Invasive Plant Management Plan
and
Environmental Assessment

National Park Service
U.S. Department of the Interior

Montezuma Castle and Tuzigoot
National Monuments

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Invasive Plant Management Plan

Environmental Assessment

Summary

Non-native, invasive plants are invading our national parks, causing tremendous damage to our resources, thereby threatening the structure, organization, function, and overall integrity of the cultural resources and natural ecosystems we aspire to protect. Controlling invasive species is a serious challenge facing Montezuma Castle and Tuzigoot National Monuments – approximately 85 species of invasive plants occur here. Of these, approximately 25 species are of particular concern because of their aggressive nature and ability to displace intact, native vegetation communities. This Invasive Plan Management Plan and Environmental Assessment outlines alternative invasive plant management strategies that are based on the principles of integrated pest management (IPM) and that use control techniques including some or all of the following: mechanical, cultural, chemical, and biological techniques.

This Environmental Assessment evaluates three alternatives; a No Action Alternative, and two additional action alternatives. The No Action alternative describes the current strategy of using limited mechanical and chemical treatments. Chemical treatments are used only on highly invasive riparian species. The second alternative would use a full range of integrated pest management techniques. The third alternative would not use chemical and biological treatments.

This Environmental Assessment has been prepared in compliance with the National Environmental Policy Act (NEPA) to provide the decision-making framework that 1) analyzes a reasonable range of alternatives to meet objectives of the proposal, 2) evaluates potential issues and impacts to the resources and values of Montezuma Castle and Tuzigoot National Monuments, and 3) identifies mitigation measures to lessen the degree or extent of these impacts. Resource topics that are included in this document because the resultant impacts may be greater-than-minor include: Soils, Vegetation, Wildlife, Special Status Species, Water Resources, Wetlands/Floodplains, Historic Structures, Archeological Resources, and Visitor Use and Experience. All other resource topics have been dismissed because the project would result in negligible or minor effects to those resources. No major effects are anticipated as a result of this project. Public scoping was conducted to assist with the development of this document and comments (all in support of the proposed project) were received.

Public Comment

If you wish to comment on the environmental assessment, you may post comments online at http://parkplanning.nps.gov/ or mail comments to Superintendent, Montezuma Castle National Monument, P.O. Box 219, Camp Verde, Arizona 86322. This environmental assessment will be on public review for 30 days. Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so. We will make all submissions from organizations, businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses available for public inspection in their entirety.

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Introduction

Invasive plants impact National Park lands throughout the country. These invaders compete with native plants for space, light, water, and nutrients. They impact the structure and function of many plant communities, often in a very negative way that reduces habitat quality by impacting forage plants, soils, hydrology, and fire cycles. As NPS land managers we are tasked with the mission to *preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations,* we have developed strategies to address and treat these invasive plants. Montezuma Castle and Tuzigoot National Monuments contain lush riparian forests, a fresh water marsh, important aquatic habitats, and a mix of desert scrubland and grassland. These habitats support abundant wildlife; especially an unusually high density and diversity of birds. These habitats also support threatened, endangered, and special status species. At the same time, the parks have significant infestations of invasive plants that are impacting the rare and diverse natural resources contained within the parks. The goal of this document is to develop a comprehensive invasive plant management plan by analyzing the environmental consequences of the available treatment alternatives and arriving at the best means of addressing this growing problem.

Invasive plant management treatments are analyzed for three park units: Montezuma Castle and Tuzigoot National Monuments, and the Montezuma Well unit of Montezuma Castle. These three units will be abbreviated as MOCA/TUZI throughout this document. These three park units were set aside to protect valuable cultural and natural resources in the Verde Valley. All three currently have substantial populations of invasive plant species. A project location map is included in Figure 1 below. Detailed location maps and invasive species distribution maps are available in Appendix A.

Montezuma Castle

Montezuma Castle is managed to interpret a five-story, 20 room dwelling built by the Sinagua in the early 12th century. The park also incorporates a number of other archeological sites including the remains of a six-story, 45 room pueblo, cavate sites, and other artifacts of the Sinaguan occupation. The Monument was set aside to maintain sustainable cultural and natural landscapes, and to protect and manage the ecological processes related to its mix of desert and riparian habitats. The park contains an ephemeral reach of Beaver Creek.

Montezuma Castle Unit includes portions of sections 8, 9, 16, and 17 of T. 14N., R. 5E. of Gila and Salt River Meridian, in Camp Verde, Arizona. This unit has an area of approximately 576 acres.

Montezuma Well

Montezuma Well, a unit of Montezuma Castle National Monument, is near the town of Lake Montezuma, Arizona. Montezuma Well was added to Montezuma Castle on October 19, 1943 and is managed by the National Park Service. The Well unit protects additional Sinagua and Hohokam sites and the large, spring-fed limestone sink (from which the site receives its name) that has no known parallel anywhere in the world. In addition to its archeological resources, the Well contains three historic 20th Century structures. There are approximately 261 acres within Montezuma Well, including a perennial reach of Wet Beaver Creek. Montezuma Well includes portions of section 36 of T.15N., R.5E. and portions of section 31 of T. 15N. R.6E. of Gila and Salt River Meridian, Arizona.

Tuzigoot

Tuzigoot is an ancient hilltop village or pueblo built by a culture known as the Sinagua. The pueblo consisted of 110 rooms including second and third story structures. The first buildings were built around A.D. 1000. The Sinagua were agriculturalists with trade connections that spanned hundreds of miles. The people left the area around 1400. Adjacent to the pueblo is Tavasci Marsh which covers approximately 83 acres and was acquired by the National Park Service in March, 2006. Tuzigoot National Monument has an administrative area of approximately 388 acres. The monument includes portions of sections 15, 20, 21, and 22 of T. 16N., R. 3E. of Gila and Salt River Meridian, near Cottonwood and Clarkdale, Arizona.

The purpose of this Environmental Assessment is to examine the environmental impacts associated with the proposal to treat invasive plant species and restore native plant communities in Montezuma Castle and Tuzigoot National Monuments, including the Montezuma Well Unit. Treatments may include: mechanical, chemical, cultural, and biological treatments. This Environmental Assessment has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, regulations of the Council on Environmental Quality (CEQ) (40 CFR 1508.9), and the National Park Service Director's Order (DO)-12 (*Conservation Planning, Environmental Impact Analysis, and Decision-making*).

Background

Montezuma Castle and Tuzigoot National Monuments have been inventoried for invasive plant species by the NPS Sonoran Desert Network Inventory and Monitoring network. The *Exotic Plant Management Plan for Montezuma Castle and Tuzigoot National Monuments* was published by Mau-Crimmins et al, 2005 (Appendix A). The *EPMP* includes a wealth of information about invasive species in the monuments including a biological description of many species, distribution maps, and information on the effectiveness of various treatment methods for each species. The *EPMP* does not address the environmental effects of the various treatment methods as is required by the National Environmental Policy Act. Therefore, this document is intended to assess the effects of implementing the EPMP. More than 80 invasive plant species have been identified in the park units, many of which are considered highly invasive and spread rapidly. Since 2005 we have been implementing some of the recommendations in the *EPMP* using Categorical Exclusions in response to NEPA requirements. The projects completed thus far have addressed some of the most highly invasive species threatening riparian areas. However, due to the number of invasive species, the extent of the infestations, and the need to fully implement integrated pest management practices we have developed this environmental assessment to fully address the problem. Ecological restoration methodologies will be implemented to encourage more resistant native plant communities that will require less re-treatment in the future.

Purpose and Need

The purpose of this planning effort is to develop a monument-wide integrated invasive plant management plan for all three park units that is in compliance with National Park Service's *Management Policies* (2006), Director's Order 12 – *Environmental Impact Analysis*, and Director's Order 77-7 - *Integrated Pest Management* which requires that the Service and each park unit use integrated pest management (IPM) to address invasive plant and other pest issues.
The proposed plan is needed to achieve the following:

- Preserve, protect, and restore natural conditions and ecological processes of MOCA/TUZI by eradicating, significantly reducing, or containing infestations of known invasive plants,
- Prevent further introductions of invasive species already present in the monuments, as well as new species introductions, by increasing visitor and staff awareness through education, by identifying mechanisms for cooperation among neighboring agencies and landowners, and by implementation of best management practices,
- Establish decision-making tools and protocols that will guide treatment plan development for routine and project-based invasive plant management activities by park staff, volunteers, and NPS Exotic Plant Management Teams (EPMTs).

Scope of Plan

The scope of this Invasive Plant Management Plan/EA is to develop a long-term management plan that would reduce the impacts of (or threats from) invasive plants to native plant communities and other natural and cultural resources within the authorized boundaries. Although this EA considers impacts within the monuments and adjacent areas that could reasonably be impacted by invasive plant management actions, only the invasive plant management activities occurring within the 1225 acres of the Monuments and that involve NPS resources are within the scope of this document.

This plan is intended to serve as long-term guidance for all invasive plant management activities; therefore, the approach is general enough to address management actions without becoming excessively restrictive. It provides resource managers with multiple treatment options and allows them to select the most appropriate treatment option or combination of treatments included in this Plan/EA to minimize potential impacts and maximize overall management success. It is also flexible enough to allow for future use of treatment actions not currently available, and to address new invasive species that may colonize the park units, provided that the effect remain similar to or less than those described in this document. However, the document is specific enough to guide site and species-specific planning considerations.

Relationship to Other Plans and Policies

The proposal to use the full range of IPM techniques in MOCA/TUZI is consistent with previous planning efforts. The DRAFT General Management Plan includes the following natural resource objectives, which are pertinent to invasive plant management planning:

> *Protect and manage ecological processes and conditions related to the mix of desert and riparian habitats to maintain sustainable cultural and natural landscapes.*

The proposal is consistent with the objectives of the *2006 National Park Service Management Policies* (NPS 2006) section 4.4.4 on the Management of Exotic Species.

