonattainment area, park managers should discuss their plans with the appropriate State air pollution control agency to determine the applicability of conformity requirements.

Federal, State, and Local Pollution Emissions Requirements and Measures

Depending on the type of activity or project there may be source-specific emission standards or mandated management practices or control measures that parks should be aware of. The NPS is required to comply with federal, state and local requirements to the same extent as any other private or public entity, regardless of any "impairment" considerations.

NPS Management Policies

Under the NPS Management Policies, the NPS will: "seek to perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas" (NPS Management Policies 2001; Section 4.7.1.) The NPS Management Policies further state that the NPS will assume an aggressive role in promoting and pursuing measures to protect Air Quality Related Values (AQRVs) from the adverse impacts of air pollution. In cases of doubt as to the impacts of existing or potential air pollution on park resources, the NPS "will err on the side of protecting air quality and related values for future generations."

Note that the Organic Act and Management Policies apply equally to all NPS-managed areas, regardless of CAA designation. Therefore, the NPS will protect resources at both Class I and Class II designated units. Furthermore, the NPS Organic Act and Management Policies provide additional protection from that afforded by the CAA's NAAQS alone because NPS has documented that specific park AQRVs can be adversely affected at levels below the NAAQS or by pollutants for which no NAAQS exist. Therefore, projects with emissions (project specific or cumulatively) that impede NPS from accomplishing management goals listed above would be more likely to be considered impairment.

Information Needs

Assessment component	Information needs *	Sources of information
Air pollution emissions, regulations, and atmospheric transport	• Calculated air pollutant emissions from the proposed project and cumulative emissions from other sources contributing to impacts on park resources. This requires information on current and proposed activity levels within the park. • Information about applicable Federal, state, and local regulations including emissions limits, performance standards or management practices and permitting requirements. • In some cases (e.g. where emissions of any pollutant are projected to exceed 50 tons/yr.), it is advantageous to perform air quality modeling to assess ambient impacts, requiring information on local meteorology, terrain, and emission sources. • National Ambient Air Quality Standards, and Conformity deminimus levels.	• Check with ARD for information on how to calculate project emissions, to determine which cumulative sources should be included, or whether modeling is recommended. Check with local and state air permitting authorities for current emissions levels of other sources, and for non-attainment area boundaries. • Park records may include information about activity levels (e.g., the number of visitors using PWCs, the # of vehicles entering the park per day). • FLAG (Federal Land Managers Air Quality Related Values Workgroup) Guidance on air quality modeling: http://www.aqd.nps.gov/ard/flagfree/ • NAAQS table at: http://www.epa.gov/airs/criteria.html. • EPA Conformity deminimus levels at: http://www.epa.gov/ttn/oarpg/genconformity.html
Air chemistry and deposition	• Ambient air quality data (ozone, particulate matter, sulfur dioxide, nitrogen dioxide) • Atmospheric deposition data • Air toxics data	• EPA, State, local, or park ambient monitoring equipment for air quality data. • National Acidic Deposition Program (NADP) and EPA-Clean Air Status and Trends Network (CASTNet) site data for deposition. • MDN and NDAMN network sites for air toxics data. • Park specific air chemistry and deposition at: http://www.aqd.nps.gov/ard/gas/index.htm#airatlas. • Representative monitoring sites within 100km of the park can often be used if in-park monitoring is not available.

		• Air Quality in the National Parks. September 2002. Second Edition. National Park Service, Air Resources Division, Lakewood, Colorado.
Air quality related value and health impacts	• Current condition and future projected condition related to air quality impacts on park AQRVs (visibility, flora, fauna, soils, water or cultural resources). This may include information on resources highly sensitive to air pollution impacts, as well as documented current impacts. • Visibility trends, natural background visibility, current condition, and historic conditions • Visibility impacts from particulate matter, nitrogen oxides and sulfur dioxides • Vegetation impacts from ozone • Deposition sensitive aquatic ecosystems (water and aquatic biota) • Current and future air quality levels relative to the NAAQS to help assess health impacts to visitors and employees	• AQRV data available from NPS-ARD, scientific literature and reports, Inventory and Monitoring (I&M)Network • Interagency Monitoring of Protected Visual Environments (IMPROVE) sites for visibility photos; transmissometer or nephelometer data; fine and coarse mass from particle filters (http://vista.cira.colostate.edu/improve/) • NPS-ARD for visibility impacts summaries for sites in some parks • NPS-ARD and I&M network air quality summaries for ozone impacts information • Park specific AQRV data at: http://www2.nature.nps.gov:82/scripts/synth.dll • NPS-ARD, NPS-WRD, and park reports for information on deposition sensitivity (acid neutralizing capacity) of park waters • Representative ambient air quality monitoring data to compare to NAAQS

*** Information needed depends upon what types of pollutant are emitted by the project**

Impact Levels

The four impact categories "negligible, minor, moderate and major" are discussed below in two parts, potential airborne pollution impacts on (1) human health (linked to the amount of projected emissions and national air quality health-based standards); and (2) park resources (linked to current and projected air quality and resource impacts). Impact levels for both parts utilize emissions numbers that are loosely based on some of the emissions thresholds found in the PSD and Conformity sections, and rationale in setting NAAQS, in the Clean Air Act. While these emissions thresholds do not apply here in the same strict regulatory sense as in the Clean Air Act, they do reflect potential levels of concern.

Impact levels can be used to assess impact of emissions that are currently occurring in a park, that may be increasing in a park, or that are being newly initiated in a park. Where investigation of ongoing activities are concerned, impact levels and the potential for impairment should be assessed relative to the natural condition, in addition to the incremental change from the no-action alternative. A cumulative-emissions calculation should also be made that would consider other types of emissions sources inside or outside of park boundaries, along with the impacts from these cumulative emissions.

The AQRV based impact levels, in the second section, utilize a variety of qualitative and quantitative measures based on published data, policy, and professional judgment. If a potential impairment were identified, the park's enabling legislation, and management objectives (relative to resource protection, human health, and visitor enjoyment goals) would be considered by the park superintendent in making a final impairment determination. In the tables below, TPY means "tons per year" and NAAQS are "National Ambient Air Quality Standards." When discussing visibility impacts in the AQRV impact levels table, the term "perceptible" is quantified in the Federal Land Manager's FLAG document, and uses parameters relevant to what can be seen by the human eye.

Assessing Impact to Human Health from Airborne Pollutants

Attainment Areas

Impact level	Proposed action (emissions)		Current air quality
Negligible	<50 TPY (each pollutant)	**AND**	<60% of the NAAQS
Minor	>50 & <100 TPY (any pollutant)	**AND**	<80% of the NAAQS
Moderate	>100 TPY (any pollutant)	**OR**	>80% of the NAAQS
Major	>250 TPY (any pollutant)	**AND**	>80% of the NAAQS

Non-attainment/Maintenance areas

Impact level	Proposed action (emissions)
Negligible	Net **decrease** in emissions from current levels
Minor	1-5 TPY
Moderate	>5 TPY and <conformity deminimus levels
Major	>or = conformity deminimus levels

Existing conditions are particularly important in air quality impact and impairment determinations, because of the potentially large degree of current impact caused by air pollution coming from outside the parks. In many cases, the degree to which air pollution has currently affected park resources will directly affect the amount of additional emissions that can be added before "impairment" to these resources occurs. Sometimes (as with visibility) a very clean current condition provides a higher likelihood that a small amount of added air pollution emissions would produce a perceptible visual impact. In other cases, (as with atmospheric deposition), an already high amount of current deposition (relative to natural background deposition levels) would also create a high likelihood that a small additional amount of emissions would cause resource impacts. Unfortunately there are no quantitative measures that can be provided to show impact levels that would apply definitively to all parks.

Minor, moderate, and major impact levels below should be characterized as "likely" when one or more of the criteria in the "proposed action predicted condition" category are true. The current condition information should be used as a modifier. For example, if the current conditions are in a higher or lower impact category than the "proposed action predicted condition", then the impact category may be adjusted upward or downward taking into account the weight of evidence and management objectives.

Assessing Impact to Air Quality Related Values (visibility, flora, fauna, soils, water, cultural resources) from Airborne Pollutants

<u>Negligible Impacts to Air Quality and AQRVs</u>

Current Condition:

- SUM06 ozone < 8 ppm-hrs. for the three month summer season.
- Deposition of wet N (NO_3-N + NH_4-N) is less than 1 kg/ha/yr. and wet SO4 is less than 3 kg/ha/yr.
- Average annual visibility conditions (in units of deciview) are better than or equal to estimated natural conditions.

Proposed Action Predicted Condition:

- Predicted emissions increases are less than 50 TPY of any pollutant.

- No perceptible visibility impacts likely (no visible smoke, plume, or haze).
- Predicted (i.e. modeled) visibility*, nitrogen and sulfur are below thresholds listed in NPS FLAG and Deposition Analysis Threshold (DAT) guidance.

<u>Minor Impacts to Air Quality and AQRVs</u>

Current Condition:

- SUM06 ozone between 8-15 ppm-hrs. for the three month summer season.
- Deposition of wet N (NO3-N + NH4-N) is above 1 kg/ha/yr. or wet SO4 is above 3kg/ha/yr, and insufficient evidence of deposition sensitive or nutrient sensitive ecosystems exist.
- Annual average visibility conditions (in units of deciview) are more than one but less than or equal to one and one half times estimated natural conditions.

Proposed Action Predicted Condition:

- Predicted emissions increases are between 50 and 100 TPY of any pollutant.
- Predicted (i.e. modeled) visibility*, nitrogen and sulfur are approaching (between 90-100%) of thresholds listed in NPS FLAG and DAT guidance.
- Perceptible visibility impacts occur, but are only visible from a small area of the park, are of short duration (less than one day) and visible to only a few park visitors on the days that they occur.

<u>Moderate Impacts to Air Quality and AQRVs</u>

Current Condition:

- SUM06 ozone 15-25 ppm-hrs. for the three month summer season.
- Deposition of wet N (NO3-N + NH4-N) is above 1 kg/ha/yr. or wet SO4 is above 3 kg/ha/yr. and sensitive ecosystems are present in the park that could likely be impacted in some way (change to physical, chemical or biological processes) from deposition.
- Annual average visibility conditions (in units of deciview) are more than one and one half but less than or equal to three times estimated natural conditions.

Proposed Action Predicted Condition:

- Predicted emissions increases are between 100 and 250 TPY of any pollutant.
- Predicted (i.e. modeled) visibility*, nitrogen and sulfur exceed thresholds listed in NPS FLAG and DAT guidance, but NPS does not believe impacts will harm integrity of the resources.
- Perceptible visibility impacts occur and are visible from several areas of the park, occur between one and several days, and many park visitors may observe them on the days that they occur.

<u>Major Impacts to Air Quality and AQRVs</u>

Current Condition:

- SUM06 ozone >25ppm-hrs. for the three month summer season.
- Deposition impacts to AQRVs have been documented in the park.
- Annual average visibility conditions (in units of deciview) are greater than three times estimated natural conditions.
- Visibility conditions are worsening (trending downward based on GPRA 10 yr. trends info) at the park.

Proposed Action Predicted Condition:

- Predicted emissions increases are greater than 250 TPY of any pollutant.
- Predicted (i.e. modeled) visibility*, nitrogen and sulfur exceed thresholds listed in NPS FLAG and DAT guidance, and NPS believes impacts may harm the integrity of resources.

- Perceptible visibility impacts occur and are visible from many areas of the park, occur many days over the course of a year, or are visible to a majority of park visitors on the days that they occur.

* For haze impact to visibility, the lower of the two thresholds identified in FLAG should be used.

Impairment Considerations and Examples

- Where air quality concentrations are projected to adversely affect visitor or employee health, they are more likely to be considered impairment.
- Where human-caused emissions in a park are likely to affect visibility conditions such that they impact visitor enjoyment or detract from the view of scenic vistas (in parks where good visibility is a goal) they are more likely to be considered impairment.
- Where human-caused emissions in a park are likely to create adverse impacts to resources/values that are: specifically mentioned in enabling legislation, key to natural or cultural integrity or opportunities for enjoyment of park, identified in the park General Management Plan or other planning document, or are in Class I areas or wilderness areas, they are more likely to be considered impairment.
- Where projected resource impacts are above air-quality "concern thresholds" for visibility, N or S deposition (as posted on the NPS-ARD web site in the FLAG or DAT guidance documents), they are more likely to be considered impairment.
- Where human-caused emissions are likely to create unnatural and visible smoke, haze, or plume (in parks where good visibility is a goal) they are more likely to be considered impairment.
- Where existing air quality adversely affects visibility, flora, fauna, soil, or water; small increases in park emissions that would exacerbate these stresses on resources would be more likely to be considered impairment.
- Where very clean air quality conditions exist for the "best visibility days" in a park, a small addition in emissions (in parks where good visibility is a goal) may be more likely to result in visibility impairment.

Impairment Examples: Air Quality and Air Quality Related Values

Action	Affected air quality or air quality related value	Impairment <u>less</u> likely	Impairment <u>more</u> likely
Winter-use management of snowmobile and other vehicles	Visitor or employee health impacts from carbon monoxide emissions	▪ Modeling predictions show that emissions would result in carbon monoxide levels that are well below the NAAQS. ▪ Monitoring shows that current carbon monoxide levels are well below the NAAQS.	▪ Modeling predictions show that emissions would result in carbon monoxide levels that approach or exceed the NAAQS and are likely to affect visitor or employee health. ▪ Monitoring shows that current carbon monoxide levels already threaten or exceed the NAAQS.

Action	Affected air quality or air quality related value	Impairment <u>less</u> likely	Impairment <u>more</u> likely
Vessel management for cruise ships and other vessels	Impacts on visibility and scenic vistas from plumes or haze	• Observations show that plumes from ship emissions are rarely visibly perceptible. • Emissions from vessels will be less than 250 TPY.	▪ Plumes or hazy conditions attributable to ship smokestack emissions are of long duration, or can be frequently observed. ▪ Very clean air quality conditions exist and plumes will be visible on days that would otherwise have the best visibility. ▪ Emissions from vessels will be greater than 250 TPY.
Road widening project is expected to increase vehicle traffic through the park	• Impacts on visibility and scenic vistas and ozone stresses on native plants from nitrogen oxide emissions • Air pollution impacts on human health	• Emissions of nitrogen oxides from vehicles will be less than 250 TPY. • No evidence of existing ozone impacts on vegetation have been found in the park. • Current ozone levels are less than 25 ppm-hrs during the summer growing season. • Background concentrations are less than 60% of the NAAQS.	• Emissions of nitrogen oxide from vehicles will be greater than 250 TPY. • Current levels of ozone monitored in the park are greater than 25 ppm-hrs for the summer growing season. • Evidence of ozone injury exists and increased vehicle emissions in the park are expected to increase the number of trees with ozone damaged needles and reduced growth. • Background concentrations are greater than 80% of the NAAQS.
Coal-fired power plant expansion is proposed 75 km from the park boundary	Impacts on visibility and acidic deposition effects due to sulfur dioxide or nitrogen oxide emissions	• State of the art emissions control technology reduces emissions impacts for visibility to levels below FLAG thresholds and deposition to levels below DAT thresholds. • Monitoring of park ecosystems finds no evidence of any existing impacts of acidic deposition to aquatic or terrestrial resources. • Emissions of nitrogen oxides or sulfur dioxide will be less than 250 TPY.	• Visibility monitoring data in the park shows decreasing (worsening) visibility over the past 10 years • Changes in visibility are above FLAG thresholds. • Monitoring of park streams shows evidence of existing impacts of acidic deposition (episodic acidification due to decreased stream acid neutralizing capacity). • Power plant emissions increases are modeled to produce deposition in the park above deposition analysis thresholds (DAT) for sulfur and nitrogen. • Emissions of sulfur dioxide or nitrogen oxides will be more than 250 TPY.
Park facilities upgrades proposed at remote location	Localized visibility impacts from power sources	• Solar panels installed for remote site electricity needs, so no visibility impacts are anticipated. • No emissions are expected.	• Diesel generators used for remote site electricity production cause visible smoke plumes and haze during inversion conditions near scenic visitor use areas.

Action	Affected air quality or air quality related value	Impairment less likely	Impairment more likely
Federal oil and gas development adjacent to park boundary	Impacts on visibility and scenic vistas from multiple gas compressor stations that produce nitrogen oxide emissions	• Atmospheric modeling demonstrates that no change in park visibility from emissions increases would occur. • Cumulative visibility impacts from all sources affecting park visibility are less than 1.5 times natural condition.	• Scenic vistas are specifically mentioned as a value in park enabling legislation. • Current air quality in the park is extremely clean (small increases in air pollution are more readily visible to the human eye). • Changes in visibility from project will be above FLAG thresholds.

LIGHTSCAPES

Background

Light, visible electromagnetic radiation streaming through the atmosphere, has a tremendous amount of natural variation. From the brightest day to the darkest night spans over 8 orders of magnitude. Despite this variation, disruption of this cycle can have significant ecological effects. Since the beginning of life on Earth, there have always been predictable cycles of light. Darkness is an important habitat component, providing cover, security, navigation, or predatory advantage to both nocturnal and diurnal species. As an extreme example, many cave environments host creatures adapted to total darkness. Light pollution, defined as stray unwanted light outside the range and timing of natural variation, is not only an ecological disrupter, but also adversely affects the natural scenery of the night. The NPS mission to "conserve scenery" extends to night and the sky above. The loss of a pristine night sky where thousands of stars are visible has been rapid. The loss of this resource for this or future generations is a direct reduction in enjoyment of visitors who regularly stargaze. It will also reduce the integrity of other resources by a loss in context; pitching one's tent in a wilderness area beneath a brilliant starry sky is becoming an endangered experience.

Light pollution affecting night skies 200 miles away has been documented. The cumulative affect of multiple artificial light sources at varying distance brightens the sky background, drowning out stars and astronomical objects by contrast reduction, and increasing the illuminance of the ground surface. Particularly dark skies are most prone to a degradation of their scenic potential, showing a significant reduction in visible stars with a small amount of light pollution. Night skies already brightened by artificial light show a lessening degradation with each incremental increase in light pollution. Within this response function may be embedded thresholds whereupon certain species, ecological processes, or key scenic resource will be impaired.

The degree of adverse impact by light pollution on park lightscape resources will vary with the following: (1) if the nighttime environment is very dark, the behavior of light is such that it would only take a very small amount of light pollution to create visibility degradation perceptible to the human eye; (2) poor air quality and dirty air will amplify existing light pollution at short to moderate distances, while sometimes reducing the affect of light pollution at long distances (approximately 100 miles); and

(3) the value of a dark night sky is relative to the local or regional scarcity of that resource, the absolute quality of that sky, the value of a dark sky as a scientific resource, the expectation of visitors to experience a dark night sky, the cultural or historic setting and relevance with the night sky, and the known or suspected ecological dependence on a natural lightscape.

Guiding Laws Regulations and Policies

Natural lightscapes (a term encompassing the dark night sky, the experience of darkness, and the ecological importance of natural light cycles) can relate to numerous other resource issues, such as endangered sea turtles disoriented by lights, to the experience of hiking at night without a flashlight, or the observation of distant galaxies through a telescope. The experience of a naturally dark night or a pristine starry night sky are important elements of "scenery" within national park units which the NPS Organic Act directs to be conserved. Perhaps the night sky was once considered so ubiquitous that it was beyond the realm of park scenery; but today we realize that the national parks protect increasingly rare portals to this universal resource.

NPS Management Policies (2001, Section 4.10) emphasize the protection of natural lightscapes not only for the enjoyment and experience of visitors, but also for protection of ecological integrity. Mitigation strategies are articulated, including restricting the use of artificial lighting only where necessary, utilizing minimum impact techniques and shielding lights to prevent unwanted light scatter.

The Clean Air Act provides ancillary protection of night skies. Under this law and its 1977 amendments, the park superintendent is given an affirmative responsibility to protect visibility and all other Class I area air quality related values (AQRVs) from the adverse effects. Nighttime visibility, like daytime visibility, is hindered by particulates, gasses, and other parameters that would reduce the transparency of the atmosphere. Nighttime visibility is additionally dependent on the amount of scattered light.

The Wilderness Act of 1964 (16 U.S.C. 1131, *et seq*.) defines wilderness as:

"an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain . . . an area of undeveloped Federal Land retaining its primeval character and influence . . . which is protected and managed so as to preserve its natural conditions (16 U.S.C. 1131(c))."

Light pollution, like air pollution, is a trans-boundary process. Maintaining the primeval character of the wilderness is challenged by the constant visual impact of light pollution. Therefore, proposed projects that create light pollution (either project specific or cumulatively) in quantities that may affect the "natural condition" of wilderness areas in the park would be more likely to be considered "impairment." Because of the radius of impact that outdoor lighting may have, projects outside of a wilderness area may still directly impact designated wilderness lands and therefore should be appropriately analyzed in accordance with wilderness guidelines (NPS Management Policies, 2001, Section 6.3). "The principle of non-degradation will be applied to wilderness management, and each wilderness area's condition will be measured and assessed against its own unimpaired standard. Natural processes will be allowed, insofar as possible, to shape and control wilderness ecosystems," (NPS Management Policies, 2001, Section 6.3.7).

Light pollution by definition is wasted light. What is scattered sideways and upward from light sources likely never reached its intended target. The reduction of light pollution and the use of efficient "night sky friendly" fixtures is an energy efficiency issue. As a leading environmental agency in the federal government, the National Park Service should manage facilities and plan activities in ways that uses energy wisely (NPS Management Policies, 2001, Section 9.1).

Most important in this discussion 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 (Sec. 1.4.3). NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values (Sec 1.4.3), including lightscapes.

Information Needs

Lightscape management in the National Park System can be divided into three categories: visitor experience of the night sky, ecological impact, and resource context.

Assessment component	Information needs	Sources of information
Visitor experience	• Quantitative baseline inventory of sky brightness in parks • Theoretical natural brightness of night sky incorporating solar flux, climate, elevation, and atmospheric properties • Natural variability in night sky brightness • Correlation between quantitative measures and experience and perception of the night by visitors • Visitor surveys and outreach to determine use and value of night sky by public • Viewshed analysis of wilderness and key scenic areas • Qualitative indices of night sky	• Inventory data from NPS Night Sky Team • SkyGlow Computer Model (Estimates of night sky brightness from point light sources) • Simple methodologies for qualitative and visual quantitative estimates of night sky brightness • Research on natural variation in sky brightness • Park initiated monitoring • World atlas of night sky brightness or other existing computer models showing existing and future conditions. • Technical assistance from Air Resources Division or NPS Night Sky Team
Ecological impact	• List of species known or suspected of being sensitive to artificial light • Thresholds of response to light by various species • Understanding of the role of darkness as a habitat element • Species specific research	• Existing research and gray literature on photobiology and effects of artificial lighting • Professional biological opinion based on general biological processes • Park or USGS directed research
Resource context	• Connection between cultural/historic resources and natural lightscape • Role of night sky in enabling legislation of park, core resources of park, or unique resources • Value of night sky as a scientific resource • Value of night sky relative to scarcity in surrounding areas and potential degradation • Wilderness designation, Class I airshed designation	• Cultural landscape inventory • Legal documents, administrative history, first person historical journals • World Atlas of night sky brightness or other existing computer models showing existing and future conditions. • Archeoastronomy research • Visitor use survey • Local planetarium, natural history museum, astronomy club or educational organization

Impact Levels

The four impact categories are discussed below in relation to visitor experience, ecological disruption, and general park context (relation to cultural or historic setting, wilderness status, etc). Not all descriptions need to be valid to identify which category is most appropriate to describe an impact.

Metrics are presented for guidance, but do not necessarily define the impact categories. V Magnitude is a measure of brightness of the sky between the stars. It is expressed as a fraction of standard star magnitudes per square arc second of area. It is measured in the Johnson Visible spectrum, roughly corresponding to green light (where the human eye is most sensitive at night). It is expressed here as a percentage deviation from natural background and measured at the zenith. Limiting Magnitude is the faintest star visible with the unaided eye, lower numbers correspond with brighter stars and increased light pollution. Limiting magnitudes are primarily dependent on light pollution and secondarily affected by atmospheric parameters such as humidity, turbulence, and air pollution. The theoretical maximum limiting magnitude is 7.2, which can potentially reveal approximately 15,000 stars. Bortle Sky Class is a qualitative description index ranging from 1 (absolutely pristine with exceptional atmospheric clarity) to 9 (heavily light polluted). Foot-candles are a standard measure of illumination at the ground surface. Under brighter skies in close proximity to light pollution, the earth surface can be brightened to levels equal to or exceeding the full moon. This measure is taken with a light meter or radiometer in natural areas or other area critical to biota. This measure captures both the direct light spilled from outdoor lamps as well as integrating the total brightness on the sky.

The context of the lightscape will also affect which impact category is selected. For example, a park that is particularly well known for its night skies and open vistas may have a more inclusive definition of a moderate or major impact. On the other hand, a densely forested park that is frequently shrouded in fog may develop a different definition of impact. Likewise, a park that stewards an ancient Anasazi ruin thought to have astronomical alignments may have employ a different definition of an unimpacted sky that relates to the cultural setting. Air quality considerations can also play a role in the context of lightscape impacts, as the presence of air pollution can increase light scattering.

Temporal factors are important in determining impact. Security lighting that is off after 8pm will have substantially less impact than lighting that is on all night. The duration of impact should be incorporated into the determination. Also implied is the sensitivity during certain times of the year. Lit towers or monuments can have a major impact on birds as they impact the structure or are navigationally confused, especially during migration periods.

The spatial scale of the impact is another key element of consideration. A single street light can have a major impact on natural light levels within a small area. This can result in disruption of biological processes locally. This may or may not be important in the context of the entire park. If it is visible from the highest mountain, or is located next to a turtle nesting area, then it is likely to be a major impact. Impacts at multiple scales can be difficult to assess, but it is highly recommended that such an assessment be conducted. Because of the wide ranging effect of light pollution and varied thresholds of disturbance, impacts should be considered from the localized or site specific scale upward to the park or even regional scale. The ranges of values listed in each of the impact categories below are to be considered approximate numbers to get parks "in the ballpark" when considering lightscape impacts.

Negligible:

a) Light conditions cycle as they would within the range of natural variability. The experience of the night sky is unfettered by artificial light, leaving the full amount of stars, astronomical objects, and atmospheric phenomena visible. No light pollution, bright stationary point source lights, or sky glow from cities are visible to an observant visitor (but may be detectable by a trained observer or instrument).

b) Illumination levels are below what would alter biological processes or behavior.

c) Historic objects, cultural landscapes, wilderness areas, and other unique resources are framed against a natural lightscape with pristine and timeless qualities.

Possible metric	Range of values
V magnitude	<20% increase from theoretical (approximately 21.70 Vmag)
Limiting magnitude	6.7-7.2 (8,500-15,000 stars)
Bortle sky class	1-3
Foot-candles	<0.001 (below detectability)

Minor:

a) The cycle of light and dark is largely intact, and light appropriately drops to minimal levels during no-moon nights. The experience of the night sky is notable, showing significant number of stars, astronomical objects, and most atmospheric phenomena. Light pollution is visible to the casual observer along the horizon at a few locations, but is unnoticed at higher angular altitudes. In large parks, a portion of the accessible terrain maintains high quality night skies.

b) Illumination levels may be within the detectability of numerous species, but fundamental biological processes such as navigation, cover, and photosynthesis are unaltered.

c) Artificial lights may be noticed, but are quickly forgotten and do not affect the experience of a historic or cultural landscape, wilderness area, or other resource unique to a particular park. All visible lights are shielded or produce no glare to the observer, allowing full use of night vision.

Possible metric	Range of values
V magnitude	<75% increase from theoretical (approx. 21.15 Vmag)
Limiting magnitude	6.2-6.6 (6,500-8,000 stars)
Bortle sky class	3-4
Foot-candles	<0.001

Moderate:

a) The cycle of light and dark is modified, and light does not drop completely to minimal levels during no-moon nights. The experience of the night sky lacks grandeur, missing a significant number of stars, astronomical objects, and hiding most atmospheric phenomena. Light pollution is obvious to the casual observer at several points along the horizon, and extends perceptibly overhead. The sky background is noticeably milky or colored in appearance. Even in large parks, no portion of the accessible terrain maintains high quality night skies.

b) Illumination levels are detectable by numerous species, and biological processes are suspected of being altered.

c) Artificial lights are frequently noticed and continue to intrude into the experience of other resources. The human eye never fully adapts to darkness due to ambient illumination or glare. Outdoor light fixtures are unshielded, too bright, or otherwise produce glare.

Possible metric	Range of values
V magnitude	<150% increase from theoretical (approx. 20.40 Vmag)
Limiting magnitude	5.5-6.1 (5,500-8,500 stars)
Bortle sky class	4-5
Foot-candles	<0.010

Major:

a) The cycle of light and dark is clearly altered, and light levels do not drop completely to minimal levels during no-moon nights. The experience of the night sky is underwhelming and similar to what one might experience in a county park or suburban location. Enough stars are lost in the glow of light pollution that some constellations lose key stars, all but the brightest astronomical objects are invisible, and atmospheric phenomena are mostly never seen. Light pollution is obvious to the casual observer at several points along the horizon, and visibly extends overhead. The sky background is noticeably bright and colored in appearance. Even in large parks, no portion of the accessible terrain maintains moderate quality night skies.

b) Illumination levels are high enough to affect a range of species, resulting in suspected or documented stress and ecological disruption.

c) Artificial lights are frequently noticed and continue to intrude into the experience of other resources. Numerous unshielded lights are visible, even at a distance, and produce enough glare that the human eye never fully adapts to darkness.

Possible metric	Range of values
V magnitude	>150% increase from theoretical (approx. <20.40 Vmag)
Limiting magnitude	<5.5 (<5,000 stars)
Bortle sky class	5-9
Foot-candles	>0.010

Impairment Considerations and Examples

NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values. Unlike many natural resource impacts, the natural lightscape is 100% recoverable. Therefore, mitigation of lighting impacts and restoration of the lightscape should always be a consideration when weighting impacts. With the improvement of lighting designs and technology, the development of scientifically based illumination engineering standards, and the emphasis on energy savings, park managers have many tools to effectively mitigate adverse artificial lighting impacts. Actions which fail to use the best available control technologies and mitigation are more likely to cause impairment.

Although the scope and magnitude of light pollution is large, mitigation and restoration of a natural lightscape is straightforward. Using outdoor lighting only where and when necessary will reduce the number of pollution sources. When lighting is necessary, using only enough light to meet the objective and using best available control technology will further minimize unwanted light. Although some outdoor lighting will always be necessary in a modern society, the amount of light pollution can be cut drastically; in some cases to negligible levels. Because outdoor lighting is often easy to retrofit or redesign, mitigation or restoration of lightscape should always be considered along with potential project impacts.

Adverse impacts from artificial lighting seldom can be traced to a single light source (when it can be traced to a single light source, it is most likely an impairment). Instead, the cumulative effect of hundreds or thousands of lights causes degradation. With the pollution sources so widespread, the analysis of impact must consider the cumulative effect. To a degree, the impact of a single proposed light cannot be separated from all of the existing lights. Often the impact of artificial light has been ongoing for years or decades, but the inaction to reduce the impact can still be considered an impairment. Fortunately, striving for a "no net increase" in lightscape impact or a restoration of natural dark is neither technically difficult nor prohibitively expensive.

Properly designed lighting is often "night sky friendly" and produces a minor or negligible impact on the natural lightscape. Too often, however, outdoor lighting proposals are reactionary. Furthermore, they fail to solve the problem; poor quality lighting can actually reduce security and safety. Such poor planning, design, and implementation may render the proposed lighting action as unnecessary, and therefore is more likely to cause an impairment.