Figure 1 – Project Locations

Public Scoping

Scoping is a process to identify the resources that may be affected by a project proposal, and to explore possible alternative ways of achieving the purpose and need while minimizing adverse impacts. Montezuma Castle and Tuzigoot National Monuments conducted both internal scoping with appropriate National Park Service staff and external scoping with the public and interested/affected groups and agencies.

Internal scoping was conducted by an interdisciplinary team of professionals from MOCA/TUZI and the National Park Service Southern Arizona Office. Interdisciplinary team members met on-site October 31, 2006 to discuss the purpose and need for the project; various alternatives; potential environmental impacts; past, present, and reasonably foreseeable projects that may have cumulative effects; and possible mitigation measures. Over the course of the scoping efforts, team members conducted additional site visits to view and evaluate the proposed invasive plant species treatments and the pasture restoration at Montezuma Well.

External scoping was initiated with the distribution of a scoping letter to inform the public of the proposal to treat invasive species at all three park units, and to generate input on the preparation of this Environmental Assessment. The scoping letter dated March 18, 2007 was mailed to 63 addressees including landowners adjacent to the Monuments, various federal and state agencies including the Arizona State Historic Preservation Officer, affiliated Native American tribes, local governments and local news agencies.

During the 30-day scoping period, no public responses were received. More information regarding scoping can be found in *Comments and Coordination*.

Impact Topics Retained for Further Analysis

Impact topics for this project have been identified on the basis of federal laws, regulations, and orders; National Park Service *2006 Management Policies*; and National Park Service knowledge of resources at MOCA/TUZI. Impact topics that are carried forward for further analysis in this Environmental Assessment are those where the proposal is expected to have a measurable effect. For each of these topics, the following text also describes the existing setting or baseline conditions (i.e. affected environment) within the project area. Some impact topics were dismissed from further consideration when the environmental effects were minor or negligible. This information will be used to analyze impacts against the current conditions of the project area in the *Environmental Consequences* chapter.

Soils

According to the National Park Service's *2006 Management Policies*, the National Park Service will preserve and protect geologic resources and features from adverse effects of human activity, while allowing natural processes to continue (NPS 2006). These policies also state that the National Park Service will strive to understand and preserve the soil resources of park units and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources. Mechanical and chemical treatments of invasive species have potential to have a measurable impact the soil resource; therefore this topic will be analyzed further.

Vegetation

According to the National Park Service's *2006 Management Policies*, the National Park Service strives to maintain all components and processes of naturally evolving park unit ecosystems, including the natural abundance, diversity, and ecological integrity of plants *(*NPS 2006*)*. Proposed invasive plant treatments including mechanical and chemical treatments would impact the native plant communities of the parks; therefore this topic will be analyzed further.

Wildlife

According to the National Park Service's *2006 Management Policies*, the National Park Service strives to maintain all components and processes of naturally evolving park unit ecosystems, including the natural abundance, diversity, and ecological integrity of animals *(*NPS 2006*)*. The proposed invasive plant treatments have the potential to affect wildlife or their habitats; therefore, this topic will be analyzed further.

Special Status Species

The Endangered Species Act of 1973 requires examination of impacts on all federally-listed threatened, endangered, and candidate species. Section 7 of the Endangered Species Act requires all federal agencies to consult with the U.S. Fish and Wildlife Service (or designated representative) to ensure that any action authorized, funded, or carried out by the agency does not jeopardize the continued existence of listed species or critical habitats. In addition, the *2006 Management Policies* and Director's Order 77 *Natural Resources Management Guidelines* require the National Park Service to examine the impacts on federal candidate species, as well as state-listed threatened, endangered, candidate, rare, declining, and sensitive species *(*NPS 2006*)*. The U.S. Fish and Wildlife Service was contacted with regards to federally- and state-listed species and there are a number of special status species in the three park units. Informal consultation with the U.S. Fish and Wildlife Service resulted in a *may affect, not likely to adversely affect* threatened and endangered species (Appendix B). We have concluded that this proposal may affect these species or their habitats; therefore, this topic is carried forward for further analysis.

Water Resources

National Park Service policies require protection of water quality consistent with the Clean Water Act. The purpose of the Clean Water Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". To enact this goal, the U.S. Army Corps of Engineers has been charged with evaluating federal actions that result in potential degradation of waters of the United States and issuing permits for actions consistent with the Clean Water Act. The U.S. Environmental Protection Agency also has responsibility for oversight and review of permits and actions, which affect waters of the United States. Chemical and mechanical invasive plant treatments have the potential to impact water quality and this subject will be analyzed in further detail.

Wetlands/Floodplains

For regulatory purposes under the Clean Water Act, the term wetlands means "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

Executive Order 11990 *Protection of Wetlands* requires federal agencies to avoid, where possible, adversely impacting wetlands. Further, Section 404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers to prohibit or regulate, through a permitting process, discharge of dredged or fill material or excavation within waters of the United States. National Park Service policies for wetlands as stated in *2006 Management Policies* and Director's Order 77-1 *Wetlands Protection*, strive to prevent the loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. In accordance with DO 77-1 *Wetlands Protection*, proposed actions that have the potential to adversely impact wetlands must be addressed in a Statement of Findings for wetlands. There will be no adverse impacts to wetlands as described in DO77-1 and no Statement of Findings has been prepared.

Executive Order 11988 *Floodplain Management* requires all federal agencies to avoid construction within the 100-year floodplain unless no other practicable alternative exists. The National Park Service under *2006 Management Policies* and Director's Order 77-2 *Floodplain Management* will strive to preserve floodplain values and minimize hazardous floodplain conditions. According to Director's Order 77-2

Floodplain Management, certain construction within a 100-year floodplain requires preparation of a Statement of Findings for floodplains. There will be no net loss of floodplains and no construction in these areas. Therefore a Statement of Findings for floodplains will not be prepared.

Mechanical, chemical and cultural treatments are proposed for wetlands and floodplains, and this impact topic has been analyzed in detail.

Historic Structures

The term "historic structures" refers to both historic and prehistoric structures, which are defined as constructions that shelter any form of human habitation or activity. The project area contains several historic and prehistoric structures that are eligible for the National Register of Historic Places. For the purpose of this EA, only structures containing standing architecture will be discussed in this section while ephemeral prehistoric sites will be addressed below under archaeological resources. Mechanical and chemical treatments are proposed in the vicinity of historic structures, therefore this topic will be analyzed further.

Archeological Resources

Section 106 of the National Historic Preservation Act, as amended in 1992 (16 USC 470 *et seq.*); the National Park Service's Director's Order 28 *Cultural Resource Management Guideline*; and National Park Service *2006 Management Policies* (NPS 2006) require the consideration of impacts on historic properties that are listed, or eligible to be listed, in the National Register of Historic Places. The National Register is the nation's inventory of historic places and the national repository of documentation on property types and their significance. The above-mentioned policies and regulations require federal agencies to coordinate consultation with State Historic Preservation Officers regarding the potential effects to properties listed on or eligible for the National Register of Historic Places.

The National Park Service, as steward of many of America's most important cultural resources, is charged to preserve historic properties for the enjoyment of present and future generations. Management decisions and activities throughout the National Park System must reflect awareness of the irreplaceable nature of these resources. The National Park Service will protect and manage cultural resources in its custody through effective research, planning, and stewardship and in accordance with the policies and principles contained in the *2006 Management Policies* and the appropriate Director's Orders. Proposed mechanical, cultural and chemical invasive plant treatments have the potential to impact archeological resources; therefore this topic will be analyzed further.

Visitor Use and Experience

According to *2006 Management Policies*, the enjoyment of park resources and values by people is part of the fundamental purpose of all park units (NPS 2006). The National Park Service is committed to providing appropriate, high quality opportunities for visitors to enjoy the parks, and will maintain within the parks an atmosphere that is open, inviting, and accessible to every segment of society. Further, the National Park Service will provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the superlative natural and cultural resources found in the parks. The National Park Service *2006 Management Policies* also state that scenic views and visual resources are considered highly valued associated characteristics that the National Park Service should strive to protect *(*NPS 2006*)*. This proposal could result in an impact to visitor use and experience; therefore this topic will be analyzed in detail.

Impact Topics Dismissed From Further Analysis

Some impact topics have been dismissed from further consideration, as listed below. The rationale for dismissing these specific topics is stated for each resource.

Park Operations

The proposed action would not significantly change overall park operations. The proposed action would enable the park to more effectively manage invasive plant populations and implement restoration of disturbed areas. The proposed action would involve relatively few staff members for short periods of time and would not measurably change overall park operations. This topic was not further analyzed in this document.

Paleontological Resources

According to *2006 Management Policies*, paleontological resources (fossils), including both organic and mineralized remains in body or trace form, will be protected, preserved, and managed for public education, interpretation, and scientific research *(*NPS 2006*)*. Montezuma Castle contains paleontological resources, in the form fossilized tracks, located at the Castle Unit in an area that is not significantly impacted by invasive plant species. Any treatment in this area would not include ground disturbing mechanical treatment. Therefore, there are no impacts to paleontological resources as a result of this proposal and they will be dismissed from further assessment.

Ethnographic Resources

Per the National Park Service's Director's Order 28 *Cultural Resource Management*, ethnographic resources are defined as any site, structure, object, landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it. According to DO-28 and Executive Order 13007 on sacred sites, the National Park Service should try to preserve and protect ethnographic resources.

Ethnographic resources are not known to exist in the proposed project area based on the lack of cultural materials present. In addition, Native American tribes traditionally associated the Monument were apprised of the proposed project in a letter dated March 18, 2007, and no responses were received from these tribes. Although no formal ethnographic survey has been conducted in the park, informal consultation with the tribes suggests there are no ethnographic resources in the parks. Therefore, this topic has been dismissed from further consideration.