Action	**Affected lightscape**	**Impairment less likely**	**Impairment more likely**
A park cooperator and lessee proposes to install several outdoor lights to provide increased security and allow work with rehabilitated wildlife at night.	Potential moderate impact to night sky, biological disruption to surrounding area directly in view of lights due to increased illuminance.	All lights to be installed will be shielded so no light escapes above a horizontal plane, illumination levels are consistent with guidelines, and the period that lights will be on is justified. The surrounding area is of low biological significance, containing no species with known or suspected sensitivity to stray light. The night sky has reduced importance as a wilderness, recreational, and scientific resource; and visitors generally do not consider the night sky an important part of the park scenery.	The park GMP identifies the protection of the night sky, or the public regularly uses the park for its valuable night skies via interpretive programs, amateur astronomer telescope viewing, or stargazing. The proposed lights do not adhere to illumination standards, have inadequate shielding or other glare control, or are not adequately justified. The proposed project is nearby a beach, and although no directed research identifies impact to biota, the bulk of scientific evidence indicates that this is a very light sensitive environment.
An expanding trail network in a solution cave will be illuminated with numerous path lights.	Deep solution caves are a naturally dark environment. Troglibitic species and other biota dependent on the naturally dark environment of the cave will be affected.	Although the lighting will cause a significant localized disruption, the lighting will only be on for a limited number of hours in a day, and will be non-operational for much of the year. The illuminated caverns represent a small fraction of the entire cave complex, providing accessible refugia for caves species dependent on darkness. Path lighting is a minimal brightness and landscape lighting is restrained and operated only briefly.	Evidence suggests that species found in the cave have significant adverse reaction to lighting, with the effect persisting long after exposure to light. The lit environment of the cave does not allow for adequate refugia, affects a large fraction of the cave, or affects key biological areas.

Action	Affected lightscape	Impairment less likely	Impairment more likely
A recent crime at park headquarters in the evening hours has raised concerns about security. A proposal is made to light building surroundings and parking lots.	Lights would affect visitor experience of night sky and nighttime environment.	Lighting is professionally designed to meet security needs with a minimum brightness. To provide uniform illumination, short post (bollard) lighting is used and is fully shielded above the horizontal; additionally, a combination of motion sensors, timers, and all-night lights are utilized to meet security needs. Only the areas used by employees or protecting key property are illuminated.	Surplus or low quality lights are used because of low capital cost without considering life cycle cost and environmental impact. Outdoor lights can be easily seen from campground and project a detectable sky glow above the headquarters. The proposed lights would not meet local codes, as the county government has been concerned about the loss of the night sky.
Several auto accidents near the entrance station have resulted in a proposal to light the approach and pad.	Several roadway lights and entrance station lights will brighten an otherwise dark area of the park, affecting the local area and night sky.	Lighting is properly designed to aid driver vision, with proper illumination levels, gradual increase and decrease of brightness, and minimal glare. Although roadway lights would by themselves produce an unavoidable impact, several other existing roadway lights are retrofitted to produce a net decrease in light pollution.	The lights would inadequately address safety concerns. Lighting would not be shielded and would produce unnecessary light pollution and glare. Lights would be visible throughout much of the wilderness area.

SOUNDSCAPES

Background

The natural soundscape is defined as the natural sound conditions in a park which exist in the absence of any human-produced noises (NPS Director's Order 47, Section D.3). The natural soundscape is a resource of the national parks associated with the natural settings and other related natural or cultural resources that may be found within a park. Natural sounds within a park are produced by wildlife, geothermal activity, and geomorphic processes such as water and wind acting on vegetation, rocks or other landform features. The natural soundscape is a park resource having inherent value, as well as having properties that may be enjoyed by people.

In accordance with policy derived from basic NPS mandates, the NPS will preserve, to the greatest extent possible, the natural soundscapes of parks. The natural soundscape is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Natural sounds occur within and beyond the range of sounds that humans can perceive, and can be transmitted through air, water, or solid materials. The Service will restore degraded soundscapes to the natural condition wherever possible, and will protect natural soundscapes from degradation due to noise.

Noise can adversely affect the natural soundscape. The term "noise" is defined in DO #47 as an unwanted or undesired sound, often unpleasant in quality, intensity or repetition. The Director's Order goes on to note "Noise is often a byproduct of desirable activities or machines. In a national park setting, noise is a subset of human-made noises." The distinction made in the Order is that not all human caused sounds are noise, only those sounds that are inappropriate to the particular time and place in the park. It should be understood that use of the word "noise" throughout this section generally implies the necessity for an investigation and understanding of the types and levels of human-caused sound that are inappropriate to park purposes. It is this finding that allows explicit use of the word "noise" relating to sounds occurring in a park. It can also adversely affect other park resources or values, including but not limited to cultural resources, wildlife, and visitor experience. It can directly impact them, for example by modifying or intruding upon the natural soundscape, masking or interfering with the natural sounds that are an intrinsic part of the environment. This section provides direction specifically with regard to impacts on the natural soundscape. The impact of noise, one aspect of the array of impacts from human activity, on other resources or values is not explored here.

Guiding Laws, Regulations and Policies

A variety of laws, regulations and policies direct and guide the management of natural soundscapes as an inherent value of national parks to be conserved, and as a resource to be enjoyed. Some of the laws are explicit to sound, or noise, as an impact on national parks or to specific sources of noise. Similarly, some regulations are specific to sources and levels of noise, and they provide a regulatory standard. Two statements of policy are directed at noise and the natural soundscape: Management Policy 4.9 (Soundscape Management from Management Policies 2001), and Director's Order #47 (Soundscape Preservation and Noise Management, December 2000). Relevant laws, regulations and executive orders are tabulated below.

Law, regulation, or executive order	Specific or general guidance for soundscape management
Laws	
NPS Organic Act (16 USC 1, 2-4) and General Authorities Act (16 USC 1a-1through 1a-8)	General guidance for management of park resources and values, of which the natural soundscape is one. See legal framework in the introductory section of this guidance.
The Wilderness Act, (September 3, 1964, P.L. 88-577)	General guidance for management of park resources and values in congressionally designated wilderness areas, of which the natural soundscape is one. Wilderness is generally regarded as a sanctuary, untrammeled by and free of the sights and sounds of man… *An area of undeveloped Federal land retaining its primeval character and influence, with outstanding opportunities for solitude.*
The Redwood Act (March 27, 1978, P.L. 95-250, 92 Stat. 163, 16 U.S.C. 1a-1)	General guidance for management of park resources and values, of which the natural soundscape is one. See legal framework in the introductory section of this guidance. The restatement of the principles of park management in this act is intended to be the basis for any judicial resolution of competing private and public values and interests in the national park system (Senate Report No. 95-528 on S. 1976 pg.7).
The Federal Aviation Act of 1958	Under this act, The FAA has the authority and mandate to prescribe rules and regulations governing the flight of aircraft, including rules as to the safe altitude of flight, for the several purposes, including the protection to the public health and welfare from aircraft noise and sonic boom.
Section 4(f) of the Department of Transportation Act of 1966 (As amended and recodified in 49 U.S.C. Section 303)	(a) It is the policy of the United States Government that special effort be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites.
Airport and Airway Development Act of 1970 (P.L. 91-258,84 Stat.226, 49 U.S.C.§2208)	Requires airport development projects to provide for the protection and enhancement of the natural resources and environmental quality and limits the secretary of transportation in circumventing this purpose. No airports can be authorized with adverse environmental impacts unless it is determined in writing that no feasible and prudent alternatives exist and steps have been taken to minimize adverse effects. Relationship is identical to §4(f) of Department of Transportation Act.
Airports In or Near National Parks Act (64 Stat.27, U.S.C. §§ 7a-e)	Allows the secretary of the interior to plan, acquire, establish, construct, enlarge or improve airports in or close to national park system units if necessary to the proper performance of DOI functions.
Grand Canyon National Park Enlargement Act (P.L. 93-620 §8)	Section 8 recognized "natural quiet as a value or resource in its own right to be protected from significant adverse effect. In addition, it specifically addressed the potential for helicopter operations to cause a significant adverse effect on natural quiet and experience of the park.
National Parks Overflight Act (1987) (P.L. 100-91)	Directs the NPS and the US Forest Service (USFS) to study the effects of aircraft overflights and report to Congress on the results. *The Report on the Effects of Aircraft Overflights on the National Park System* was submitted to Congress in 1994.
National Air Tour Management Act of 2000	This act prohibits a commercial air tour operator from conducting commercial air tours operations over a national park or tribal lands, except in accordance with the act, conditions prescribed for that operator by the FAA Administrator and any commercial air tour management plan for the park or tribal lands. The act sets forth specific requirements with respect to: 1) the granting of authority to commercial air tour operators to conduct air tour operations over national parks or abutting tribal lands with specified exceptions; and 2) establishment of commercial air tour management plans.
Executive orders	

Law, regulation, or executive order	Specific or general guidance for soundscape management
Executive Order 11644 Off Road Vehicles on Public Lands, as amended by Executive order 11898	General guidance:, promulgates guidelines for controlled use of off road vehicles on public lands. The executive orders define off-road vehicles as: " any motorized vehicle that is capable of cross country travel over snow, ice or other natural terrain ...the widespread use of such vehicles has demonstrated the need for a unified federal policy…that will ensure that the use of off-road vehicles on public lands will be controlled and directed so as to protect the resources of these lands, to promote the safety of all users and to minimize the conflicts among the various users of those lands."
Regulations	
36 CFR Section 2.12 Audio Disturbances	(Paraphrase) The following is prohibited: Operating motorized equipment or machinery that exceeds a noise level of 60 decibels measured on the A-weighted scale at 50 feet or, if below that level, nevertheless, makes noise which is unreasonable, considering the nature and purpose of the actors conduct, location time of day or night, purpose for which the area was established, impact on park users, and other factors that should govern the conduct of a reasonably prudent person under the circumstances.
36 CFR Section 2.18: Snowmobiles	The following is prohibited: Operating a snowmobile that makes excessive noise. Excessive noise for snowmobiles manufactured after July 1, 1975 is a level of total snowmobile noise that exceeds 78 decibels measured on the A-weighted scale at 50 feet. Snowmobiles manufactured between July 1, 1973 and July 1, 1975 shall not register more than 82 decibels on the A-weighted scale at 50 feet. All decibel measurements shall be based on snowmobile operation at or near full throttle.
36 CFR Chapter 1, § 3.7: Noise Abatement	Operating a vessel in or upon inland water so as to exceed a noise level of 82 decibels measured at a distance of 82 feet (25 meters) from the vessel is prohibited. Testing procedures employed to determine such noise levels shall be in accordance with or equal to the Exterior Sound Level Measurement Procedure for Vessels recommended by the Society of Automotive Engineers SAE-J34a (Revised 1977).

National Park Service Policy

A number of service wide policies, published in *NPS Management Policies 2001* address or, in significant ways, relate to soundscape management. Below is a listing of those policies, followed by a brief presentation of DO#47.

1.4 Park Management

- 1.4.1 The Laws Generally Governing Park Management
- 1.4.2 "Impairment" and "Derogation": One Standard
- 1.4.3 The NPS Obligation to Conserve and Provide for Enjoyment of Park Resources/Values
- 1.4.4 The Prohibition on Impairment of Park Resources and Values
- 1.4.5 What Constitutes Impairment of Park Resources and Values
- 1.4.6 What Constitutes Park Resources and Values
- 1.4.7 Decision- making Requirements to Avoid Impairments
- 1.5 External Threats and Opportunities
- 1.6 Environmental Leadership

3. Land Protection

- 3.1 General
- 3.4 Addressing Threats from External Sources

4. Natural Resource Management

- 4.1.3 Evaluating Impacts on Natural Resources
- 4.1.5 Restoration of Natural Systems
- 4.4.1 General Principles for Managing Biological Resources
- 4.9 Soundscape Management

6.2 Identification and Designation of the Wilderness Resource

- 6.2.1 Assessment of Wilderness Suitability or Non-suitability
- 6.2.1.1 Primary Suitability Criteria
- 6.2.1.2 Additional Considerations in Determining Suitability
- 6.3.4.1 Zoning for Wilderness
- 6.4.3 Recreational Use Management in Wilderness

8. Use of the Parks

- 8.1 General
- 8.2 Visitor Use
- 8.2.3 Use of Motorized Equipment
- 8.2.3.1 Off-road Vehicle Use
- 8.2.3.2 Snowmobiles
- 8.2.3.3 Personal Watercraft
- 8.4 Overflights and Aviation Uses
- 8.4.1 Alaska and Remote Areas
- 8.4.1 Alaska and Remote Areas
- 8.4.2 Education
- 8.4.3 General Aviation
- 8.4.4 Administrative Use
- 8.4.5 Military Aviation
- 8.4.6 Commercial Air Tour Management
- 8.4.7 Permitted Overflights
- 8.4.8 Airports and Landing Sites

Director's Order #47 Soundscape Preservation and Noise Management

DO #47 emphasizes policy (4.9) and requires "to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources." … "The fundamental principle underlying the establishment of soundscape preservation objectives is the obligation to protect or restore the natural soundscape to the level consistent with park purposes, taking into account other applicable laws." Other operant statements from DO #47:

- Noise is generally considered appropriate if it is generated from activities consistent with park purposes (as defined in legislation, proclamations, and public planning processes) and at levels consistent with those purposes.
- "Where natural soundscape conditions are currently not impacted by inappropriate noise sources, the objective must be to maintain those conditions. Where the soundscape is found to be degraded, the objective is to facilitate and promote progress toward the restoration of the natural soundscape."
- Park superintendents are to address the preservation of natural soundscapes and the elimination, mitigation, or minimization of inappropriate noise sources in a "Soundscape Management Plan."

Information Needs

Determination of adverse impacts on the natural soundscape presupposes that park units have general management plans with specific objectives and standards, by management zone, that provide suitable guidance in making such findings. Those that do not are required in DO#47 to write "soundscape preservation and noise management plans" in order to provide a basis for this analysis. The requirements laid out in DO #47, or that are inferred from it, are presented in the following table as information items and uses.

All of the planning and analysis requirements are supported by basic acoustic data measurements. A number of acoustic metrics can be derived from these data, suitable for interpreting the natural acoustic environment and for describing impacts on it. These same metrics can be used in defining standards for management of soundscapes and for setting impact levels. Examples are: L_{eq} (constant sound energy level); L_{90} (sound level exceeded 90% of the time, approximating background); L_{50} (sound level exceeded 50% of the time); % time human-caused sound is audible/detectable; area or distance over which a sound source is audible/detectable; noise frequency of occurrence and noise free intervals. It must be emphasized here, as it is elsewhere, that use of the acoustics data in making determinations is dependent upon management decisions that set criteria for impact and impairment levels. The following table illustrates basic data needs as building blocks for setting levels of significance, and for measuring impacts relative to them.

Assessment component	Information needs	Sources of information or measurement methods
Identify areas that are acoustically representative within a park. This map stratifies the park to allow a characterization of the ambient soundscape, and to provide a basis for acoustic inventory development. Acoustic variability is estimated.	This is a menu of potential needs: • Vegetation cover type or habitat • Landform • Elevation and aspect • Land use (management zone) • Seasonal use patterns • Active geomorphic features • Seasonal variability	Most information should be available with existing park mapping, USGS maps, and resource inventories.
Characterize the ambient park soundscape. This is the aggregate of all sounds, natural and human caused,	Acoustic data collected/arrayed by acoustically representative areas. • Sound frequency data (spectra)	This data must be measured. • One-second, average sound level for 1/3 octave bands

Assessment component	Information needs	Sources of information or measurement methods
within the park. It is a total- sound database and is needed to make further characterizations.	• Sound level data (decibels) • Sound source identification data (type of sound) • Biologic (biophonic) data	• 20 second or greater digital recording of all sounds, with programmable sample scheme • Attended logging
Characterize the ambient natural park soundscape. This is used as a baseline for impact analyses and to help in developing impact levels.	Acoustic data (see 2) is resolved to identify human caused sound characteristics and screen them out. Identify natural sound sources, levels, frequency spectra.	Item 2. Acoustic data screening models/processes.
Characterize the impact of human-caused sound on the natural soundscape. Used as a basis for determining the appropriateness of sound sources and levels, and present levels of inappropriate or excessive noise. It is needed to help develop impact levels and inputs to sound propagation models.	Acoustic data (see 2) is resolved to identify human caused sound characteristics. Sounds and sound levels are identified and associated with purposes for which the park was established. Determinations are needed by area or management zone of the park.	Item 2. Acoustic data screening models/processes. Establishment legislation, relevant regulations, park management plans.