Cultural Landscapes

According to the National Park Service's Director's Order 28 *Cultural Resource Management Guideline*, a cultural landscape is a reflection of human adaptation and use of natural resources, and is often expressed in the way land is organized and divided, patterns of settlement, land use, systems of circulation, and the types of structures that are built. Although a formal cultural landscape inventory has not been conducted for the Monuments, all activities will be conducted in such a manner as to avoid impacting currently unknown cultural landscapes. As the project proposes to restore the physical landscape to a native floral assemblage, it can be safely assumed that the project can only improve upon any unknown cultural landscapes. Therefore, this topic has been dismissed from further consideration.

Museum Collections

According to Director's Order 24 *Museum Collections,* the National Park Service requires the consideration of impacts on museum collections (historic artifacts, natural specimens, and archival and manuscript material), and provides further policy guidance, standards, and requirements for preserving, protecting, documenting, and providing access to, and use of, National Park Service museum collections. Museum collections would not be impacted by this proposal and the topic of museum collections has been dismissed from further consideration.

Air Quality

The Clean Air Act of 1963 (42 U.S.C. 7401 *et seq.*) was established to promote the public health and welfare by protecting and enhancing the nation's air quality. The act establishes specific programs that provide special protection for air resources and air quality related values associated with National Park Service units. Section 118 of the Clean Air Act requires a park unit to meet all federal, state, and local air pollution standards. MOCA/TUZI are designated as a Class II air quality areas under the Clean Air Act. A Class II designation indicates the maximum allowable increase in concentrations of pollutants over baseline concentrations of sulfur dioxide and particulate matter as specified in Section 163 of the Clean Air Act. Further, the Clean Air Act provides that the federal land manager has an affirmative responsibility to protect air quality related values (including visibility, plants, animals, soils, water quality, cultural resources, and visitor health) from adverse pollution impacts (EPA 2000).

There is the potential to cause minor, short-term impacts to air quality if mechanical methods of invasive plant treatments and restoration techniques are implemented, such as dust from tillage or exhaust from chainsaw operation. No long-term adverse impacts to air quality related values would occur from implementing this project. Therefore, air quality was dismissed as an impact topic from this environmental assessment.

Soundscape Management

In accordance with *2006 Management Policies* and Director's Order 47 *Sound Preservation and Noise Management*, an important component of the National Park Service's mission is the preservation of natural soundscapes associated with national park units *(*NPS 2006*)*. Natural soundscapes exist in the absence of human-caused sound. The natural ambient soundscape is the aggregate of all the natural sounds that occur in park units, 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 frequencies, magnitudes, and durations of human-caused sound considered acceptable varies among National Park Service units as well as potentially throughout each park unit, being generally greater in developed areas and less in undeveloped areas.

Impacts to the soundscape could occur from the implementation of invasive species treatments from the operation of chainsaws, tractors, ATV's or other mechanized equipment. These impacts are predicted to be minor and short-term, limited to the time of treatments. Therefore, the topic of soundscape management was dismissed as an impact topic.

Lightscape Management

In accordance with *2006 Management Policies*, the National Park Service strives to preserve natural ambient landscapes, which are natural resources and values that exist in the absence of human caused light *(*NPS 2006*)*. MOCA/TUZI strives to limit the use of artificial outdoor lighting to that which is necessary for basic safety requirements. There would be no impacts to lightscape management and this topic has been dismissed from further analysis.

Socioeconomics

The proposed action would neither change local and regional land use nor appreciably impact local businesses or other agencies. Implementation of the proposed action could provide a negligible impact to the economies of nearby Lake Montezuma, Rimrock, Camp Verde, Clarkdale and Cottonwood, Arizona. There could be minimal increases in employment opportunities and revenue generated from this project. Any increase in workforce and revenue would be temporary and negligible. Because the impacts to the socioeconomic environment would be negligible, this topic has been dismissed.

Prime and Unique Farmlands

The Farmland Protection Policy Act of 1981, as amended, requires federal agencies to consider adverse effects to prime and unique farmlands that would result in the conversion of these lands to non-agricultural uses. Prime or unique farmland is classified by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), and is defined as soil that particularly produces general crops such as common foods, forage, fiber, and oil seed; unique farmland produces specialty crops such as fruits, vegetables, and nuts. There are no prime and unique farmlands designated in the parks and this topic has been dismissed.

Indian Trust Resources

Secretarial Order 3175 requires that any anticipated impacts to Indian trust resources from a proposed project or action by the Department of Interior agencies be explicitly addressed in environmental documents. The federal Indian trust responsibility is a legally enforceable fiduciary obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal law with respect to American Indian and Alaska Native tribes.

There are no Indian trust resources at MOCA/TUZI. The lands comprising the Monuments are not held in trust by the Secretary of the Interior for the benefit of Indians due to their status as Indians. Therefore, the project would have negligible effects on Indian trust resources, and this topic was dismissed as an impact topic.

Environmental Justice

Executive Order 12898 *General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. The proposed action would not have disproportionate health or environmental effects on minorities or low-income populations or communities. Therefore, environmental justice has been dismissed as an impact topic in this document.

INVASIVE PLANT MANAGEMENT PLAN AND ALTERNATIVES

Invasive Plant Management Plan

The alternatives (p20) were designed to implement NPS Director's Order 77-7 - Integrated Pest Management, from which the 10 Invasive Plant Management steps outlined below were developed. These policies mandate the use of an integrated approach to pest management that includes: prevention, education, inventory, monitoring, tracking management, prioritization, cooperation, appropriate treatments, develop work plans, and restoration. Implementing the 10 steps of the plan would have negligible environmental affects, except for Step 8 - Identify the control techniques most appropriate for each species; and Step 10 - Restoration. Therefore, the control techniques or treatment methods form the basis for the development of three alternatives and the environmental effects of implementation of different treatment methods are analyzed.

All alternatives would use an adaptive management approach to invasive plant management. The adaptive, integrated approach is defined as a system for the planning and implementation of a program, using an interdisciplinary approach, to select a method for containing or controlling an undesirable plant species or groups of species using all available methods including education, prevention, physical or mechanical methods, biological control agents, herbicide methods, cultural methods, and general land management. However, the ability to use the adaptive, integrated approach is limited under Alternatives I and III as not all possible treatments are available for use.

Infestations of invasive plants that may become established but which are not currently identified on the species list or known to occur in the parks would be treated, provided the effects of the treatment are similar to, or less than, those defined for the selected alternative. This analysis proposes to treat all species considered invasive within the monuments, both native and non-native. There are some native species that have become invasive on heavily disturbed areas. Such species include silverleaf nightshade and carelessweed. Examples of heavily disturbed areas include the pasture at Montezuma Well and Tavasci Marsh at Tuzigoot that were farmed in the past. If prescribed management fails to result in the desired outcome, alternative strategies will be developed, and management will be adapted until the desired conditions are achieved. New alternative strategies will be reviewed on a site-specific and case-by-case basis. If it is demonstrated through analysis that the environmental impacts of a new approach fall outside the impacts as disclosed in this document, then additional environmental and cultural analysis would be undertaken under NEPA and §106 of the National Historic Preservation Act.

The 10 Steps for Invasive Plant Management outlined below were developed from information contained in the *Exotic Plant Management Plan for Montezuma Castle and Tuzigoot National Monuments* found in Appendix A (Mau-Crimmins et al 2005), hereafter described as the *EPMP*. The *EPMP contains a* more detailed description of these actions, as well as information on the biology of invasive species, distribution maps, and a description of effective treatments for each species. However, the *EPMP* did not follow the NPS Director's Order 77-7 for implementing integrated pest management, and did not assess the environmental impacts of implementing treatments and restoration as required by NEPA. This document analyzes the environmental effects of implementing the treatment strategies outlined in the *EPMP* as well as other appropriate integrated pest management practices. Dinosaur National Monument *Invasive Plant Management Plan and Environmental Assessment* (NPS 2005) has been used extensively in the development of this environmental assessment.

Invasive Plant Management 10 Steps:

1. Prevent new infestations by employing prevention and early detection techniques

The most effective, economical, and ecologically sound approach to managing invasive species with zero risk to resources of value is to prevent their invasion in the first place. Often, managers direct limited resources to fighting firmly established infestations because, by that stage, management is expensive and eradication is likely impossible. While it is desirable to manage infestations on order to limit the spread of invasive plants into non-infested areas, limited resources might be spent more efficiently on proactive invasive plant management that both contains existing invasive plant infestations and focuses strongly on prevention or early detection of new invasions.

In this plan, MOCA/TUZI seeks to adopt a set of invasive plant prevention guidelines. These are practical and proactive techniques designed to prevent invasion and permanent establishment of invasive plants during the course of daily or routine activities and operations. They include:

- Incorporating invasive plant prevention and control into project planning.
- Avoiding or removing sources of introduction and spread of invasive plant seed and propagules to prevent new invasive plant infestations and the spread of existing invasives.
- Avoiding the creation of environmental conditions that promote invasive plant germination and establishment.
- Re-establishing native vegetation to prevent conditions conducive to establishment of invasive plants when project disturbances create bare ground.
- Improving the effectiveness of prevention practices through invasive plant awareness and education.

Early detection of invading plants minimizes spread, enhances opportunities for eradication, and is most effectively done at the local level by land managers and landowners. Early detection of invasive plants is a vital sign of the Sonoran Desert Inventory and Monitoring Network (SODN) (http://www.nature.nps.gov/im/units/sodn/conceptualmodels/fr-index.html). MOCA/TUZI will work with SODN to monitor the detection and spread of invasive species. The *EPMP* identified a number of management zones for each park unit defined as geographic areas with similar invasive species and/or similar treatment or monitoring needs. These areas are a high priority for monitoring and include:

Montezuma Castle
Entrance Road
Riparian Corridor
Mesa above Ruins
Montezuma Well
Within the Well
Agricultural Field (pasture)
Residential Housing Area
Riparian Corridor
Tuzigoot
Around the Ruins
Park Uplands
Housing Area
Along the Roads North of Housing
Near the Visitor Center
Expansion Lands Including Tavasci Marsh

2. Educate visitors and staff about invasive plants and their management in

There are several programs already in place that make connections with the public regarding invasive species. There is an annual volunteer work day with Walmart and Unilever that includes invasive plant pulling as an activity. The last two years there have been a number of small volunteer groups that have pulled horehound and sown native grass seed in the Montezuma Well pasture area.