Impact Levels

The development of impact levels that are effective in the analysis of proposed actions is dependent upon several things. First, suitable and specific guidance/objectives must be derived from a current soundscape management plan. Second, within the hierarchy of objectives, indicators and standards must be provided. For each management zone there must be one or more indicators described whose measurement is an index to performance in meeting the objective. Then, for each indicator, there must be a standard by which performance is actually measured. Third, there must be a viable and acceptable tool (or method) for measuring the indicator and for modeling it, if appropriate, in an effects analysis. This can only happen if the same indicator is being used for both. With this basis, impact levels can be developed to tie the impacts analysis (for a proposed action and alternatives) to park objectives for an effective comparison. In short, the basis for determination of adverse impact – and later for impairment – is the degree to which anticipated alternatives depart from objectives stated in the management plan.

Potential indicators for impact analysis include a variety of acoustic metrics or interpretations (see Information Needs). These indicators must be viewed in the context of where and when impacts occur. Definitions of significance level must integrate all these concerns. Context, time factors (e.g., duration, frequency of occurrence, and sensitive time periods), location and intensity interact in a complex manner to determine the degree of noise impact for an activity. In addition to the impact on the natural soundscape, noise might have additional and different impacts on other resources. For example, a certain duration and intensity of noise might have a moderate impact on the natural soundscape of a park but a completely unacceptable impact on a species of concern or on a particular cultural or religious site. Also, a given intensity would have greater impact if it occurred more often, for longer duration, or over a greater area. The time of day or time of year a given noise occurs can also have a significant influence on the impact it will have. Management judgment, based upon a well-supported and documented rationale, must be used to determine what degree of impact best applies in individual parks.

The example definitions of impact levels shown in Table 1 reflect the criteria to be applied in describing effects of noise on soundscapes. These definitions are provided as general guidance and should not be adopted as the park-specific levels without sufficient preparation as described above. Direction for management of various park units differs, sometimes dramatically, and therefore the levels must be set park-by-park and management zone-by-management zone. For example, a national recreation area, by its nature, is required to allow recreational boating uses which will produce noise. Therefore, the impact levels for an NRA could be significantly different than for developed areas in another park. Clearly they would be different for wilderness zones.

In general, standards for restoring and maintaining natural soundscapes should be relatively consistent from park to park where similar zone types exist. The level and type of impact, as it may vary from park to park, could result in different levels of mitigation needed to achieve the same standard. These impact levels may be used as a guideline to make conclusions about impacts from a proposed action or alternatives to it on the soundscape. It is appropriate to consider impacts across the range of management zone types that are affected by an action, so wording is provided for the wilderness end of the spectrum and for the developed end. Note that the impacts of a proposed action (and its noise) on wildlife, cultural resources, or visitor experience would be defined specifically in those sections of an environmental document and may or may not be a cause for action in itself. In other words, a noise condition that might otherwise be acceptable from the soundscape standpoint may be unacceptable from a wildlife protection, cultural resource, or visitor use standpoint.

Short-term impacts of a lesser degree are likely to fall into the "negligible" category, whereas long-term impacts must be evaluated specific to the criteria. Short-term impacts are those that occur for the duration of a time-finite project such as facility construction or maintenance, or a one-time only event. A general rule for short-term determination is any impact whose total duration is less than 5 years. Impacts that are caused by an action which is permitted for a term of more than a year, or allowed to continue programmatically and indefinitely, could be considered long-term (as in 10-year term permits). Short-term impacts of a generally greater degree are likely to fall into the "minor" category, whereas long-term impacts must be evaluated specific to the criteria. Short-term impacts are not likely to fall into the "moderate" category; long-term impacts must be evaluated specific to the criteria.

The term "detectability" as used below, is synonymously with "audibility." Audibility is used in acoustic literature, but the intent is to avoid the connotation of impacts on humans or visitor experience and emphasize impact on the soundscape. Audibility is the capability of a sound to be detected by animals; since the human ear is capable of detecting human–caused sounds it is an important instrument for defining impacts.

Level/Management zone		Definition
Negligible	Natural or wilderness	Sound created by the action is not detectable for a statistically significant portion of the area or a statistically significant amount of time within the area. Natural sounds that are unique to the park are not interfered with over a statistically significant length of time. For the time when human-caused sound is detectable, its influence on the natural ambient sound pressure level is 1 dBA or less. (The general rule is that if the difference in two measured sound pressure levels (SPL), in this case the natural vs. the human-caused (noise) SPL, is 10 dBA (decibels on an A-weighted scale) or greater, the influence of the quieter sound on the total SPL can be ignored. If the noise is 10 dBA less than the natural SPL, the influence on the natural SPL is about 0.5 dBA. If the noise is 6 dBA less than the natural ambient, the influence of the noise is about 1 dBA. If the noise is the same SPL as the natural, it adds about 3 dBA to the natural ambient SPL.)
	Development	Sound created by the action does not add in a statistically significant way (up to 5%) to the total ambient sound environment, either by decibel level or by a new sound frequency signature. Natural sounds that are unique to the park are not interfered with beyond the ambient level of impact over a statistically significant length of time.
Minor	Natural or wilderness	Sound created by the action is detectable in 10 percent of the area for 10% of the amount of time during which the sound is generated. Sounds produce levels up to 6dBA over the natural ambient level. Natural sounds that are unique to the park are interfered with less than 5% of the time.
	Development	Sound created by the action adds to the total ambient sound environment, either by decibel level or by a new sound frequency signature, but not more than 10% of the time. Natural sounds are not interfered with beyond the ambient level of impact more than 10% of the time.
Moderate	Natural or wilderness	Sound created by the action is detectable in 10 percent of the area for 50% of the amount of time during which the sound is generated. Sounds produce levels up to 6dBA over the natural ambient level. Natural sounds that are unique to the park are interfered with less than 10% of the time.
	Development	Sound created by the action adds to the total ambient noise environment, either by decibel level or by a new sound frequency signature, but not more than 20% of the time. Natural sounds are not interfered with beyond the ambient level of impact more than 20% of the time.
Major	Natural or wilderness	Sound created by the action is detectable in more than 10 percent of the area for 50% of the amount of time during which the noise is generated. OR: Detectable sounds produce levels more than 6dBA over the natural ambient level in up to 10% of the area. OR: Natural sounds that are unique to the park are interfered with more than 10% of the time.
	Development	Sound created by the action adds to the total ambient noise environment, either by decibel level or by a new sound frequency signature, more than 20% of the time. Natural sounds are interfered with beyond the ambient level of impact more than 20% of the time.

Cumulative Impacts

The impact level criteria above apply to the direct and indirect impacts of a site or action specific proposed action (or alternatives to a proposal) stated in terms of sound indicators – either measured or modeled. Different thresholds may apply to the cumulative effects of all sound sources that might be evaluated in a programmatic or comprehensive plan. The cumulative impacts analysis must present all current or reasonably foreseeable impacts on the soundscape and add the impacts of the proposed action (or for each alternative) to the total. If the impact levels defined apply to the impacts of a proposed action then there should be a separate definition for cumulative impacts. This concept is critical, since it eliminates confusion and underpins any determination of impairment.

The analysis of cumulative impact may be based upon one or more of several physical (geographic) areas of concern, which in turn would be the foci for articulating impact levels. The area of concern could be a point or area within the park having the greatest sensitivity to human-caused sound, such as the core of a wilderness area. Alternately, the area of concern could be represented by the entire park. It could also be represented by the location of a feature or resource in the park, demonstrated to be fundamental to the park purpose.

The analysis process is to focus on the area(s) of concern and list all the sources of human caused noise that affect that point or area. Ideally, that would involve time-series data measuring the frequency spectrum and the sound pressure of the noise when it occurs – i.e., using the same metrics by which the proposed action impacts are described. The impacts of all current noise plus the proposed can then be viewed additively. All human-caused noise needs to be considered: aircraft overflight noise (commercial, military or general aviation, air tour operations); ambient highway noise; visitor noise; vehicle noise (autos, buses, recreational vehicles, motorcycles, snowmobiles, snow coaches, personal water craft, motor boats); NPS operational noise (generators, trucks, snowplows, paving machines).

The total cumulative impact threshold would be articulated in the same general terms as the above impact criteria–for example, maximum area of sound impact within the park, maximum dB(A) relative to the baseline natural sound level, limits of noise free intervals, etc. Decision-makers need to pose the question: in consideration of the ambient noise level plus the noise contributed by a proposed action, what is the maximum level of impact consistent with park mandates and soundscape policy? There are many possible permutations to consider, as described in the impact levels section, involving: area or location impacted; frequency, timing and duration of impact; and key soundscape or related resources to be protected or restored.

The effect of the cumulative impact threshold, relative to the amount of ambient noise being experienced, is to define an available increment for producing new noise. The greater the level of ambient noise, theoretically, the smaller the available increment for allowing new noise. Such rules of operation need to be balanced against the current policy to maintain existing soundscape quality and restore degraded ones. In mitigating the impacts of noise through technology or administrative action, management faces the choice of allowing new noise sources within the increment or providing a quieter, more natural soundscape.

Impairment Considerations and Examples

Examples of rationale for finding a greater or less likelihood of impairment are presented in the table below. It is most likely that impairment would be found as a function of the cumulative impact from human-caused sound; that is, the sound of a proposed action plus all the other sources of noise that affect a park. A proposed action by itself may not reach the level of impairment, but it could push the total impact of noise over a pre-determined threshold. It is conceivable that a park soundscape may be considered impaired under the total ambient noise level that currently exists, such that any new proposed action would constitute impairment.

The decision-maker can find impairment on the natural soundscape at any impact level where adverse impact may occur, with suitable rationale supported by analysis of direct and indirect or cumulative effects. An impairment finding can be based on either or both. The analysis of specific proposed actions that affect natural soundscapes, wherein a determination of impairment must be made, would be facilitated and guided by a programmatic soundscape plan containing specific standards. Standards would be derived using scientific methods, and a process subject to public involvement. A decision document for a soundscape management plan would effectively put in place a supportable structure for making impairment judgments in future environmental analyses.

Action	Affected soundscape resource/Characteristic	Impairment less likely	Impairment more likely
General: all ongoing or proposed actions individually	The natural sound environment as a resource associated with the purposes for which a park was established. The soundscape can be viewed as affected on two levels: the natural sounds associated with lack of human-caused sound, and special sounds associated with unique park values. Natural sounds in all parks include the sounds of flora and fauna, wind in the trees or across rock formations, flowing water or waves on the shoreline. Many sources of natural sound that make up the soundscape can be identified as unique to, or uniquely represented in, a park. Natural soundscapes in many parks may contain special or unique sounds such as thermal venting, bubbling hot springs, lava flowing, wolves howling, or calls of rare and endangered birds.	Unique natural or cultural sounds and settings associated with specific park purposes are not adversely and significantly affected. Any impacts are mostly limited to developed zones and hours of operation within the park. Impairment is less likely for short-term actions, and those having negligible to minor impacts on the soundscape as defined.	Natural sounds, especially those identified as unique to the park, are adversely and significantly affected. Few noise free intervals occur during hours of operation, and noise may be characterized as greatly in excess of natural sound levels. Impairment is more likely for long-term actions or long term commitments, and those having moderate to major impacts on the soundscape as defined. Secondary or indirect adverse impacts to wildlife, visitor experience or cultural values occur and are irreversible or irretrievable.
Park operations: road repair, snowplowing, vegetation treatment, trail maintenance		Park operations and their impacts are directly tied to specific park purposes for resource protection and conservation. Minimum tools necessary for park operations are implemented, including the use of best available quiet technology, and impacts are limited in frequency of occurrence or short duration.	Park operations occur with greater frequency, longer duration, and louder mechanization than is necessary for basic park purposes. Some park operations are not representative of the minimum tool necessary, and some may not support fundamental park purposes.
Visitor access: motorized use - autos, buses, snow machines, boats, personal water craft		Modes of visitor access are heavily dominated by the best available quiet technology. Mass transit modes are available to increase the ratio of visitors to vehicles. Impacts can be mitigated by using available authority to distribute use, limit use in critical areas, or require certain modes of access.	Visitor access is largely unrestricted as to mode of transport or numbers of vehicles permitted throughout the park's transportation system. A large percentage of vehicular access is represented by vehicles that do not meet best available "quiet" technology. Mass transit access is unavailable or not used.
Overflights: concession air tours, other air tours, general aviation, military flights		The combined impact of overflights does not affect a significant area in the park. Impacts from this source are limited mostly to developed zones in the park, where the sound of park operations and visitor access may dominate the soundscape. Sources of noise that are permitted by the park utilize the quietest available technologies or means to mitigate impacts.	The combined impact of general aviation, air tour operations, or other aircraft overflights affects a significant area in the park. Impacts from this source affect natural or wilderness areas. Sources of noise that are permitted by the park are not adequately limited as to technology, amount of use, flight path or other operational methods.

Action	Affected soundscape resource/Characteristic	Impairment <u>less</u> likely	Impairment <u>more</u> likely
Cumulative impacts: all sources combined		All sources of human-caused sound do not affect a significant area of the park for any significant length of time, or at more than low sound levels.	All sources of human-caused sound affect a significant area of the park; or, they affect natural sounds over a significant length of time; or high sound levels are evident.

GEOLOGIC RESOURCES

Background

The term "geologic resources" includes both geologic features and geologic processes. Geologic processes are the natural physical, chemical, and biological forces that act within natural systems, as well as upon human developments, across a broad spectrum of space and time. Such processes include, but are not limited to, soil formation and erosion, sedimentation, glaciation, karst processes, shoreline processes, and seismic and volcanic activity.

The term "geologic features" describes the products and physical components of geologic processes. Examples of geologic features in parks include rocks, soils, and minerals; geysers and hot springs in geothermal systems; cave and karst systems; canyons and arches in erosional landscapes; sand dunes, moraines, and terraces in depositional landscapes; coral reefs; dramatic or unusual rock outcrops and formations; and paleontological and paleoecological resources such as fossilized plants or animals, or their traces.

Examples of ways that impacts or impairment of park geologic resources can affect other park resources include:

- Widening a cave opening increases the airflow into the cave system and triggers an alteration of the existing humidity, thereby affecting the delicate ecosystems within the cave.
- Allowing trampling in an area, either by livestock or visitors, may affect soils through accelerated compaction or erosion, and therefore alter the rate of sediment input into nearby water sources and disturb the ecology of those systems.
- Failing to repair or replace leaky sewage lines near geothermal features can introduce foreign organic matter into the geothermal areas, thus significantly jeopardizing existing microbial organisms.

Guiding Laws, Regulations, and Policies

The chart below briefly describes the laws, regulations, and policies that apply to various types of park geologic resources. These authorities were distilled into a chart rather than text as used in the other sections of this guidance document because both park geologic resources and the authorities which apply to them are numerous and diverse. This chart does not include the park enabling statutes or other specific laws that apply only to one or a few parks.