MOCA/TUZI will increase efforts to inform the public and staff about invasive plants and the monument's strategy for managing them. Some ideas for expanding awareness among visitors and staff presented in the *EPMP* include:

- Visitor center displays and brochures on invasive species and their management within the monuments.
- Partnering with neighboring agencies and organizations in regional educational awareness efforts.
- Developing an invasive species webpage within the Montezuma Castle and Tuzigoot National Monuments website that will provide current information on the activities of the monuments, regional news, and technical information on management.
- Initiate staff project days where monument staff can learn about a particular invasive plant problem in the park and then participate in a short work project focusing on a particular goal or species, such as improving rare plant habitat or eradicating a new invader.
- Hold informal annual meetings with interdisciplinary staff members and adjacent landowners who may be potentially impacted by invasive plant management activities to give updates, discuss effectiveness of treatment techniques, and inform them of upcoming annual work plan.
- Distributing press releases to the local media concerning invasive plant control activities, dates, locations, and treatment methods.

3. Inventory of Invasive Plants in Montezuma Castle and Tuzigoot National Monuments

Work by Halvorson and Guertin (2003) and Mau-Crimmins et al (2005) have provided the park units with a fairly complete list of invasive species present at the time of the surveys. Halvorson and Guertin (2003) conducted a preliminary assessment of the extent of 50 nonnative species in the monuments. In 2003 a more comprehensive survey was initiated through the cooperation of the Cooperative Ecosystem Studies Unit, Sonoran Desert Inventory and Monitoring Network, and the University of Arizona that mapped the spatial location, distribution, and abundance of target nonnative plant species at all three park units. Field work was conducted in 2003 and 2004 and the results were reported in the *Exotic Plant Management Plan*. The *EPMP* includes a full list of species that were inventoried (Appendix A). Invasive species that are known to be present in the monuments and may be treated as part of this analysis are listed below. Please note that some are 'native' species that are considered invasive plants due to the invasive nature in agricultural settings. This analysis is intended to be dynamic and to treat invasive species that are not known to exist in the park units at this time, but may invade in the future. NPS park staff are working together with SODN staff on protocols to track the status and trends of invasive species within the parks, as well as on the early detection of invasive species (http://www.nature.nps.gov/im/units/sodn/conceptualmodels/fr-index.html). Table 1 is a list of invasive plant species adapted from the EPMP. Species shown in bold type are highly invasive species that are well established within at least one of the park units and are a priority for treatment.

Table 1: Inventory of Invasive Plants

Scientific Name	Common Name	Arizona Status
Acroptilon repens (L.) DC.	Hardheads	1, 2
Aegilops cylindrica Host	Jointed goatgrass	1, 2
Ailanthus altissima (P. Mill.) Swingle	tree of heaven	
Amaranthus blitoides S. Wats.	Mat amaranth	
Amaranthus palmeri S. Wats.	Carelessweed	Native*
Avena fatua L.	wild oat	
Avena sativa L.	common oat	
Boerhavia coccinea P. Mill.	Scarlet spiderling	Native*
Brassica tournefortii Gouan	Sahara mustard	
Bromus catharticus Vahl	rescuegrass	
Bromus diandrus Roth	ripgut brome	
Bromus hordeaceus L.	soft brome	
Bromus inermis Leyss.	Smooth brome	
Bromus rigidus Roth	ripgut brome	

Scientific Name	Common Name	Arizona Status
Bromus rubens L.	red brome	
Bromus tectorum L.	cheatgrass	
Capsella bursa-pastoris (L.)Medik	Shepherd's purse	
Centaurea melitensis L.	Malta star-thistle	
Centaurea solstitialis L	yellow star-thistle	1, 2
Chenopodium murale L.	nettleleaf goosefoot	
Chlorispora tenella (Pallas) DC.	Crossflower	
Cichorium intybus L.	chicory	
Cirsium vulgare (Savi)Ten.	bull thistle	
Convovulus arvensis L.	field bindweed	
Cynodon dactylon (L.) Pers.	Bermuda grass	
Cyperus esculentus L.	chufa flatsedge	
Descurainia sophia (L.) Webb ex Prantl Herb	Sophia	
Digitaria sanguinalis (L.) Scop.	Hairy crabgrass	Native*
Echinochloa colona (L.) Link	jungle rice	
Echinochloa crus-galli (L.) Beauv.	Barnyard grass	
Elaeagnus angustifolia L.	Russian olive	
Eragrostis cilianensis (All.) Vign. Ex Janchen	stinkgrass	
Eragrostis curvula (Schrad.) Nees	weeping lovegrass	
Eragrostis lehmanniana Nees	Lehmann lovegrass	
Erodium cicutarium (L.) L'Hér. Ex Ait.	Redstem stork's bill	
Hordeum spp. L.	Barley	**
Ipomoea coccinea L.	redstar	
Ipomoea hederacea Jacq.	ivyleaf morning-glory	1
Kochia scoparia (L.) Schrad.	Mexican-fireweed plant	
Lactuca saligna L.	willowleaf lettuce	
Lactuca serriola L.	prickly lettuce	
Lamium amplexicaule L.	henbit deadnettle	
Linaria dalmatica (L.) P. Mill	Dalmatian toadflax	1, 2
Lolium arundinaceum (Schreb.)S.J.	tall fescue	
Lolium pratense L.	meadow ryegrass	
Lotus corniculatus L.	birdfoot deervetch	
Malus pumila P. Mill.	Paradise apple	
Malva neglecta Wallr.	Common mallow	
Malva parviflora L.	cheeseweed mallow	
Marrubium vulgare L.	horehound	
Matthiola longipetala (Vent.)DC.	Night scented stock	
Medicago sp.	Burclover	1, 3 **
Melilotus officinalis (L.) Lam.	Yellow sweetclover	
Melilotus indicus (L.) All.	White sweetclover	
Mentha spicata L.	spearmint	
Paspalum dilatatum Poir.	Dallisgrass	
Pennisetum glaucum (L.)R.Br.	Pearl millet	
Phalaris aquatica L.	bulbous canarygrass	
Plantago lanceolata L.	narrowleaf plantain	
Polygonum aviculare L.	prostrate knotweed	
Polypogon monspeliensis (L.) Desf.	Annual rabbitsfoot grass	
Polypogon viridis (Gouan) Breistr.	Beardless rabbitfoot grass	
Rubus discolor Weihe &Nees	Himalayan blackberry	
Rumex crispus L.	curly dock	
Salsola kali L.	Russian thistle	

Scientific Name	Common Name	Arizona Status
Salsola tragus L.	prickly Russian thistle	
Schismus arabicus Nees	Arabian schismus	
Schismus barbatus (Loefl. ex L.) Thellung	Mediterranean grass	
Setaria viridus (L.) Beauv.	Green bristlegrass	
Sida abutifolia P. Mill.	Spreading fanpetals	
Sisymbrium altissimum L.	tall tumblemustard	
Sisymbrium irio L.	London rocket	
Solanum elaeagnifolium Cav.	Silverleaf nightshade	Native*
Sonchus asper (L.) Hill	spiny sowthistle	
Sorghum halepense (L.) Pers.	Johnson grass	
***Tamarix* spp.**	tamarisk	**
Taraxacum laevigatum (Willd.)D.C.	rock dandelion	
Taraxacum officinale G.H.Weber ex Wiggers	common dandelion	
Taraxacum palustre (Lyons)Symons	marsh dandelion	
Tragapogon dubius Scop.	Yellow salsify	
Tribulus terrestris L.	Puncturevine	1, 3
Trifolium repens L.	white clover	
Verbascum thapsus L.	common mullein	
Vinca major L.	bigleaf periwinkle	
Xanthium strumarium L.	rough cocklebur	Native*

* Native to U.S. according to http://plants.usda.gov
1 Prohibited noxious invasive plant (Arizona Department of Agriculture 2003)
2 Restricted noxious invasive plant (Arizona Department of Agriculture 2003)
3 Regulated noxious invasive plant (Arizona Department of Agriculture 2003)
** Several related species

4. Monitor effectiveness of control efforts

Monitoring is the repeated collection and analysis of information to evaluate progress and effectiveness in meeting resource management objectives, and is an essential part of an integrated invasive plant program. Based on inventory and ranking criteria, a good monitoring program saves time and money by telling managers which control techniques are working and which ones are not. Monitoring programs can range from simple, such as taking photo points, to more complex plot and transect data collection. All are ongoing processes that will detect useful trends with each year of repetition. Without monitoring, there is no way of knowing whether control efforts are contributing to fulfillment of desired management objectives (CNAP 2000).

A number of NPS entities and other agencies are currently researching and developing invasive species treatment effectiveness monitoring protocols that may be used by MOCA/TUZI to monitor treatments. The NPS entities include the Sonoran Desert Network (SODN), and Lake Meade/Petrified Forest Exotic Plant Management Teams; in addition to a number of other parks, EPMT's, and I&M networks. These monitoring protocols will likely include techniques such as photo points, transects, and/or plots. Minimum monitoring standards will be established for consistency and comparability of results across SODN parks. Data generated from park monitoring programs will be entered into a monitoring module in the SODN invasive species management database that is currently under development and is described in Proposed Action #5.

5. Track invasive plant management efforts

Invasive plant management efforts will be tracked at the park. If work is conducted by an NPS EPMT, they will be responsible for the collection and reporting of this information as part of their reporting process. EPMTs will share that data with the park for reporting in the Pesticide Use Proposal System,

GPRA reporting, and for inclusion in the park natural resource GIS database. Treatment data will also be shared with SODN and archived in their databases.

6. Prioritize both invasive plant species and locations to be controlled

Because it is impossible to control every invasive species, it makes sense to focus management efforts on those species that have, or could have, the greatest impact to the monuments resources or to neighboring agro/economic activities. Prioritizing management activities by both species and location will help guide the most efficient use of resources (specifically staff time and budget) according to predetermined invasive plant management objectives. Species that are not likely to pose a large threat to resources may be treated with volunteer labor, when available.

State or Federal government agencies may list any plant that is deemed an economic threat, an environmental threat, or a threat to public health as "noxious". Arizona has a State Noxious Invasive Plant List (R3-4-244 and R3-4-245) (www.azda.gov/PSD/quarantine5.htm). Arizona is also under the jurisdiction of the federal noxious invasive plant list http://www.aphis.usda.gov/ppq/invasive plants. (source = http://www.azdot.gov/Highways/NResources/Priority_Weeds.asp).

The NPS Southern Arizona Office is working with SODN and the 11 SODN network parks to review and compile priorities for the network's goals for future inventory, control, and monitoring needs. The end result will be a list, with supporting documentation, of priority species, as well as a "watch list" for all southern Arizona parks.

The Alien Plant Ranking System v 7.1 (APRS Implementation Team 2001) was applied to the invasive species of MOCA/TUZI to determine and rank priority treatment species as part of the development of the *Exotic Plant Management Plan* (Appendix A). The *EPMP* contains species abstracts in an appendix for APRS target species at the monuments that includes species specific information including description, geographic distribution, reproductive and vegetative biology, ecological distribution, invasive plant status, microbial pathogens, insect pathogens, herbicide control and other control methods; as well as an extensive list of cited literature. Current priorities are to treat highly invasive plant species threatening valuable riparian habitats.

7. Work with adjacent landowners, local, state and federal agencies, local interest groups, invasive plant cooperative networks, and others to develop and achieve common goals of invasive plant management

The spread of invasive plants throughout Arizona poses a serious environmental and economic threat to public land, ranchland, farmland and private property in Yavapai County. Because the success of an invasive plant management program is, in part, dependent on the actions of one's neighbors, MOCA/TUZI natural resource staff are in the process of building partnerships with other federal, state and local government agencies, non-profit organizations, and private landowners to develop joint strategies for curbing this threat.

The following agencies, organizations, and landowners are potential partners that have expressed interest in working with MOCA/TUZI on invasive species management:

- Arizona State Parks
  Dead Horse Ranch State Park
  Verde Valley Greenway
- US Forest Service
  Coconino National Forest
  Prescott National Forest
- Yavapai County Extension Service
- US Fish and Wildlife Service
- Arizona Department of Transportation
- Verde Natural Resource Conservation District

- Friends of Montezuma Well
- Other volunteer groups such as WalMart and Unilever

Potential projects for these partnerships include:

- Treatment of invasive species at Tuzigoot NM and Tavasci Marsh conducted in cooperation with Dead Horse Ranch State Park and Verde River Greenway.
- Friends of Montezuma Well assisting in invasive species treatments and restoration projects at Montezuma Well.
- Formation of a cooperative invasive plant treatment group to treat highly invasive species along the Verde River.

MOCA/TUZI has been, and will continue to, participate in invasive plant management meetings, discussions and treatments with other agencies and groups, and remains committed to pursuing new partnerships with interested entities to manage invasive plants cooperatively in the Verde Valley.

8. Identify control techniques most appropriate for each species

Using the NEPA process and the *Exotic Plant Management Plan*, control techniques will be selected that achieve maximum effectiveness in control while minimizing risks to humans and natural and cultural resources. The selected control actions should be effective at killing invasive plants or managing infestations at an acceptable threshold level. The existing *EPMP* describes a number of species specific management treatments that have been found to be the most effective for the biology and growth characteristics of those species. The treatments fall into five basic categories: mechanical, cultural, chemical, biological, and prevention. Each category is described below and provides the definitions for impact analysis in the Environmental Consequences Chapter.

A. Mechanical Control

Mechanical techniques for control of invasive plants in MOCA/TUZI include mowing, cutting/sawing, digging, pulling, spudding (severing of roots below the root crown), discing/plowing and smothering. Mechanical techniques can be especially effective in preventing seed production in annual and biennial forbs and in exhausting root reserves in perennial plants (Meunscher 1980). Timing of these controls can be extremely important in determining outcome.

Mechanical control of some species such as annual forbs such Sahara mustard (*Brassica tourefourtii*) has proven to be very effective. For perennial plants that reproduce vegetatively from root parts, mechanical treatments are generally not expected to provide complete control, even when repeated. Most often, they can be used as a tool for stressing the plants to make other treatments more effective (Derscheid et al. 1961, Renz and DiTomaso 1998).

B. Cultural Control

Cultural controls consist of actions that managers can take to indirectly impact invasive plant populations. They can often be very cost-effective and therefore useful on large scales. Proposed treatments that have been shown to be effective on invasive plants in other areas include: prescribed fire, livestock grazing, implementation of Best Management Practices, and restoration/revegetation.

Prescribed burning consists of planning, setting, and managing fire to accomplish resource management objectives (CNAP 2000). Fire is necessary to prompt germination of some plants, but it can also reduce the abundance of some species. The most successful uses of fire for invasive species control result from burns that try to mimic or restore historical (natural) fire regimes, which have been disrupted by land use changes, suppression practices, fire breaks, or development (Tu et al. 2001). Prescribed burns would be applied only after developing site specific burn plans in cooperation with Saguaro National Park Fire Management Staff and additional consultation with the US Fish and Wildlife Service.

Some studies have shown success using domestic livestock to selectively overgraze certain invasive plant species to prevent seed set or weaken plant structure. There are no plans to use livestock grazing at MOCA/TUZI as an invasive species treatment at this time.

Restoration can be defined as the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER 2002). In the context of this EA, damage or degradation refers to the presence of invasive plants, while the establishment of desirable native vegetation is the recovery that we are trying to assist. Assisting the establishment of desirable vegetation through revegetation practices contributes to the larger goal of restoration as well as the goal of invasive plant management (Jacobs et al. 1998). The establishment of a diverse community of desirable vegetation can prevent invasive plant encroachment by utilizing all, or most, available resource niches (Sheley et al. 1996). Revegetation practices include seedbed preparation, broadcast seeding, drill seeding, container planting and sprigging live branches (Roundy 1996). Following successful treatment of invasive species, restoration practices may be implemented. The pasture at Montezuma Well is an example where extensive restoration is planned under Alternative II.

C. Chemical Control

Chemical control in this document refers to the use of herbicides to kill or injure target plants, as well as chemicals applied along with herbicides that improve their efficacy (adjuvants). Chemical treatments include the use of a number of recommended herbicides including both pre- and post-emergent herbicides. Herbicides that are most commonly recommended for use in the *Exotic Plant Management Plan* are outlined below. Additional information on the impacts of these herbicides is in detailed in the EPMP. Other herbicides may be used, including known herbicides found to be effective on additional specie and herbicides that may be developed in the future, provided that their effects are equal to or less than those described in this document. For example, a recently developed herbicide not available in 2005 when the *Exotic Plant Management Plan* was written is aminopyralid (Milestone™) is currently recommended as effective on a number of broadleaf species. Other herbicides that will be considered for use are the relatively new 'smart herbicides' such as Habitat™ that provide 'intelligent', long-term vegetation control by affecting enzymes found only in plants – not in birds, mammals, fish, insects or humans. Habitat™ breaks down quickly in water, allowing desirable vegetation to germinate and repopulate a treated site. Because it is considered a low volume herbicide, it provides more control with less chemical load on the environment, compared to other herbicides. Some techniques used for mechanical, cultural, and chemical applications involve the use of motorized vehicles, such as ATV's.

Table 2: Herbicides

Herbicides	Trade Name
glyphosate	RoundUp™ or Rodeo™
2,4-D	Invasive Plantone™, Aqua-Kleen™
clopyralid	Transline™
dicambia	Clarity™, Banvel™
imazapic	Plateau™, Cadre™
imazapyr	Habitat™
triclopyr	Garlon 3A or 4™, Access™

D. Biological Control

Biological control can be defined as the deliberate introduction or manipulation of a invasive's natural enemies (such as insects and pathogens) with the goal of suppressing the invasive population (Wilson and Huffaker 1976). The theoretical framework for the use of biological controls is based on the hypothesis that the success of many non-native invasive plants is the result of their release from predators or pathogens found in their native range when introduced in a new range (Cronk and Fuller 1995). By introducing predators or pathogens, usually from the invasive plants' native range, their success can be curbed, allowing native plants to compete on

more equal terms. Bio-control agents are not capable of completely eradicating a invasive plant population, because as the number of host plants declines, so does the population of bio-control agents. However, bio-control can be a useful tool in reducing the initial size or density of an invasive plant infestation, making other treatments more efficacious.

The *Exotic Plant Management Plan* reviewed the literature for information on insect and microbial pathogens for a number of invasive species known to occur in the park units. The results of this review indicated that biological controls for invasive species at MOCA/TUZI are very limited, with unknown or low effectiveness. If biological controls are selected for invasive plant treatments, only biological control agents approved by the USDA Animal and Plant Health Inspection Service (APHIS) would be considered for use. Additional consultation with US Fish and Wildlife Service would be conducted prior to the release of biological control agents to ensure there are no unintended impacts to non-target species.