Resource	Laws	Regulations	NPS Management Policies (2001)
All geologic resources		36 C.F.R. § 2.1 prohibits possessing/ destroying/disturbing mineral resources, cave resources, and paleontological specimens in park units. Limited exceptions: 36 C.F.R. § 7.9 allows some limited gold panning in Whiskeytown, and 36 C.F.R. § 13.20 allows some surface collection of rocks and minerals in some Alaska parks (not Klondike Gold Rush, Sitka, Denali, Glacier Bay, and Katmai) by non-disturbing methods (e.g., no pickaxes), which can be stopped by superintendent if collection causes significant adverse effects on park resources and visitor enjoyment.	Section 4.8.1 requires NPS to allow natural geologic processes to proceed unimpeded. NPS can intervene in these processes only when required by Congress, when necessary for saving human lives, or when there is no other feasible way to protect other natural resources/ park facilities/historic properties. Section 4.8.2 requires NPS to protect geologic features from adverse effects of human activity.
Caves and karst systems	Federal Cave Resources Protection Act of 1988 Requires Interior/Agriculture to identify "significant caves" on Federal lands, regulate/restrict use of those caves as appropriate, and include significant caves in land management planning efforts. Imposes civil and criminal penalties for harming a cave or cave resources. Authorizes Secretaries to withhold information about specific location of a significant cave from a FOIA requester.	FCRPA regulations (43 C.F.R. Part 37) state that all NPS caves are "significant" and set forth procedures for determining/releasing confidential information about specific cave locations to a FOIA requester.	Section 4.8.1.2 requires NPS to maintain karst integrity, minimize impacts. Section 4.8.2.2 requires NPS to protect caves, allow new development in or on caves if it will not impact cave environment, and to remove existing developments if they impair caves. Section 6.3.11.2 explains how to manage caves in/adjacent to wilderness.
Paleontology	National Parks Omnibus Management Act of 1998, § 207, allows the NPS to protect the confidentiality of the nature and specific location of paleontological objects.	NPS regulations (36 C.F.R. §§ 2.1(a)(1)(iii), 2.5, 13.20) prohibit all collection of paleontological resources in parks, except for scientific purposes. Prohibition applies even in Alaska parks where the surface collection of other geologic resources is permitted.	Section 4.8.2.1 emphasizes I & M, encourages scientific research, directs parks to maintain confidentiality of paleontological information, and allows parks to buy fossils only in accordance with certain criteria.
Coastal features and processes	Coastal Zone Management Act requires Federal agencies to prepare a consistency determination for every Federal agency activity in or outside of the coastal zone that affects land or water use of the coastal zone. Clean Water Act/Rivers and Harbors Act require that dredge and fill		Section 4.8.1.1 requires NPS to: - Allow natural processes to continue without interference, - Investigate alternatives for mitigating the effects of human alterations of natural processes and restoring natural conditions, - Study impacts of cultural resource protection proposals on natural resources, - Use the most effective and natural-looking erosion control methods available, and Section 4.8.1.1 (cont'd) - Avoid putting new developments in areas subject to natural shoreline

Resource	Laws	Regulations	NPS Management Policies (2001)
	actions comply with a Corps of Engineers Section 404 permit. Executive Order 13089 (coral reefs) (1998) calls for reduction of impacts to coral reefs. Executive Order 13158 (marine protected areas) (2000) requires every federal agency, to the extent permitted by law and the maximum extent practicable, to avoid harming marine protected areas.		processes unless certain factors are present.

Resource	Laws	Regulations	NPS Management Policies (2001)
Landscapes and surface processes			Section 4.1.5 directs the NPS to re-establish natural functions and processes in human-disturbed components of natural systems in parks unless directed otherwise by Congress. Section 4.4.2.4 directs the NPS to allow natural recovery of landscapes disturbed by natural phenomena, unless manipulation of the landscape is necessary to protect park development or human safety. Section 4.8.1.3 directs the NPS to strive to understand/strategically retreat from/avoid interfering with natural geologic processes that could be hazardous to visitor safety and park developments.
Geothermal	Geothermal Steam Act of 1970, as amended in 1988, states: - No geothermal leasing is allowed in parks. - "Significant" thermal features exist in 16 park units (the features listed by the NPS at 52 Fed. Reg. 28793-28800 (August 3, 1987), plus the thermal features in Crater Lake, Big Bend, and Lake Mead). - NPS is required to monitor those features. - Based on <u>scientific evidence</u>, Secretary of Interior must protect significant NPS thermal features from leasing effects.		Section 4.8.2.3 requires NPS to: - Preserve/maintain integrity of all thermal resources in parks. - Work closely with outside agencies. - Monitor significant thermal features.
Soils	Clean Water Act		Section 4.8.2.4 requires NPS to: - Prevent unnatural erosion, removal, and contamination. - Conduct soil surveys. - Minimize unavoidable excavation. - Develop/follow written prescriptions (instructions).

Nonfederal and federal mineral development activities	General Mining Act of 1872: - Allows U.S. citizens to locate mining claims on Federal lands. - Imposes administrative & economic validity requirements for "unpatented" claims (the right to extract Federally-	NPS regulations at 36 C.F.R. Parts 9a and 9b require the owners/operators of mining claims and nonfederal oil & gas rights to: - Demonstrate bona fide title to mining claim or oil & gas right. - Submit a plan of operations to NPS describing where, when, how. - Prepare/submit a reclamation plan. - Submit a bond to cover reclamation and potential liability.	Section 6.4.9 requires NPS to manage mineral-related activities in NPS wilderness in accordance with the regulations at 36 C.F.R. Parts 1, 5, 6, 9A, and 9B. Section 8.7 restates the regulatory requirements for mineral exploration and development generally, but also adds requirements.

	owned minerals). - Imposes additional requirements for the processing of "patenting" claims (claimant owns surface and subsurface). Mining in the Parks Act of 1976 authorized NPS to regulate all activities resulting from exercise of mineral rights, on patented and unpatented mining claims in all areas of the System, in order to preserve and manage those areas. Federal Mineral Leasing Statutes (Oil & Gas, Salable Minerals, and Non-locatable Minerals) including the park enabling statutes for Glen Canyon, Lake Mead and Whiskeytown NRAs allow the BLM to issue federal mineral lease in the noted units provided that the Bureau obtains NPS consent. Such consent must be predicated on a finding of no significant adverse effect on park resources and/or administration.	NPS regulations at 36 C.F.R. Parts 1, 5, and 6 require the owners/operators of other types of mineral rights to obtain a special use permit from the NPS as a § 5.3 business operation, and to comply with the solid waste regulations at Part 6. BLM/NPS regulations at 43 C.F.R. Parts 3100, 3400, and 3500 govern Federal mineral leasing.	
Park sand and gravel resources			Section 9.1.3.3 clarifies that only the NPS or its agent can extract park-owned common variety minerals (e.g., sand and gravel), and: - Only for park administrative uses. - After compliance with NEPA & other federal, state, and local laws, and a finding of non-impairment. - After finding the use is park's most reasonable alternative based on environment and economics. - Parks should use existing pits and create new pits only in accordance with park-wide borrow mgmt plan. - Spoil areas must comply with Part 6 standards - NPS must evaluate use of external quarries. Any deviations from this policy require written waiver from the Secretary, Assistant Secretary, or Director.

Information Needs

Geologic resource management in the National Park System includes three major program components: resource protection, disturbed land restoration, and management of private mineral exploration and development. Making management decisions about these resources, including impact and impairment decisions, requires a wide spectrum of information. In situations when it is difficult or impossible to obtain all of the information identified here, the "Lack of Information and Risk Assessment" subsection in the Introduction of this guidance document may help to determine which pieces of information are the most vital for the park's decision-making.

Assessment component	Information needs	Sources of information
Geologic features and processes	Identification of location and extent of significant geologic features (caves, paleontological resources, landforms, glaciers, geothermal features, etc.) and geologic processes Sensitivity of geologic features to change Soil physical, chemical, and biological properties, and the sensitivity of these properties to change Evaluation of surface resiliency, stability, and integrity (including soils, slope stability and shoreline and fluvial processes) and related geologic hazards Overview of park's soil and geologic resource issues Projections of any secondary impacts (e.g., increased theft due to increased access to an area)	• NPS NR- Map inventories • Geological maps and reports (U.S. Geological Survey, state geological surveys, local universities) • Soils data and maps available from the NPS Soils Inventory & Monitoring Program or USDA's National Resource Conservation Service • Coastal geomorphology data available from the Corps of Engineers and NOAA • Monitoring program data • New park or DSC studies if necessary • Geologic Resources Division
Disturbed land restoration	• Location, acreage, and adverse effects of abandoned roads, landfills, hazardous waste sites, mines, campgrounds, dams, railroads, and other abandoned developments (e.g., an analysis of contaminants, structures, or alterations to the land that may pose a monetary or safety liability to the NPS) • Overview of disturbed area issues • Land use in development zone showing existing NPS development footprint with transportation corridors • Detailed site analysis • Location, type, and quantity of hazardous materials in development zone • Projections of any secondary impacts (e.g., increased theft due to increased access to an area)	• NPS NR- Map inventories • NPS service-wide abandoned mineral lands database • Park GIS and surveys (field GIS technical support center or DSC can assist) • U.S. Geological Survey topographic maps • Aerial photography • Park hazardous materials survey • Park data about sand/gravel availability • New park studies, if necessary • Geologic Resources Division
Minerals management (including NPS extraction of in-park sand and gravel sources for park purposes)	• Extent (acreage), location, ownership, development potential, and expected impacts of past, existing, and proposed mineral operations, and associated access routes • Number, location, acreage, of historical and existing internal and external sand/gravel extraction locations and ownership • Land use in development zone showing existing NPS development footprint with transportation corridors • Location, type, and quantity of hazardous materials in development zone • Availability of sand and gravel for construction • Projections of any secondary impacts (e.g., increased theft due to increased access to an area)	• Bureau of Land Management and county records • State division of mines/geology or geological survey maps and records • U.S. Geological Survey maps and records • Park GIS and surveys (field GIS technical support center or DSC can assist) • Park should already have data about sand/gravel availability • New park or DSC studies if necessary • Aerial photography • Geologic Resources Division

Impact Levels

NPS environmental assessments and environmental impact statements often compare the impacts of various alternatives by categorizing the impacts as "negligible," "minor," "moderate," or "major." Using these impact levels (referred to as "impact thresholds" in Director's Order #12) may help park managers and staff make the decision about whether an alternative would go so far as to impair a park resource or value.

In order to compare impacts using these four impact levels, parks will need to first define the four levels. To adequately define the levels and evaluate the impacts of proposed or ongoing actions on a park's geologic resources, parks should involve a geologist and other specialists such a soil scientist and paleontologist in the planning effort. This could include working on the interdisciplinary team or through consultations with NPS or other geologic experts.

Impact levels are park-specific, and will depend on the condition and context of the park's geologic and other natural resources, the park's other resources, physical setting, and other factors. Geologic features and geologic processes are so different from each other that it may be appropriate for parks to use different impact levels for each, as provided below. These examples should provide a starting point for a park's development of its own impact level definitions.

Geologic Features

Director's Order # 12 requires the NPS to assess impacts on specific geologic features such as caves, biological soil crusts, or paleontological resources that would be affected by a proposed action, rather than on the broader term "geologic features." Therefore, the following definitions would need to be tailored to the specific geologic features in the project area, and if possible, quantified.

Negligible: Impacts to geologic features would not be detectable based on standard scientific methodologies.

Minor: Impacts to geologic features would be detectable but slight. Monitoring would likely detect changes to the features, and the loss of associated contextual information would be minimal.

Moderate: Impacts to geologic features would be readily apparent, but the area of disturbance would be localized. Monitoring would identify most affected geologic features, but some features and/or associated contextual information would be lost.

Major: Impacts would result in substantial or widespread loss or alteration of geologic features. Restoration of the features may be possible over the long term.

Geologic Processes
The list of impact levels, below, is based on the extent to which the frequency, magnitude, and duration of natural geologic processes stay within natural variability (NV). The NV for each geologic process will be tailored to individual park units or ecosystems. To establish a park's NV for each geologic process potentially impacted by a proposed or ongoing action, one should:

- Obtain monitoring data from the Vital Signs Inventory and Monitoring program.
- Obtain data about geologic or soil-forming processes from U.S. Geological Survey, the USDA Natural Resources Conservation Service, other state and federal agencies, and/or academic experts, and assistance in interpreting this data.
- Consult records (i.e., military records may contain information about sand dune movement).

Negligible: Impacts to geologic processes would not be detectable based on standard scientific methodologies. Impacts result in frequency, magnitude, and duration measurements that are well within NV.

Minor: Impacts to geologic processes would be detectable but slight. Frequency, magnitude, and duration measurements are expected to remain within NV, possibly showing small, short-term disruptions. Disruptions to key geologic processes are expected to be short-term and within NV.

Moderate: Impacts to geologic processes would be readily apparent. Frequency, magnitude, and duration measurements are expected to be outside NV for short periods of time, but return to NV. Disruptions within NV may be long-term. Disruptions to key geologic processes or ecosystems are expected to be short-term and temporarily outside NV.

Major: Impacts would result in substantial or widespread loss or alteration of geologic processes. Frequency, magnitude, and duration measurements are expected to be outside NV for short to long periods of time, or even be permanent. Disruptions within NV may be long-term. Disruptions to key geologic processes or ecosystems may be long-term or permanent.

Impairment Considerations and Examples

Once the park has assessed the impacts of a proposed or ongoing action and its alternatives, it must make an impairment determination. To do this, the NPS is required to consider the park enabling legislation, policies and other requirements, and park management objectives, and whether the affected resources or values are integral to the purposes of the park or necessary for the public's enjoyment of the park. Because these factors vary from park to park, what is impairment in one park may not be impairment in another.

The following are examples of actions that are **less likely** or **more likely** to impair park geologic resources and the visitor enjoyment and scientific value of those resources. These examples assume that the potentially affected resources are integral to the park, based on the considerations listed in the previous paragraph.

Actions	**Potentially affected geologic features/processes**	**Impairment less likely**	**Impairment more likely**
Building a new road segment, widening or straightening an existing road, or otherwise enlarging the areal extent of a road.	Paleontology resources	Any known or suspected localities lying in the road corridor would be assessed prior to disturbance. During construction, resources would be avoided or collected. The risks of resource damage to park fossils due to increased access would be minimal or would be mitigated via increased ranger patrols.	The road corridor is aligned through a fossil locality, and insufficient assurances or resources exist for adequate mitigation during construction, resulting in permanent damage to or loss of key paleontological resources. The increased access resulting from the road construction would increase the ability of fossil hunters to find and permanently remove specimens from the park.

Actions	Potentially affected geologic features/processes	Impairment <u>less</u> likely	Impairment <u>more</u> likely
	Biological soil crusts	Extent of disturbance would be localized during construction. Road design would prevent damage to adjacent areas along the road corridor.	Extent of disturbance would be widespread or potentially large due to construction methods or increased visitor access to areas adjoining road corridor.
	Natural surficial processes	Proper road design (e.g., outsloping and placement of culverts) and siting (e.g., hard substrate and/or flatter areas) would permit natural water flow patterns, thus mitigating potential erosion and landslides.	Road siting and/or design would result in water impoundment, channelization, or redirection, resulting in substantial damage or loss of key geologic features. Erosion or other surficial changes would occur, permanently altering the landscape.
Drilling geothermal, oil or gas, or other wells in or adjacent to a park	Geothermal features and processes	Well would be cased through a geothermal aquifer, thereby eliminating or greatly reducing risks of contamination, water loss, and changes to temperature water chemistry.	Well would severely and/or permanently change the temperature, volume, or chemistry of the park's geothermal aquifer.
	Geologic strata	Well would be cased, thereby eliminating or greatly reducing risks of contamination of aquifers, washing out geologic layers such as coal and other mineral deposits, and subsidence.	Improperly drilled and completed well would cause contamination of aquifers, subsidence, or other severe and/or permanent effects on park resources.
	Sand dunes	Well would tap aquifers that are not connected to sand dunes.	Sand dunes would lose moisture and as a result become more mobile, thereby altering extent and location of dunes within the park.
Installing coastal and stream erosion control (e.g., jetties, armoring, sandbags, beach nourishment, riprap, artificial dunes)	Beach and wetlands	Erosion control measures would be installed seasonally or temporarily, minimizing disruption of sediment movement and mimicking natural sediment movement. Soft stabilization methods would be used. Other mitigation measures would ensure minimal impacts to vegetation, wildlife, and visitors.	Erosion control measures would be permanent, restricting natural sediment supply and inhibiting natural soil movement. Hard stabilization structures would be used, destroying or diminishing habitat quality and quantity, visitor enjoyment, and aesthetic qualities.
Installing water control devices (e.g., culverts and check dams)*	Stream channel banks, wetlands, and natural sediment movement (accretion, erosion, deposition, etc.)	Natural water flow would be mimicked due to the volume, slope, and number of culverts.	Water control device would permanently and/or severely reduce naturally occurring flood events, or alter natural stream flow patterns resulting in permanent loss of geologic resources.