E. Prevention

IPM also includes actions that don't directly impact invasive plant populations and don't require environmental analysis (and thus are not analyzed in the impact analysis in the Environmental Effects Chapter), but are nevertheless an integral part of a successful invasive plant management plan. These actions include prevention and early detection of invasive plant introductions and spread, inventory, monitoring, and education.

Prevention is generally agreed to be the most effective and economic form of invasive plant management (Sheley et al. 1999). There are countless ways of preventing invasive plant introductions, such as minimizing unnecessary soil disturbance, containing neighboring invasive plant infestations, establishing and properly maintaining desirable vegetation, using only barren fill and gravel in park construction and maintenance activities, cleaning park vehicles and equipment after working in an infested area, and landscaping only with non-invasive native plants (Mau-Crimmins et al 2005).

General prevention measures such as these are also known as Best Management Practices and are outlined in Proposed Management Action 1. Proposed education, inventory, and monitoring efforts for MOCA/TUZI are also addressed in Proposed Actions 2, 3, and 4, respectively.

Evaluation of Control Techniques

Control techniques will be evaluated based on the following attributes:

A. The control technique poses little to no risk to native vegetation, wetlands, wildlife, or other natural resources.

MOCA/TUZI will continue to make a good faith effort and use extreme care in evaluating treatment options and ensuring all environmental compliance standards are met, especially in protecting water quality and aquatic resources. MOCA/TUZI will continue to review new relevant scientific literature, references, and support research to ensure a control technique is biologically sound. Examples of work in MOCA/TUZI to prevent/reduce risks to natural resources include active cooperation with NPS professional Exotic Plant Management Teams from Petrified Forest NP and Lake Meade NRA, and frequent consultations with NPS Integrated Pest Management staff.

MOCA/TUZI has adopted an Herbicide Spill Prevention/Containment Plan as part of our ongoing informal consultation with the US Fish and Wildlife Service (Appendix B). Label directions will be strictly followed. No open containers of herbicides are allowed in areas of native vegetation, in riparian areas, or near areas of open water. All refilling of herbicide tanks and sprayers will be conducted in designated staging areas where there is no risk to native vegetation or water quality.

B. The control technique poses little to no risk to cultural resources.

MOCA/TUZI will continue to make a good faith effort to evaluate treatment options and ensure all Section 106 compliance standards are met. If a control technique is determined to affect a cultural resource, site specific compliance will be initiated by the park staff in consultation with affiliated tribes and the state historic preservation office. Staff will continue to review new relevant scientific literature and references to ensure control techniques are sound for use in areas of cultural significance.

C. The control technique poses little to no risk to the human environment or to the safety of park visitors or park employees.

Some techniques have the potential to harm humans. Injuries can occur when using everything from a shovel or saw to fire and herbicides. Visitors and other staff can be harmed as well if management is occurring in areas frequented by the public. For this reason, job hazard analyses (JHA) are developed for activities such as sawing and using herbicides. The purpose of these analyses is to define the techniques and tools required for the activity, identify potential hazards for each step or phase of the activity, and mitigate the potential for problems and injuries during each step or phase. JHAs are reviewed every year for thoroughness and are required reading for everyone (volunteer or staff) participating in the activity. Larger infestations may be treated by a professional Exotic Plant Management Team trained and certified in the application and safe use of pesticides.

Other precautions for reducing and eliminating risk to humans during invasive plant activities include posting notice of the activity in high use areas or scheduling the activity (when possible) during periods of low visitor use in the area (both time of day and time of year). MOCA/TUZI will continue to review and refine treatment activities to avoid negatively impacting human use and safety in and near treatment areas.

D. The control technique is cost-effective to implement.

Cost is not the only driving factor in selecting control techniques, but is considered in the context of size, location, integrity of resources threatened, and management goal (eradication, suppression, containment) for a particular infestation or area. Choice of techniques and management strategy has both short and long-term cost implications. Short-term impacts are mostly negative and include the cost of the initial treatments and possibly foregoing an activity (such as closing a hiking trail) while the area recovers. However, in the long-term, protecting surrounding non-infested areas or ecosystem functions is key to realizing and understanding the actual versus potential future costs of invasive plant management not just for the acreage actually infested but for the entire monument and the surrounding lands.

9. Create annual work plans to guide invasive plant management activities

There are specific recommended control techniques for a number of invasive species found at MOCA/TUZI in the *Exotic Plant Management Plan* (Mau-Crimmins et al 2005). Using this guidance, as well as considering the size, location, and management objective for an area, an annual work plan for all three park units will be created to guide control, monitoring, restoration, and prevention/education efforts. If complete eradication is not feasible, the management objective [by area or by species] will be to suppress or contain the infestation below the threshold level with consideration to any federal and state management directives on the particular species. The annual work plan will also be used to guide sources of labor to invasive plant projects of appropriate size and nature. While staff and volunteers are the primary source of invasive plant management labor in the monuments, adoption of an invasive species work plan will also enable the monuments to make better use of the NPS Exotic Plant Management Teams.

10. Restoration

Restoration is defined as a method to mitigate disturbed areas or control invasive plant problems by restoring native vegetation communities to conditions existing prior to disturbance or invasion. In many cases, no active restoration may be necessary if bare ground/rock is the desired condition or if there is enough desired vegetation in proximity to occupy niches opened by invasive plant control procedures. However, when desired vegetation canopy is nonexistent or inadequate for the site conditions, active restoration is required to speed recovery of a healthy and competitive plant community.

Many invasive plant management efforts focus on simply controlling invasive plants, with limited regard to the existing or resulting plant community. Before any invasive plant control takes place, a stewardship plan that establishes desired future condition objectives relevant to anticipated land use must be considered. Simply killing invasive plants is not an adequate objective, especially for large-scale infestations. However, a generalized objective might be to develop a healthy plant community that is relatively invasive plant-resistant, while meeting other land-use objectives such as listed species habitat, roadside and recreational use maintenance (Jacobs et. al. 1998).

In dry, desert environments like those at MOCA/TUZI, restoration in general has the potential to be costly and has a high risk of failure, even when properly implemented. Depending on the site and characteristics of the infestation(s) to be treated, staff will identify a strategy for larger, active restoration projects that consider factors such as creating a self-sustaining and persistent desirable plant community that meets management objectives. Planning considerations would include involving neighboring landowners/managers when necessary, species and seeding methods, and follow-up treatments that will best achieve desired conditions (Jacobs et. al. 1998). Restoration techniques used in MOCA/TUZI may include, but are not limited to, seeding, shrub/sapling plantings, soil amendments, tilling, and or irrigation. The pasture at Montezuma Well has been identified as a high priority for restoration following invasive species treatments.

ALTERNATIVES

Alternatives Considered

Alternatives were framed through discussion among NPS staff from Montezuma Castle and Tuzigoot, NPS Southern Arizona Office, EPMTs from Lake Meade NRA and Petrified Forest NP, NPS Intermountain Region planning staff, and integrated pest management staff. Additional input was received from Arizona State Parks and the University of Arizona Cooperative Extension Service. The alternatives cover the range of what is physically possible, acceptable by policy, and feasible for local managers; i.e. all reasonable alternatives. Criteria used in the selection of reasonable alternatives include:

- Potential for protecting the parks' natural and cultural resources
- Effectiveness, efficiency, and economy in eradicating or controlling invasive plant infestations
- Ability to ensure human health and safety

Alternative I: No Action - Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

This alternative represents the No Action Alternative and proposed a continuation of current management practices using mechanical, cultural and limited chemical treatments to control invasive plant infestations. This alternative would implement the 10 Steps of Invasive Plant Management to a degree, however, the implementation of Step 8 – selection of the most appropriate treatments methods would be limited.

Current management practices are not able to fully address the invasive species problem. Treatments using mechanical methods cannot be fully implemented because of their high labor cost. Therefore, relatively little effort can be focused on the less invasive species such as horehound, sweet clover, blue mustard, etc., where mechanical treatments would be effective. At best, these less invasive species are sometimes treated using volunteer labor, or are mowed along the roadsides. In addition, mechanical methods are not effective treatments for such highly invasive species as Dalmatian toadflax, Johnson grass, tamarisk, Russian knapweed, and Malta starthistle. If current practices were to be fully implemented, mechanical treatments would remain the primary method of invasive weed control.

In 2006 the parks first used chemical control to reduce populations of two highly invasive species: tamarisk and Malta starthistle. We have defined highly invasive species defined as those species that have the potential to spread rapidly, particularly in riparian areas with good soil moisture, and a high potential to displace native species and degrade special status species habitats. Additional treatments were implemented to treat invasive plants at Tavasci Marsh and Montezuma Castle that includes: tamarisk, Russian knapweed, Russian olive, and tree of heaven.

There have been ongoing volunteer and staff projects to control horehound using mechanical treatments. In addition, the pasture at Montezuma Well and roadside areas are being mowed to reduce invasive plants.

Restoration is limited under this alternative because of the small areas we are currently treating. There has been very limited reseeding following the small mechanical treatments that have been implemented. The small areas currently being treated using chemical treatments are in riparian areas where revegetation is expected to occur from adjacent native plant communities. Larger areas such as the pasture at Montezuma Well would not be treated and restored under this alternative because the size of the infested area and species present preclude the use of only mechanical treatments.

If this alternative is selected, the park would continue to conduct small-scale invasive plant control management using mechanical, cultural, and chemical control techniques within the framework of CE's and programmatic compliances. Chemical treatments would be limited to small infestations/populations

of highly invasive species that threaten special status species habitats. Other invasive species with less potential to spread and displace native plants may be treated using mechanical and cultural methods and treatments, and would be implemented as volunteer labor is available.

This alternative does not provide for the proactive or full implementation of the integrated pest management approach, using the most effective treatment method for each species. Therefore, it offers a limited ability to successfully address individual and/or unique invasive species situations in both infestation size and potential combinations of available techniques.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

The preferred alternative proposes to consider the implementation of the full range of appropriate IPM techniques available and fully implement the 10 Steps for Invasive Plant Management. This alternative would provide for proactive, responsible, and adaptive (defined below) integrated invasive species management. The integrated approach is defined as a system for the planning and implementation of a program, using an interdisciplinary approach, to select a method for containing or controlling an undesirable plant species or groups of species using all available methods including education; prevention; physical or mechanical methods; biological control agents; herbicide methods; cultural methods; and general land management. It is a multidisciplinary, ecological approach to managing unwanted plant species. This more integrated approach incorporates the parks' current management practices with the use of chemical treatments on additional invasive species, and the ability to use biological control agents. It is anticipated that more acres will be treated and restored under this alternative than under either Alternatives I or III since staff would have the option of selecting the most effective treatment(s) from the full range of available management techniques and strategies. Many of the invasive species are not effectively treated using mechanical and cultural methods especially since there are a number of species that are stimulated to sprout and sucker following mechanical disturbance. The restoration of native plant communities following IPM treatments is an important aspect of this alternative.

Pasture Restoration. IPM techniques would be used to restore the pasture area at Montezuma Well (see map below). Ten to twelve acres in the old pasture would be treated with herbicides to reduce the extensive invasive species populations. Herbicides may be followed by mechanical treatments such as discing to further reduce the invasive species and prepare a seed bed for replanting of native species. Native species would be maintained through irrigation, for approximately three years until they have become well established. Irrigation of this area would result in the need to repair and maintain the existing ditch. Approximately 18 additional acres of the pasture would be allowed to succeed to mesquite bosque, however, there may be a need to treat invasives in these areas. Spot treatments of invasive species throughout the pasture would include mechanical, cultural and chemical treatments, as needed. The restoration would be varied and include a large grassland planting, restoration of the native mesquite bosque plant community, enhancement of riparian buffer areas, and establishment of several small interpretive gardens. Native species may include: side oats grama, sand drop seed, cane beard grass, four-wing saltbush, coffeeberry, yerba de pasmo, and western soapberry. Up to ten interpretive signs on native vegetation would be installed to NPS specifications. There would also be three or four interpretive plots where prehistoric crops, historic crops, and wildlife food plants would be planted and interpreted. Approximately three miles of trail would be built, portions of which would be ADA accessible. A viewing platform over the pasture may be built in the existing picnic area, and a gazebo to offer shade to visitors may be built along the edge of the riparian area.

This project would serve to control invasive species, connect the riparian corridors of the irrigation ditch and Wet Beaver Creek, enhance rare grassland and mesquite bosque wildlife habitat, and provide for visitor enjoyment of these areas. A detailed description of the project can be found in the recently submitted Arizona Water Protection Fund (AWPF) grant application (AWPF 2007).

With the use of chemical treatments, it is possible to begin controlling the less invasive species not currently being addressed. Following chemical treatments, these areas may be maintained using mechanical and cultural methods. Many of these areas with high visibility to visitors would eventually be restored to native species.

This alternative is most likely to be successful in preventing unacceptable levels of invasive plants using the most effective and economical means while posing the least hazard to people, property, and the environment.

This alternative most clearly meets the directive established in DO 77-7 that calls for "IPM procedures to be used to determine when to control invasives and other pests and whether to use mechanical, physical, chemical, cultural, or biological means…". It allows the most flexibility and creativity in using available techniques to address invasive species situations in both size and scope of infestations. Each infestation, or common areas of infestations, would have a treatment implementation plan, which in turn will direct the development of annual operating plans to achieve desired management objectives.

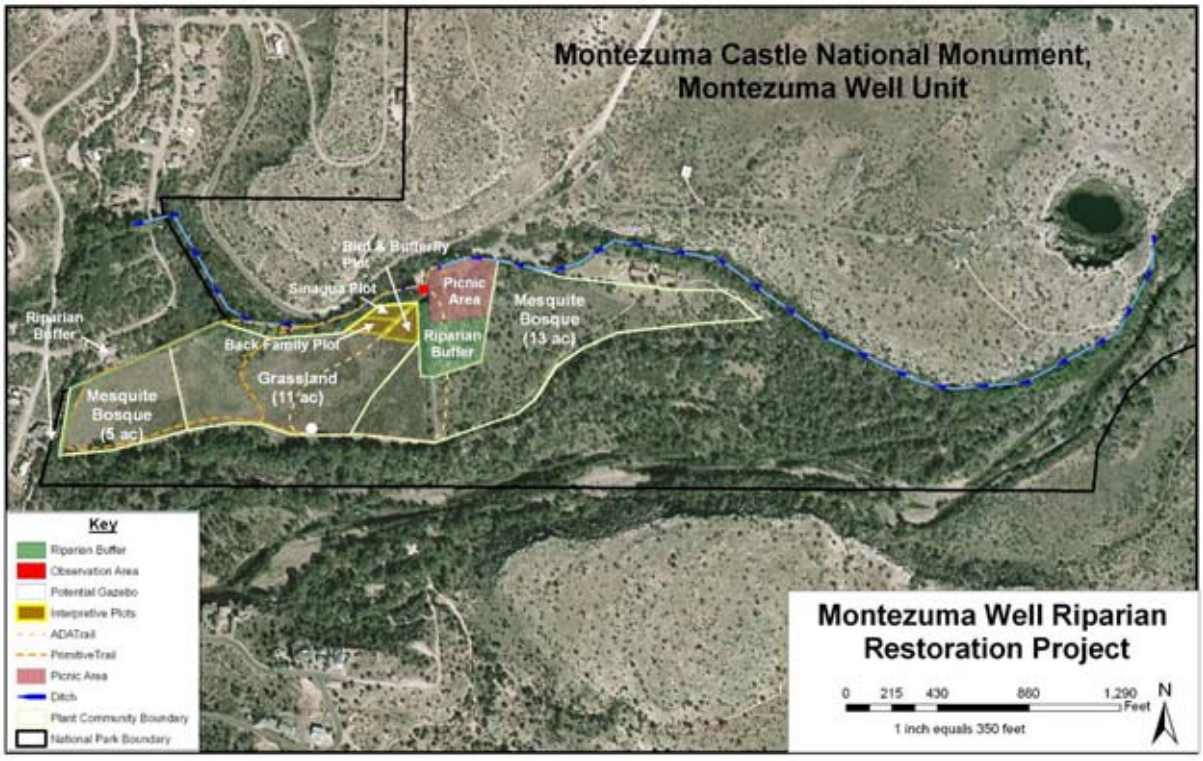

Figure 2 - Montezuma Well Pasture Restoration Project Detail

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

This alternative proposes the consideration of a more limited range of management tools, eliminating potentially controversial techniques such as chemical herbicides and biological control. Implementation of the 10 Steps for Invasive Plant Management would be limited under this alternative. Restrictions on the ability to integrate a full range of treatment methods would restrict the implementation of Step 8 (selection of the most appropriate treatments methods). Restrictions on the use of treatments would in turn reduce our ability to work with cooperators and could hamper the ability to track the spread of invasive plants.

Because of its labor-intensive nature, and site and species-specific limitations of mechanical and cultural control techniques, it is anticipated that under this alternative fewer acres will be treated annually than under either of the other two alternatives. Mechanical and cultural control methods are not effective on a number of invasive species such as tamarisk and Russian knapweed. These species are stimulated by mechanical removal of above ground portions. For mechanical removal to be effective, all roots must be

removed to prevent re-sprouting otherwise, these and other highly invasive species will continue to spread.

The monuments will not be able to successfully implement several of the 10 proposed management actions under this alternative. For example, it would not be possible to apply the most appropriate control technique if chemical and/or biological controls were found to be most effective and appropriate for the level of control desired. The monuments may also have difficulty developing and maintaining invasive species partnerships and maintaining cooperative management agreement goals with surrounding landowners and agencies if effective techniques and strategies are limited. Restoration of native plant communities would be limited under this alternative to small mechanically treated areas. The pasture at Montezuma Well would not be restored. The infestation of invasive species in the pasture is too extensive to treat using chemical and cultural methods and revegetation efforts would not be effective.

Table 3: Summary of Alternatives

Alternative Elements/Actions	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Prevent new infestations by employing prevention and early detection techniques	FULL IMPLEMENTATION: A comprehensive set of BMPs for prevention would be adopted (which includes existing prevention measures) and proactive early detection efforts (rapid assessment inventory, education, tracking) would be implemented.	FULL IMPLEMENTATION: A comprehensive set of BMPs for prevention would be adopted (which includes existing prevention measures) and proactive early detection efforts (rapid assessment inventory, education, tracking) would be implemented.	FULL IMPLEMENTATION: A comprehensive set of BMPs for prevention would be adopted (which includes existing prevention measures) and proactive early detection efforts (rapid assessment inventory, education, tracking) would be implemented.
Educate visitors and staff about invasive plants and their management	FULL IMPLEMENTATION: Monuments would expand current education and outreach programs to improve visitor, staff, partner, and stakeholder awareness of monuments and regional invasive species issues.	FULL IMPLEMENTATION: Monuments would expand current education and outreach programs to improve visitor, staff, partner, and stakeholder awareness of monuments and regional invasive species issues.	FULL IMPLEMENTATION: Monuments would expand current education and outreach programs to improve visitor, staff, partner, and stakeholder awareness of monuments and regional invasive species issues.