* See also Section II.B. Watershed Processes and Conditions; Stream Channels and Riparian Resources

ECOSYSTEMS

Background

Ecosystems are living organisms in an area interacting with each other and their physical environment. The term "ecosystem" for the purposes of this document includes significant areas of plant communities or vegetation (because of their role as a management unit), ecosystem structure and ecosystem processes. Ecosystems are scale-dependent and can range from small areas of interaction between serpentine soils, specific plant and Lepidoptera species, to watersheds to biomes. Examples range from forest types, grasslands, estuaries, wetlands, riparian zones, stream channels to landscapes that capture the matrix of these component systems. Boundaries of these systems can be drawn for the purpose of designating management units, so long as it is recognized that boundaries are open, and the designated system is influenced by functioning ecosystems and processes within it, and those that surround the designated unit.

A characteristic of ecosystems is that they have emergent properties that are measurable at specific scales. This is considered in the concept of ecological integrity. Ecological integrity has been defined as a combination of ecosystem health, the continued ability to withstand stress, and the continued ability for ongoing change. Ecosystem health is the process, function, and structure of a delineated system. The ability for ecosystems to incorporate change is important in allowing evolutionary changes that are core to NPS's goals to protect genetic diversity. It is also important because it reflects the dynamic nature of ecosystems. An ecosystem with integrity, then, is one that has its full range of elements, and processes particular to its geographic area. While all of the interactions that drive system integrity cannot be evaluated or monitored specifically, evaluating some temporal and spatial aspects, through an understanding of indirect and cumulative effects, of the management action can help predict system-level responses to the action.

Guiding Laws, Regulations and Policies

Resources are intrinsically intertwined and ecosystems can be seen conceptually as an umbrella incorporating aspects of biological, geological, water, air and other natural resources. Many of the guiding laws, regulations and policies, and impact levels (as detailed in all of the sections preceding this) for component parts of ecosystems apply indirectly to ecosystems.

Information Needs

In addition to acquiring information related to component resources, the following will assist managers in evaluating the integrity of their ecosystems:

Develop Ecological Models:
A conceptual model is a visual or narrative summary that describes the important components of the ecosystem and the interactions among them. Conceptual model diagrams often take the form of a "boxes and arrows" diagram, whereby mutually exclusive components are shown in boxes and interactions among the components are shown with arrows. Development of a conceptual model helps in understanding how the diverse components of a system interact, and promotes integration and communication among scientists and managers from different disciplines. It also helps us understand:

- The relations among various levels of ecological hierarchy, e.g. landscape – ecosystem – communities – populations of species and ecotypes. Many indirect effects of projects occur at a different level than that at which a treatment or project was applied.
- The potential resilience and other responses of a system to natural disturbance – we have moved away from more static concepts of stability, or equilibrium for given "stages" of ecosystem development, or plant succession, because we recognize that disturbances and stochastic events result in dynamic systems.
- The role of any known keystone species – if population levels of these species are significantly affected, the resulting impact on other species and the biological community can be great.
- Whether the action will disrupt a natural disturbance or cause the park to alter natural characteristics (intensity, variability, spatial and temporal dimensions) of such an occurrence (more fire suppression, or altered prescribed burn season to accommodate a structure; artificial stream channels to accommodate a park office building).

Assessment component	Information needs	Sources of information
Natural history (patterns, processes, components) (current conditions)	• Rarity ranking and ecoregional context (e.g., common, endemic, peripheral) of species and communities. • Successional stages and abiotic controls on ecosystem development including quantitative information on natural disturbances to the system. • Indicator species – Species native to a landscape but that have different amplitudes of tolerance. A sensitive indicator species often has a narrow amplitude of tolerance to change in its environment, while weedy indicator species are adapted to a wider range of stresses from the environment. Increases in these weedy species and/or decreases in sensitive species help provide qualitative measures of system "health." • Species interactions with other organisms and environment • Natural Range of Variation of primary production, herbivory, disturbances, erosion, etc.	• State Heritage programs, NatureServe • NPS NRPC Soils Program • Natural Resources Conservation Service • NPS Vegetation Mapping Program • NPS Fire Ecology Program • Regional Academic Institutions
Indirect/cumulative effects/models (predicted / desired future conditions)	• The resources of concern and their location, • A summary of all previous actions taken that have resulted in impact (or potential likely impact) to park resources (including both direct and indirect impacts), • A quantitative assessment of the projected direct and indirect effects or risks of the new proposed action, • An understanding of biological and ecological characteristics of the species and ecosystem impacted as discussed above (including range of natural variability and relative condition), • An understanding of population status and distribution of the species or other resources of concern, • Understanding of the temporal and spatial scale of the assessment, and the defensibility of the assessment selected • Evaluation of effects across levels of ecological hierarchy	• NPS Inventory and Monitoring Networks • The Nature Conservancy Learning Networks • Regional Academic Institutions • Long-Term Ecological Research Stations • NPS Fire Ecology Program

Impact Levels

Impacts on ecosystems should evaluate not only component resources outlined in previous sections, but spatial and temporal organization (patterns and processes) of these components. It should evaluate interactive effects across levels of ecological hierarchy.
A particular note needs to be made about rare species and biological communities in ecosystems. Rarity categories for species and biological communities are defined as:

G1	Critically Imperiled—Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000) or acres (<2,000) or linear miles (<10).
G2	Imperiled—Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000) or acres (2,000 to 10,000) or linear miles (10 to 50).
G3	Vulnerable—Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.

Given their status and the particular (and likely not repeatable) circumstances that resulted in their occurrence at a given location, any actions could potentially result in major impacts on populations or habitat of G1 and G2 species and communities. Actions potentially affecting G3 species and communities should receive additional scrutiny, as should actions that impact unique geologic and water features.

A second concept warranting clarification is stability. Managers deal with a multitude of descriptors for ecosystems that range from “resistant” or “well-buffered”, to “delicate”, “fragile” or “sensitive.” Technical literature refers to concepts of resilience, resistance, persistence and elasticity, and often the use of these terms is not consistent. All of these terms, technical and general, address ecosystem stability, or resistance to change. Two of several properties identified for stability are resistance and resilience. Resistance is easily understood as a system staying unchanged despite the presence of disturbances. Resilience is defined as the magnitude of disturbance that can be absorbed or accommodated by an ecosystem before its structure is changed to a fundamentally different state, or the capacity of an ecosystem to return to the original state after a temporary disturbance. “Fragile systems” such as deserts or caves will be impacted to a larger extent by disturbances, than would occur in a more stable system such as a lodgepole pine forest. The fragile systems have less resistance, less resiliency and will either take longer to recover or not cross back across the threshold to the original state. The resilience of any system decreases when management limits the range of natural variation. So, actions that push ecosystems or resources beyond the natural variation as well as those that artificially reduce or constrain the natural variation can have equally disastrous results when some other perturbation impacts the ecosystem.

Negligible: Impacts to the composition and function of ecosystems at key organizational levels are not detectable in the short term, and are not predicted to occur in long term.

Severity: Trivial effects on populations, abiotic features or processes
Duration: Short-term to long-term effects
Timing: Outside of critical timing windows of key resources or ecosystems

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term	X		
	Long-term	X		
	Permanent			

Minor: Impacts are detectable, but the severity and timing of changes to parameter measurements are not expected to be outside the natural variability (NV) and not expected to have any long-term effects on biological, abiotic or ecosystem resources. Certain common patterns may have short-term disruptions on a broad spatial scale. Key ecosystem processes may have short-term disruptions that are within NV, and habitat for all species remains functional.

Severity: Trivial effects on populations, abiotic features or areas of designated ecosystems with very small proportions of populations or system affected. Impacts are well within NV.
Duration: Short-term to permanent affects.
Timing: Outside of critical timing windows of key resources or ecosystems.

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term		X	
	Long-term			
	Permanent	X		

Moderate: Impacts are detectable and the severity and timing of changes to parameter measurements are expected to be outside the natural variability (NV) for short periods of time and changes within the NV may be long-term in nature. Ecosystem patterns may experience permanent disruption or loss on a limited spatial scale. Key ecosystem processes may have short-term disruptions that are outside NV (but return to NV), and habitat for all species remains functional.

Severity: Substantial effects on populations, or habitat over limited areas or measurable small effects on populations over a large area.
Impacts are within or outside NV. Where impacts are outside NV, conditions and propagules will enhance resiliency and eventual recovery of patterns and processes
Duration: Short-term to long-term effects.
Timing: Some impacts may occur during key time periods for populations/ecosystems.

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term		X	X
	Long-term		X	

	Permanent			

Major: Impacts are detectable and the severity and timing of changes to parameter measurements are expected to be outside the natural variability (NV) for short to long periods of time – or even be permanent. Changes within the NV may be long-term or permanent in nature. In extreme cases, species may be extirpated from the park and ecological patterns simplified, key ecosystem processes like dune nourishment may be disrupted, or habitat for any species is rendered not functional. Ecosystem resilience is "site" dependent, or impacts may affect resiliency levels of the system, so differences between moderate and major impacts may depend on system characteristics, such as precipitation (arid ecosystems are generally considered fragile due to long recovery periods after disturbance compared to mesic ecosystems)

Severity: Substantial effects on individual components, patterns and processes over a large area. Impacts are within or outside NV.
Duration: Short-term to long-term to permanent effects.
Timing: Substantial impacts during key time periods for components or ecosystems.

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term			X
	Long-term		X	X
	Permanent		X	X

In summary, thresholds of impact can be placed into the following table. Note that some boxes may have two potential thresholds, depending on the magnitude of the impact.

		Severity and timing		
		Trivial	Within NV	Outside NV
Duration	Short-term	Negligible	Minor/Moderate	Moderate/Major
	Long-term	Negligible	Moderate/Major	Major
	Permanent	Minor	Major	Major

Impairment Considerations and Examples

In some cases, an action will have a straightforward "cause-and-effect" relationship that can be evaluated. Such direct effects can be most easily measured once the action is taken, and can often be fairly accurately predicted prior to the action. However, much of the preceding discussion refers to effects on more complex situations involving ecosystem concepts of "interactions," "dynamics," "integration," and "conditions and processes." It is important to acknowledge the role of the ecosystem perspective in evaluating impairment for many other proposed actions.

Indirect ecological effects can often be very difficult to predict and ascertain. Often indirect effects transcend the boundaries of the area or species directly affected. For example, in the Pacific Northwest and Alaska, one or more species of terrestrial carnivores may be fairly dependent on spawning salmon stocks as an important food source to help them gain necessary fat content for successful winter hibernation. A loss of this food source for even one season may be extremely harmful to the population status. A project such as a limited-catch fishing season, or allowance for a decrease in water flow that might impact the run of salmon up a park stream for only one season may not be considered harmful to the integrity of the salmon population as a whole, but may be deemed harmful to the integrity of park resources through indirect impacts on the dependent carnivore species. Many marine species are wide ranging and impacts to park resources with a marine environment will have a high likelihood of indirect effects.

Because it will often not be possible to actually measure the amount of interdependence of all ecosystem components in a quantitative way or make quantitative estimates of indirect impacts, most assessments of indirect impacts will involve the evaluation of risk posed to other components of the ecosystem (other than those known to be directly impacted) by the proposed action. In this case, keystone or other indicator species or processes should be identified for evaluation. Also, a high probability of impact over a wide range of associated species and/or geographical area, or indirect harm to a critical park or endangered species may be sufficient to determine that the proposed action should be considered a harm to the integrity of park resources, even if it may not constitute harm to the integrity of the species present at the particular area and time of direct impact.

Cumulative effects must also be evaluated for ecosystems. Two cumulative effect scenarios can be identified. The first is that the proposed action in itself will not harm the resource but when considered with existing impacts of other previous actions, that have also been determined not to cause harm to the resource individually or jointly, is believed will cause harm to the resource. This is land ownership independent and can be considered as a spatial cumulative effect. The second is that a single impact as a result of the activity or action will only have minor effects but repeated actions eventually lead to the degradation of the resource (temporal cumulative effect). In this case, the manager may be put in the difficult position of identifying the threshold point at which the action or activity becomes harmful to the resource.

In theory, a full cumulative effects evaluation would involve compiling all effects (documented and potential) from all previous actions that have been taken that could impact park resources (including both direct and indirect effects). All potential direct and indirect effects of the current proposed action are then added to see whether the existing impacts are increased by the proposed action to the point of harm to the integrity. It is not likely that all impact information of past actions will be available, particularly in any quantitative way. Even if this information is available, because ecosystems are considered as systems the designated management units may have emergent properties greater than the sum of its component features. Therefore determination of cumulative effects may not simply be additive in an ecosystem context. Therefore, managers will again be left with having to make best professional judgment decisions as to the degree of total cumulative impacts and risk to the overall integrity of park resources posed by cumulative impacts of the proposed action.

Despite the difficulties when it comes to cumulative impact assessments, managers must (in accordance NPS Management Policies *Section 1.4.5*) attempt to assess this factor when considering whether a proposed action will result in impairment of park resources. When addressing possible cumulative effects, conceptual models of all ecosystem relationships are highly recommended to guide the manager’s thinking about potential total cumulative effects. These models can be used to support a simple cumulative effect assessment, through options such as a checklist, through increasingly complex assessment types such as matrices, indices and quantitative, predictive models. Conceptual models are primary components of an adaptive management approach, which along with focused efforts to minimize local impacts of an action, are first-step alternatives to conducting detailed cumulative impact assessments.

NPS Management Policies **do not** state that a certain level of cumulative impact shall not be exceeded. Factors to be considered at the cumulative level are similar to those discussed above for the other factors of determination. A proposed action, when judged alone, may not constitute impairment, but when considered in light of multiple other actions that are known to be impacting the same resource(s), it may be considered to cause harm to the integrity of park resources or values. For example, a proposed action that will result in the loss of a small amount of habitat that currently supports several individuals of a widely ranging game fish species would not, in itself, likely cause harm to the integrity of the population. However, if this species is being subjected to heavy fishing pressure elsewhere and is known to be seriously over fished, the cumulative impacts of the proposed action and existing fishing pressures may be cause to conclude that the proposed action could result in harm to the integrity of the population.

When potential impacts to an organism or associated ecosystem would not be acceptable but determination of such impacts is not likely to be conclusive, managers should apply the precautionary principle. The precautionary principle has been universally adopted in conservation and preservation work and is reflected in many environmental and public health statutes. The precautionary principle has been defined as "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." It includes taking action in the face of uncertainty, shifting burdens of proof to those who create risks, analysis of alternatives to potentially harmful activities, and participatory decision-making methods. More simply, it warns managers to thoroughly think through any decisions that could result in an irreversible impact on a resource, and to err towards the side of conservatism for the long-term fitness of a population, or long-term preservation of a resource. It also requires that the proponent of an action provide conclusive evidence that effects of an action will not result in impairment. If direct, indirect, or cumulative effects on various resources and/or ecosystems likely constitute impairment of park resources and values, then the action would need to be modified or abandoned.

Conversely, if it appears that impacts to associated species or a wide geographical area is very unlikely, a determination that the proposed action will not constitute harm to the integrity may be justified even though all ecological relationships have not been extensively documented. The important point here is that often an informed decision has to be made on the best available information and the degree or likelihood of risk to other species or resources should be considered in making such decisions. Planning through adaptive management should provide for contingencies to an unforeseen negative effect under this scenario.

Parks will experience cases whereby an action leads to conflicting resource impacts. In this case an action that leads to the degradation of one resource also results in the benefit for other resources. Decisions may need to be case-by-case but at the minimum, park legislation must be consulted and the question must be asked: “Are the benefits to some resources so important that the impact of another resource is worth it?” The park should also closely evaluate its information base. Could one of the resources in question be present as a result of inappropriate management decisions in the past? An example could be that bird species may have inhabited dense pinyon-juniper stands. The park may be committed to conservation of all of the species in the park, but if the vegetation stands are thick as a result of fire suppression, then it is more appropriate to restore the vegetation to an appropriate density. In another example, the bird species is endemic and the needed vegetation restoration will likely impair the viability of the bird’s population, especially since its remaining breeding habitat areas are now inside the park. Another example is the use of herbicides to control invasive plant species. The invasive species clearly represent a threat to native plant communities and no action in this case would result in impairment of that native plant resource. However, no long-term data have been collected regarding the fate of herbicide by-products so any evaluation of soil organisms over time can be made, thus potentially providing a conflict between the spirit of the precautionary principle and the park's enabling legislation. The park should make full use of the NEPA planning process and resource experts to identify potential compatible alternatives to management needs**.**

An ecosystem context is added to the examples below for earlier examples of impairment presented in other sections. Examples are provided for situations that are more likely to impair park resources and that are less likely to impair resources. Parks need to evaluate these examples in the context of their enabling legislation and management goals to see how they apply to their specific situations.

Action	**Affected ecosystem resource, characteristic, or function**	**Impairment less likely**	**Impairment more likely**
Development of a road, parking or structural facility.	Population viability of rare species or ecological communities with a rank of G1-G3.	Facility placement is directed to habitat areas of populations of more abundant species (G4-G5), or so few individuals of a G1-G3 species are impacted that population viability or the quality of the population is not negatively affected. Park has worked with partners to identify and preserve other examples of G1-G3 species or communities.	Placement of a facility in an area that negatively affects G1-G3 species or communities to a threshold of degradation or loss.
	System connectivity	Facilities do not disrupt important feeding areas or migration routes. Roads are not aligned completely along ecotonal boundaries	Animal and water flow routes are carefully considered in facility placement.
	Plant and soil communities, primary production, food webs	Project footprint is minimized. Topsoil and native plants are salvaged and stored properly for replacement landscaping, Edge effects of light, sound and species spread are minimized into native communities through project placement and native landscaping.	Best management practices for salvage and storage are ignored. Edges of project adjacent to native plant communities are abrupt and open. Non-native species are used in landscaping.
Management of a hazardous substance	Sensitive species, species interactions and food webs, nutrient cycles	Any hazardous substances used in park operations are stored and handled using established guidelines and practices for preparation, application, use, containment, storage and disposal. Any releases of significant magnitude are addressed immediately. Any chemical use is limited to short-term improvements of the ecosystem and chemicals and amendments leave no residuals that could lead to long-term alteration of the	Hazardous substances in significant quantities are allowed to be released into the ecosystem with no immediate remedial action. Hazardous substances in significant quantities that are discovered on-site are not addressed.

Action	Affected ecosystem resource, characteristic, or function	Impairment <u>less</u> likely	Impairment <u>more</u> likely
		system.	
Special use permits are to be issued for cropping or grazing	Nutrient cycles	Isolated wetlands are not connected to local or regional groundwater systems. Best management practices will be applied to maximize fertilizer uptake by crops. Riparian buffers are designed to capture excess fertilizer. Integrated Pest Management practices are used to minimize chemical biocide use.	Wetlands and riparian areas will be plowed and planted, or they will be excluded from agriculture but protective buffers will not be established. Connectivity of annual precipitation to groundwater supplies will be disrupted or diverted. Agricultural chemicals are allowed to accumulate in soils, altering nutrient concentration and cycling.
	Species composition	Stocking densities and grazing rotation, or crop rotation and weed management are conducted to favor polycultures including native agricultural weeds that provide habitat for native invertebrates and other species. Native grasses are allowed to recover in grazed areas.	Overgrazing leads to loss of grass species and the development of a shrub community, or agricultural practices lead to invasions of non-native species, and long-term or permanent loss of biodiversity. The system is shifted across the threshold to an alternate, simplified state.
Expansion of visitor use, or interpretation programs	Fragile ecosystem plant and soil communities, nutrient cycles	Visitors are directed away from more sensitive areas by trails that are designed for appropriate erosion control. Number of trails are minimized while still offering visitors appropriate opportunities to learn about and experience park features.	A network of social trails or roads creates the beginning of a cascade effect on biological crust damage, lower absorption of rainfall, gully creation, and redirection of nutrient and sediment pathways.
Wildland-Urban Interface treatments of fuels	Native community species composition and structure, landscape connectivity	Appropriate fire regime models are applied to the ecosystem in question. Area of WUI treatments are modeled based on fire behavior and likelihood of effectiveness. Facility and community protection is emphasized. Understory is maintained for erosion control and edge effect minimization.	Inappropriate fire regime models are applied that do not reflect fire behavior in the broader landscape. WUI zones are completely cleared of understory species and a majority of large tree individuals. Treatments are not tailored to site or conditions but follow a one-size-fits-all approach.
Independent resource activity planning	Ecosystem patterns and processes	Desired Future Conditions are developed by management programs and appropriate scientists and stakeholders. Strategies are designed that integrate planning and actions to achieve the Desired Future Condition.	Weed, fire and other resource programs do not integrate planning and timing of activities, leading to burn management that enhances non-native species spread that in turn, alters fire regimes to favor an alternate, simplified and degraded ecosystem.

CASE STUDIES

The following case studies are included to provide specific historical examples of how park impacts and impairment decisions have been made. In addition, there are several draft NPS NEPA documents that have addressed impacts and impairment, so they will be mentioned here as well. These are the Yosemite Fire Management Plan Draft EIS (www.nps.gov/yose/planning/fire/index.htm) and the Lake Mead National Recreation Area Lake Management Plan Draft EIS (www.nps.gov/lame/lmpdraft/home.htm).

CASE STUDY: IMPACT ASSESSMENT AND IMPAIRMENT DETERMINATIONS FOR RIPARIAN/WETLAND ECOSYSTEMS: MIDDLE SALT CREEK CANYON ACCESS PLAN ENVIRONMENTAL ASSESSMENT, CANYONLANDS NATIONAL PARK, UTAH

Background

Canyonlands is one of the few national parks to issue a NEPA document determining that a contemplated activity would cause impairment of park resources or values. In 1998 the U.S. District Court for Utah ruled that vehicle travel on the upper 8.2 miles of the Salt Creek four-wheel drive road caused permanent impairment of park resources, in violation of the NPS Organic Act, and enjoined vehicle use. Salt Creek is the heart of a National Register Archeological District and supports one of the most important riparian ecosystems in the park Four-wheel-drive groups appealed the decision, and in 2000 the U.S. Tenth Circuit Court of Appeals remanded the case to the district court, with instructions to utilize a broader standard of deference, re-examine the administrative record and consider the new NPS Management Policies on impairment, the central issue in the case. The park subsequently initiated a new EA process, analyzing the impacts of a range of access alternatives and addressing the issues on remand to the district court. The district court stayed its proceedings on the impairment question until completion of the new EA. The EA was released for public review in June 2002, and a finding of no significant impact (FONSI), selecting an alternative that prohibits motor vehicle use, was signed in September, 2002.

The EA analyzed the following four management alternatives:

- Limited year-around vehicle access under the permit system established in the 1995 Backcountry Management Plan (BMP).
- Part-year vehicle access under the permit system.
- Realignment of the existing four-wheel-drive road.
- Year-round prohibitions on motorized vehicles, or a combination of these actions.

The three vehicle-access alternatives have been found to cause impairment of park resources or values, which is prohibited by the National Park Service Organic Act. Consequently, Alternative D, which will prohibit motorized vehicles year-round while allowing access by hiking or pack stock, was identified as the preferred alternative.

Impact Assessment Methodology for Riparian/Wetland Ecosystems

Early scoping by CANY staff identified potential impacts to riparian/wetland ecosystems as one of the most important potentially affected natural resources for analysis in the EA. The riparian/wetland ecosystem complex was further divided into three subcomponents for relative impact analysis: riparian/wetland area functioning condition; area of riparian wetland disturbance; and water quality.

Data from the park's monitoring program, independent scientific investigations, and input from scientists with particular subject matter, regional and/or local expertise were used. Relevant scientific and resource management literature was also considered. The park used the Bureau of Land Management's Proper Functioning Condition approach to assess riparian/wetland impacts. PFC is a widely used qualitative method which considers hydrologic, vegetative, and geomorphic characteristics. A riparian-wetland area is considered to be in proper functioning condition when adequate vegetation, landform, or large woody debris is present to withstand increases in stream flow with minimal disturbance to the channel, floodplain, and associated plant communities. Areas that do not meet these criteria would be described as either "Functional-At Risk" or "Nonfunctional."

Impact Levels

The following impact levels were applied to identify the severity of impact for the riparian/wetland ecosystem category:

- **Riparian/Wetland Functioning Condition**
  This standardized evaluation procedure has three possible ratings for riparian areas: Properly Functioning Condition, Functional, At Risk, and Nonfunctional.

  Impact levels are based on functional condition ratings expected to result from contemplated alternatives:
  - **Negligible:** maintains existing proper functioning condition.
  - **Minor:** maintains existing functional—at risk condition and trend.
  - **Moderate:** improves or degrades to functional—at risk condition; or maintains existing functional—at risk condition but changes trend (e.g. from upward to no trend or vice versa).
  - **Major:** improves to PFC, regardless of prior condition; maintains, or degrades to, nonfunctional condition.

- **Area (acres/square feet) of Riparian/Wetland Disturbance**
  Thresholds are based on Army Corps of Engineers thresholds for various nationwide permits for actions affecting waters of the U.S., including wetlands:
  - **Negligible:** loss/effect to less than 1/3 acre of wetland.
  - **Minor:** loss/effect to 1/3 - 3 acres of wetland.
  - **Moderate:** loss/effect to 3 - 10 acres of wetland.
  - **Major:** loss/effect to over 10 acres of wetland.

- **Water Quality**
  Thresholds are based on Utah state water quality standards, pollution indicators, and criteria for assessing support of designated uses for Salt Creek designated uses that include domestic use with prior treatment, secondary contact recreation, warm water aquatic life, and agriculture, when effects can reasonably be associated with contemplated management alternatives (e.g. prominent differences in creek sections with and without vehicle travel):

- **Negligible:** Changes, but not exceedences, in any pollution indicator level, without violating water quality standards.
- **Minor:** Changes in frequency of exceedences of any pollution indicator, but no violations of water quality standards.
- **Moderate:** Changes in frequency or magnitude of violations of water quality standards, but not sufficient to cause change in degree of support of designated uses (full, partial, or non- use support).
- **Major:** Change in frequency or magnitude of violations of water quality standards, sufficient to cause change in degree of support of designated uses.

Impairment of Riparian Resources

Salt Creek has the most extensive surface water and riparian vegetation in Canyonlands National Park, other than the Green and Colorado Rivers. Surface water and riparian habitat are among the rarest habitat types in the arid Canyonlands environment, and are particularly important to wildlife. Salt Creek supports the park's richest assemblage of birds and other vertebrate wildlife outside the river corridors. For these reasons, the Salt Creek riparian/wetland ecosystem was found to be a resource whose conservation is key to the natural integrity of the park.

Alternatives A through C, each of which would allow some level of vehicle use, would not allow the riparian system to reach properly functioning condition (PFC). Under these alternatives, geomorphic and vegetation characteristics where vehicles travel the streambed and riparian area would be inadequate to dissipate flood energy and resist erosive force. The system would remain in its current "functional-at risk" condition at least temporarily, but in this condition it would be vulnerable to major indirect impacts at any time from commonly occurring flood events (5- to 25-year floods). While the direct impact of vehicle traffic would be minor to moderate, the indirect impact, on functioning condition, area of riparian/wetland disturbance, and water quality, would be major. These major impacts on a resource key to the natural integrity of the park were found to constitute impairment.

Alternative D (which prohibits vehicle use year-round) was not found to cause impairment. Under this alternative, riparian functioning condition would improve to PFC in the intermediate to long term, with a corresponding decline in the risk of major indirect flood impacts. Area of riparian/wetland disturbance and water quality would improve as well. Once in PFC, the system would withstand commonly occurring flood events without major degradation.

Additional details on this Environmental Assessment, and the analyses used in preparing it, are available through Canyonlands National Park, and National Park Service Water Resources Division staff.

CASE STUDY: FINAL YOSEMITE VALLEY PLAN SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT, YOSEMITE NATIONAL PARK, CALIFORNIA (EXCERPT FROM RECORD OF DECISION)
(http://www.nps.gov/yose/planning/yvp/rod.html)

Findings on Impairment of Park Resources and Values

The National Park Service had a challenging task in evaluating and selecting an alternative for implementation from the Yosemite Valley Plan Supplemental EIS, because all alternatives result in some degree of adverse impacts to some resources. In addition to selecting an alternative for implementation, the NPS had to determine whether any of these combinations of impacts to resources would constitute an impairment. Ultimately, the NPS determined that implementation of Alternative 2 of the *Yosemite Valley Plan* would not constitute an impairment to Yosemite National Park's resources and values. This conclusion was based on a thorough analysis of the environmental impacts described in the *Final Yosemite Valley Plan/SEIS*, the public comments received, relevant scientific studies, and the professional judgment of the decision-maker. While the alternative had some negative impacts, in all cases these adverse impacts are the result of actions taken to preserve and restore other park resources and values. Overall, the plan results in major benefits to park resources and values, opportunities for their enjoyment, and it does not result in their impairment.

In determining whether impairment may occur, park managers consider the severity, duration, and magnitude of the impact; the resources and values affected; and direct, indirect, and cumulative effects of the action. According to National Park Service Policy, "An impact would be more likely to constitute an impairment to the extent that it affects a resource or value whose conservation is: a) Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; b) Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or c) Identified as a goal in the park's general management plan or other relevant National Park Service planning documents."

This policy does not prohibit impacts to park resources and values. The National Park Service has the discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, so long as the impacts do not constitute impairment. Moreover, an impact is 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.

Human activity and past development have resulted in the ongoing disruption of natural systems and processes in Yosemite Valley for generations. The No Action Alternative would result in future unplanned and uncoordinated actions that are merely reactive to immediate concerns. Furthermore, these actions would likely be responsive to immediate, short-term, adverse impacts that demand attention, but may result in long term impairment to park values and resources. For example, the Merced River in Yosemite Valley has undergone substantial change, including adverse impacts to river hydrology, channel morphology, and associated meadows, wetlands, and riparian areas. The Merced River system is an integral component of the Valley's natural processes and has been specifically cited as an important natural feature in the first legislative action to preserve Yosemite Valley (1864). Should ongoing adverse impacts to the river system continue unchecked without the components of Alternative 2 that implement the *Merced River Plan*, impairment of this critical system will likely occur at some point in the future. Thus, the ability of the public to experience, understand, appreciate, and enjoy the Merced River in the Valley could also be impaired.

The actions comprising Alternative 2 will achieve the goals of the *Yosemite Valley Plan* (which include protecting and enhancing the natural and cultural resources of Yosemite Valley and providing opportunities for high-quality, resource-based visitor experiences) in a comprehensive, integrated manner that takes into account the interplay between resource protection and visitor use. Actions implemented under Alternative 2 that will cause overall negligible adverse impacts, minor adverse impacts, short term impacts, and beneficial impacts to park resources and values, as described in the *Final Yosemite Valley Plan/SEIS* (see Volume IB), will not constitute impairment. This is because these impacts have limited severity and/or duration and will not result in appreciable irreversible commitments of resources. Beneficial effects identified in the Final SEIS include effects related to restoring and protecting park resources and values.

This decision was made based on the direction of requirements in NPS Management Policies 2001. For example, the decision to implement Alternative 2 will result in consolidated day-visitor parking and a transit system to reduce traffic congestion and eliminate scattered parking (and its associated adverse impacts to park resources and visitor experience). Over the short term, a transit system will impact air quality emissions by reducing volatile organic compounds, carbon monoxide, and particulate matter (10 microns in diameter, or less) and by increasing nitrogen oxide, as long as it uses existing diesel technology. This is due to the increased number of buses required to service out-of-Valley parking areas. The *Final Yosemite Valley Plan/SEIS* concludes that this would be a short-term adverse impact because the National Park Service has committed to making continuing and progressive use of the best-available transportation technology. Replacement or new buses will meet or exceed newly legislated standards governing vehicle emissions that demand dramatic reductions in emissions over the next decade. Thus, the decision to emphasize public transportation rather than private automobiles will result in continuous improvements to air quality that will become more pronounced over time. Therefore, while one air quality component (nitrogen oxide) may be adversely impacted in the short term as a result of this decision, it will not cause impairment.

Sugar Pine Bridge, on the National Register of Historic Places, will be removed and the impact to cultural resources will be major and adverse. However, the action taken will be to remove a bridge that interferes with and may lead to impairment of the hydrological processes of the Merced River. The Merced River is cited as a feature in the first legislative action to preserve Yosemite Valley (1864), is a Wild and Scenic River, and is considered central to the Valley's scenery and ecological processes. The removal of Sugar Pine Bridge will protect and enhance the Outstandingly Remarkable Values of the Merced Wild and Scenic River by allowing the river to meander more freely. Because the adverse impact of bridge removal is an unavoidable result of an action necessary to preserve and restore the integrity of the Merced River, removal of Sugar Pine Bridge will not constitute impairment.

During the busiest times of the year, travel time to Yosemite Valley for day-visitors using out-of-Valley parking areas will be longer. However, there will be opportunities for improving visitor understanding and appreciation of park resources and values at remote visitor centers, at out-of-Valley parking areas, and on the shuttle buses. By using the shuttle system, visitors will be able to focus their attention on the scenery, trip planning, educational materials, and other information rather than driving their private vehicles and looking for parking places. At present, visitor demand exceeds available parking in Yosemite Valley, which can result in visitors being redirected or turned away when the Restricted Access Plan is implemented. The decision to implement Alternative 2 will result in a coordinated and comprehensive set of actions which will ensure that people can visit and experience the Valley in a manner that prevents impairment of park values and resources. While this would not be as convenient for users of out-of-Valley parking areas, it would prevent impairment to park values and resources that would result from constructing a higher number of day-visitor parking spaces in Yosemite Valley to meet demand.

In conclusion, the National Park Service has determined, through consideration of trade-offs in potential impacts, that the implementation of Alternative 2 will not result in impairment of resources and values in Yosemite National Park.

CASE STUDY: WOLF REINTRODUCTION–A YELLOWSTONE LESSON (Adapted from an essay by John D. Varley, 18 September 2002)

We can only imagine what the authors of the Yellowstone Organic Act were thinking in 1871-72 when they were piecing together the language setting aside the world's first national park. Whatever was behind it, it turned out to be both inspiring and persuasive because the NPS Organic Act that followed in 1916, and the laws creating national park systems in over 160 other countries, have pretty much embraced the same concept. As we all know, that concept challenges managers of parks to preserve all of its living and non-living parts, unimpaired, for the benefit of present and future generations.

Like any other radically new concept, the principles underpinning the Yellowstone Act and those that followed went through growing pains. Early on, subsistence hunting and fishing was allowed in Yellowstone attracting many sportsmen. Mountain lions, coyotes and wolves, broadly accepted by societal standards as "bad animals" in that earlier era, were shot on sight. If an elk or bison was killed by a subsistence hunter it was often "high-graded" for its most desirable parts and the remainder of the carcass was laced with strychnine to take care of the doomed scavengers to follow. By 1918, predators had been thinned in Yellowstone to the point they were already rare when the Congress of the United States administered the *coups de grace* by passing a law that called for the complete extermination of wolves. The federal agencies, including the newly created National Park Service, did precisely that.

In modern ecological parlance, what was lost with the wolf extermination campaign in the 1920s was a keystone species, which like its namesake--a crucial wedge-shaped stone at the crown of an arch--is a species whose role in an ecosystem is crucial. Without its keystone an arch collapses, and in that state few would argue the arch has not been seriously impaired. Likewise, the removal of a species from a natural functioning ecosystem is a serious impairment to the preservation of that ecosystem. What logically follows is that which affects the integrity of an ecosystem also affects this generation of Americans and all future generations. In other words, it was crucial that wolves be restored to the Yellowstone Ecosystem if it was expected to be healthy and functioning properly.

While it might have been inspired legal thinking to try, Yellowstone did not specifically use the word "impaired" when they proposed wolf restoration. Instead, they used every word, phrase and concept that meant essentially the same thing. In their proposal they talked about a crucial species, the missing link, the vacant niche, the car engine without a spark plug, the lost keystone, and the park's need "to right a terrible wrong." While all of these could be described as impairment look-a-likes, the all-important "i" word was never invoked.

Looking back, it may be worthwhile to ask if the elimination of wolves from Yellowstone would have been considered impairment by today's standards. What would the analysts say now if wolves had been living continuously in Yellowstone and were ordered exterminated today, perhaps this time not by Congress but by another federal regulatory agency?

In the 1980s and early 90s many observers thought the best argument for wolf restoration was simply the fact that the restoration of wolves to Yellowstone would return the ecosystem to its original, pre-Columbian biological diversity. Looking back 500 years in Yellowstone, this would mean "perfect" native biological diversity–all native floral and faunal species present and accounted for–not one native species missing from the functional ecological mix. The very idea of "perfect or untrammeled biodiversity" could easily lead us to the human values associated with the impairment standard. Much of the United States is concerned with the growing loss of native biological diversity and its preservation is a significant concern. To our knowledge, Yellowstone is the only place in the lower 48 states that can claim to have all of the species of flora and fauna that occurred when Columbus set foot on North American shores.

Another kind of human value materialized with the return of wolves to the ecosystem and that is their popularity with today's citizens. Undoubtedly, and to the dismay of the park's grizzly bears and other charismatic creatures, wolves became the species most desired to be seen by park visitors. And, because wolves were most visible in a less visited portion of Yellowstone, the area became very popular literally overnight and it significantly changed the demographics of visitation park wide.

But values, as important as they are in our society, are individualistic and are a human construct, and thus are often open to dispute. Additionally, they are values associated with the presence of wolves, not their absence. What can be said of their absence and the impairment standard?

As a viable population, wolves were absent from Yellowstone for about 70 years, which is probably long enough to judge what their absence meant to the ecosystem, including the cumulative impacts of their absence. We make those projections based on the influence wolves have now since their return. It is known, for example, that wolves reduce within-year and between-year variability in carcass availability, so in addition to feeding themselves, they feed dozens of other species. For instance, many wolf-kill carcass observers wonder what ravens, magpies, bald and golden eagles, and grizzly and black bears did to obtain high quality protein over the 70 years wolves were absent? Their attendance at wolf-kills is regular now. How did 57 species of obligate carrion beetles survive over that same period? The 57 species unquestionably survived but did another 50 species fail to span the absence? The ramification of much more red meat availability to a host of scavenger species is still being studied but early indications suggest it is highly significant.

Coyotes were the great winners during wolf absence as they expanded into and at least partially filled the vacant wolf niche. Foxes, somewhat wolf-friendly but a clear loser in the face of a coyote dominated landscape, may have begun to prosper since the wolf reappeared.

Of the ungulates, elk are clearly the wolves' best friend. After nearly a century of widespread and intense criticism of Yellowstone's alleged over-population of elk, at least one letterhead group has formed to protest the new scarcity of elk, their villain being the wolves. But agency and university scientists believe the future of park elk is bright.

Remarkably, some scientists believe they are seeing the effects of wolf presence, at least in the core wolf areas, on plant life.

Thus, the removal of the wolf, the consummate Yellowstone keystone, had ecological ramifications of the extraordinary sort if the return of the wolf is any indication. The trophic cascade has begun and will be studied and debated for decades to come.

So did the absence of wolves violate the purposes of the Yellowstone Act? Maybe, maybe not. The eradication of wolves was a Congressional directive, which would not ordinarily be viewed as impairment. Interestingly, the directive was an amendment to the 1918 annual budget bill and did not come from an authorizing committee as the Yellowstone or National Park Service organic acts did.

Were wolves key to the natural integrity of the park or to opportunities for the enjoyment of the park? Absolutely, and provable on both counts.

For the 70-year period wolves were absent was Yellowstone unimpaired or impaired? To Yellowstone managers, biologists and other close observers of the post-1995 reintroduction period, there is probably little doubt that the park was impaired without the wolves. Among a similar group of people pre-1995, the reintroduction planning era, there were substantially more doubts simply because of all of the unknowns involved.

The question we must ask ourselves is this: Do we have to lose a species as important as the wolf in order for a park to make an impairment judgment? Most animal species wouldn't qualify as keystone species. Compounding that aspect is the fact that most keystone species are probably unknown. Could non-keystone species trigger an impairment finding? The answers to these questions are, of course, not simple.

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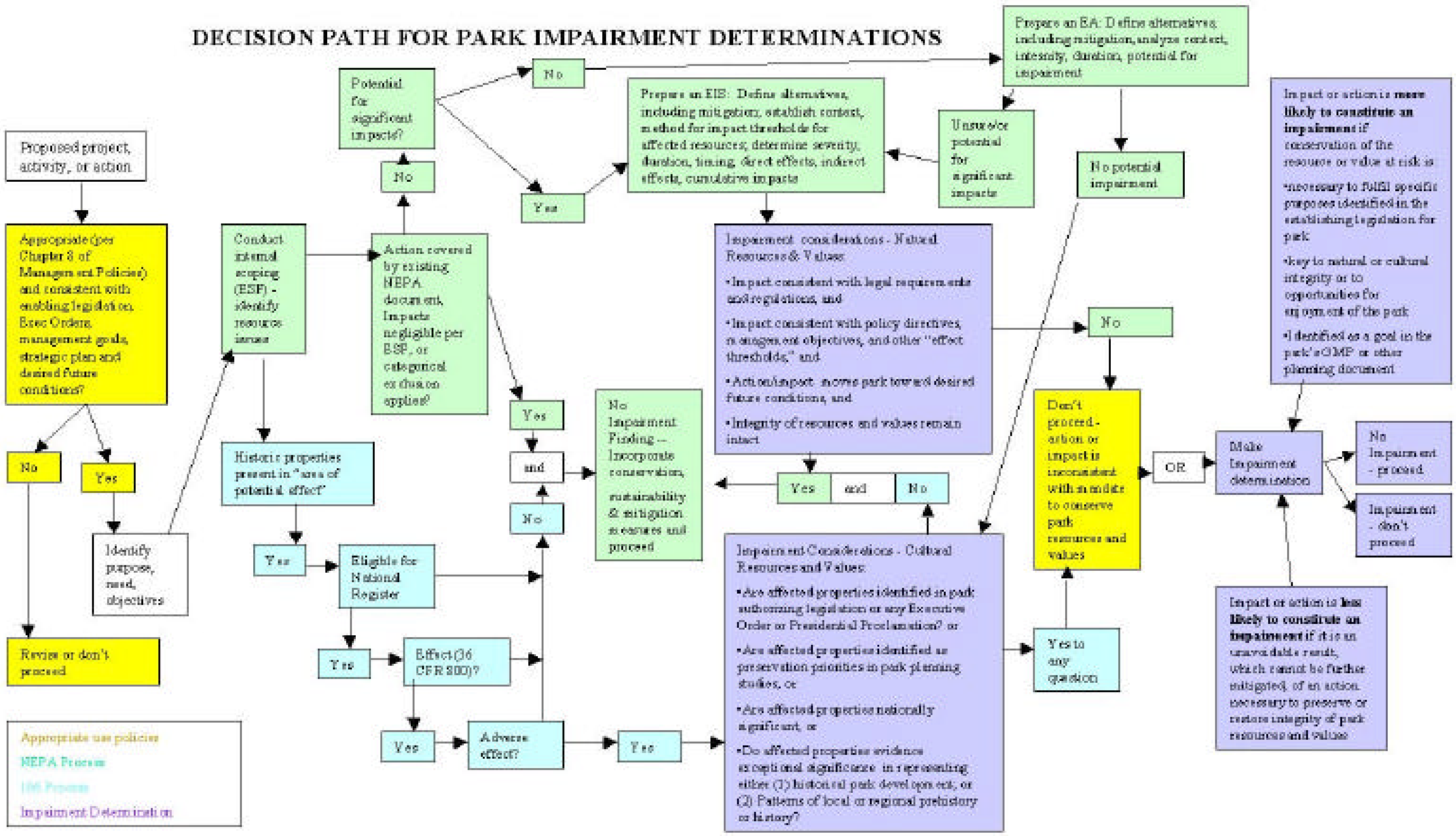

DECISION PATH FOR PARK IMPAIRMENT DETERMINATIONS
Proposed project, activity, or action
Appropriate (per Chapter 8 of Management Policies) and consistent with enabling legislation, Exec Orders, management goals, strategic plan and desired Future conditions?
No
Yes
Review or don't proceed
Identify purpose, need, objectives
Conduct internal scoping (ESF) - identify resource issues
Historic properties present in "area of potential effect"
Yes
Eligible for National Register
Yes
Effect (36 CFR 800)?
Yes
Adverse effect?
Yes
Action covered by existing NEPA document, Impacts negligible per ESF, or categorical exclusion applies?
No
Potential for significant impacts?
No
Yes
Yes
and
No
No Impairment Finding -- Incorporate conservation, sustainability & mitigation measures and proceed
Prepare an EIS: Define alternatives, including mitigation; establish context, method for impact thresholds for affected resources; determine severity, duration, timing, direct effects, indirect effects, cumulative impacts
Prepare an EA: Define alternatives, including mitigation, analyze context, intensity, duration, potential for impairment
Unsure/or potential for significant impacts
No potential impairment
Impairment considerations - Natural Resources & Values:
•Impact consistent with legal requirements and regulations, and
•Impact consistent with policy directives, management objectives, and other "effect thresholds," and
•Action/impact moves park toward desired future conditions, and
•Integrity of resources and values remain intact
No
Yes
and
No
Impairment Considerations - Cultural Resources and Values:
•Are affected properties identified in park authorizing legislation or any Executive Order or Presidential Proclamation? or
•Are affected properties identified as preservation priorities in park planning studies, or
•Are affected properties nationally significant, or
•Do affected properties evidence exceptional significance in representing either (1) historical park development, or (2) Patterns of local or regional prehistory or history?
Yes to any question
Don't proceed - action or impact is inconsistent with mandate to conserve park resources and values
OR
Make Impairment determination
No Impairment - proceed
Impairment - don't proceed
Impact or action is more likely to constitute an impairment if conservation of the resource or value at risk is:
•necessary to fulfil specific purposes identified in the establishing legislation for park
•key to natural or cultural integrity or to opportunities for enjoyment of the park
•Identified as a goal in the park's GMP or other planning document
Impact or action is less likely to constitute an impairment if it is an unavoidable result, which cannot be further mitigated, of an action necessary to preserve or restore integrity of park resources and values
Appropriate use policies
NEPA Process
106 Process
Impairment Determination