Alternative Elements/Actions	*Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	*Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	*Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Inventory invasive plants	FULL IMPLEMENTATION: Monument-wide inventories were completed in 2005. Continued cooperation with SODN on invasive species vital sign monitoring.	FULL IMPLEMENTATION: Monument-wide inventories completed in 2005. Continued cooperation with SODN on invasive species vital sign monitoring.	LIMITED IMPLEMENTATION: Monument-wide inventories were completed in 2005. While park will continue cooperation with SODN on invasive species vital sign monitoring; it may be difficult to keep inventories up to date as invasive species are expected to spread under this alternative.
Monitor effectiveness of control efforts	LIMITED IMPLEMENTATION: Monitoring programs would be designed for all major treatment projects to determine whether management objectives are being met. Treatment success and the ability to use adaptive management to modify treatments would be reduced as the ability to use chemical controls would be limited.	FULL IMPLEMENTATION: Monitoring programs would be designed for all major treatment projects to determine whether management objectives are being met. Overall treatment success would be evaluated, and adaptive management would be used to modify treatments as appropriate.	LIMITED IMPLEMENTATION: Monitoring programs would be designed for all major treatment projects to determine whether management objectives are being met. Treatment success and the ability to use adaptive management to modify treatments would be limited by elimination of chemical and biological control methods.
Track invasive plant management efforts	FULL IMPLEMENTATION: In addition to annual pesticide reporting, monuments would continue cooperation with SODN on invasive species vital signs monitoring and EPMT tracking and effectiveness monitoring.	FULL IMPLEMENTATION: In addition to annual pesticide reporting, monuments would continue cooperation with SODN on invasive species vital signs monitoring and EPMT tracking and effectiveness monitoring.	FULL IMPLEMENTATION: In addition to annual pesticide reporting, monuments would continue cooperation with SODN on invasive species vital signs monitoring. EPMT involvement would be limited due to the lack of chemical treatments.

Alternative Elements/Actions	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Prioritize both invasive plant species and locations to be controlled	LIMITED IMPLEMENTATION: Current prioritizations for some species and locations would be focused on highly invasive riparian species. Efforts to reprioritize would be considered following new infestations and spread of existing populations.	FULL IMPLEMENTATION: All species considered invasive in the monuments will be prioritized using an established ranking protocol to create a list that is monuments specific. Treatment locations would be identified and prioritized based on supporting documentation.	LIMITED IMPLEMENTATION: Availability of techniques will have an influence on the sites and species able to be treated, thereby limiting the utility and purpose of the ranking process.
Work with adjacent landowners, local, state and federal agencies, local interest groups, invasive plant cooperative networks, and others to develop and achieve common goals of invasive plant management	LIMITED IMPLEMENTATION: Monument would seek to expand collaboration efforts and new partnerships with interested parties, however it will likely be limited in its ability to create, fulfill, and maintain these partnerships because of a limited use of techniques.	FULL IMPLEMENTATION: Monument would expand collaboration efforts and new partnerships with neighboring landowners, other parks, park visitors, invasive plant management experts, other resource managers, and local, state, and federal officials.	LIMITED IMPLEMENTATION: Monument would seek to expand collaboration efforts and new partnerships with interested parties, however it will likely be limited in its ability to create, fulfill, and maintain these partnerships because of a limited use of techniques. There is the threat of invasive populations expanding from the monuments and infesting adjacent lands.

Alternative Elements/Actions	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Identify control techniques most appropriate for each species	LIMITED IMPLEMENTATION: Monuments would continue invasive plant management using only a portion of all treatments and techniques available. These techniques would be implemented in accordance with mitigation measures identified in this chapter.	FULL IMPLEMENTATION: The monument would have an assessment of the environmental effects of implementing the *Exotic Plant Management Plan* using integrated techniques. The *EPMP* would assist resource managers to coordinate knowledge of invasive plant biology, the environment, and all available technology to prevent unacceptable levels of invasive plant damage, using environmentally sound, cost-effective management strategies that pose the least possible risk to people, park resources, and the environment. These techniques would be implemented in accordance with mitigation measures identified in this chapter.	LIMITED IMPLEMENTATION: Monument would conduct invasive plant management using only a portion of all treatments and techniques available. These techniques would be implemented in accordance with mitigation measures identified in this chapter.
Create annual work plans to guide invasive plant management activities	LIMITED IMPLEMENTATION: Monument resource managers would have a standardized process in place to assist with invasive plant management. However, treatments would be less under this alternative because of the limited use of IPM techniques. The process will guide annual work or site-specific plans to identify invasive plants, determine invasive plant management priorities, identify and evaluate the efficacy and environmental effects of the limited treatment(s).	FULL IMPLEMENTATION: Monument resource managers would have a standardized process in place to assist with invasive plant management planning. The process will guide annual work or site-specific plans to identify invasive plants, determine invasive plant management priorities, identify and evaluate the efficacy and environmental effects of the proposed treatment(s).	LIMITED IMPLEMENTATION: Monument resource managers would have a standardized process in place to assist with invasive plant management. However, treatments would be very limited under this alternative because of the limited use of IPM techniques. The process will guide annual work or site-specific plans to identify invasive plants, determine invasive plant management priorities, identify and evaluate the efficacy and environmental effects of the limited treatment(s).

Alternative Elements/Actions	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Restoration	LIMITED IMPLEMENTATION: Restoration would be limited under this alternative as riparian areas treated are expected to naturally revegetate. Mechanical treatments may include hand seeding of small areas, but these treatments are not expected to effectively control many of the invasive populations. The pasture at Montezuma Well would not be restored.	FULL IMPLEMENTATION: Additional emphasis on restoration planning and implementation following treatments as part of IPM planning would occur. The pasture at Montezuma Well would be restored as chemicals are expected to effectively control the invasive species.	LIMITED IMPLEMENTATION: Restoration would be very limited under this alternative and may include hand seeding of small areas as mechanical treatments are not expected to effectively control many of the worst invasive populations. The pasture at Montezuma Well would not be restored

Alternatives Considered and Rejected

One additional alternative was identified and considered in the scoping process. It was regarded as unreasonable within the context of NPS policies (Director's Order 12, Section 2.7B) and was therefore eliminated from further analysis. Section 2.7B identifies as unreasonable those alternatives that could not be implemented if they were chosen, that cannot be implemented for technical or logistical reasons, that do not meet park mandates, that are not consistent with management objectives, or that may have severe environmental impacts.

Alternative IV was called the "no invasive plant management or control" (or "do nothing") alternative. Without active management or control, invasive species would continue to cause irrevocable damage to the monument's resources, and severely degrade visitor use and enjoyment of MOCA/TUZI as well as surrounding and adjacent land uses and values. This alternative was rejected because it does not meet the requirements of the park's enabling legislation to protect natural resources, the NPS Organic Act, NPS policies, or federal, state, and county noxious invasive plant acts and provisions.

Mitigation Measures Common to All Alternatives

There are a number of mitigation measures common to all alternatives. Mitigation measures are related to a number of resource areas. A mitigation checklist has been prepared and must be reviewed prior to any treatments (Appendix C).

- **Cultural Resources**
  Mechanical treatments in close proximity to historic and prehistoric cultural resource sites will only be used under the supervision of a cultural resource specialist to avoid the possibility of not only disturbing subsurface archeological material or undermining remaining standing architecture. Prescribed burns will only be implemented after the approval of a burn plan, and only used in areas away from cultural resource sites. Should any treatment be determined to potentially affect cultural resources, site specific compliance with section 106 of the National Historic Preservation Act will be initiated with the park's affiliated tribes as well as the state historic preservation office.

  The park archeologist will work closely with the park biologist and invasive species treatment crews in the location and identification of historic and prehistoric structures. Park staff conducting invasive plant management work will be trained yearly in cultural site awareness to learn how to identify and avoid archeological and historical resources on the ground. This training has been very successful in other parks to assure the protection of park cultural resources (Wells 2004). Should presently unidentified archeological resources be discovered during project implementation, work in that location would stop until the resources are properly recorded by an NPS archeologist and evaluated under National Register of Historic Places eligibility criteria in consultation with the Arizona State Historic Preservation Officer (AZ SHPO) and affiliated tribes as appropriate. If the resources are determined eligible, appropriate measures would be implemented either to avoid resource impacts or to mitigate disturbance. In compliance with the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), the NPS would also notify and consult affiliated tribal representatives for proper treatment of human remains, funerary, and sacred objects, should these be discovered. All workers would be informed of penalties for illegally collecting artifacts or intentionally damaging any archeological or historic property in the vicinity. Should any unusual treatment conditions or locations arise related to cultural resources, park staff would contact the park archeologist to determine how to proceed.

- **Mapping of Invasive Plant Species**
  Newly discovered invasive plant species and infestations would be mapped with a GPS unit, and the park's resource staff would be notified. All workers' clothing and footwear and all tools and equipment will be cleaned at the treatment sites to ensure that seeds or propagules from invasive plant plants are not transported to new locations. Park staff will continue to work with SODN on their invasive species vital sign monitoring and to store GIS data.

- **Job and Tool Use Safety**
  A job hazard analysis (JHA) that outlines job hazards and safety precautions will be developed for each project, and all project participants will receive tool safety training and will be required to use the appropriate personal protective equipment (PPE) for each associated task. The tools would be kept in appropriate storage locations at all times. The use of tools would follow procedures outlined in the JHA.

- **Visitor Experience**
  NPS staff will be available to provide educational and informational messages to any groups encountered during project implementation. Infestations located near heavily used areas will be mechanically controlled (if feasible) and the work will be completed when visitors will be least impacted.

- **Native Plant Restoration**
  Active native species restoration may be used in project areas when funding and propagules are available. All restoration efforts would use native species. Restoration would seek to restore the natural conditions prior to invasive plant species arrival or to prevent re-invasion after removal. Active restoration would include the collection of seed and/or cuttings from native plants in the project area. Any seed spreading or planting of cuttings would seek to replicate the composition and structure of the native plant communities. Extensive monitoring and maintenance would be conducted in these areas to ensure project success. Non-native species may be planted in small interpretive plots to enhance interpretive opportunities, provided they are not invasive in nature.

- **Soil Compaction and Biotic Community Disturbance**
  To minimize soil compaction, the following mitigation measures would be incorporated into all action alternatives:
  - The project leader would determine the access route that would cause the least disturbance to sensitive soils and vegetation. Access to areas would use existing wildlife or hiking trails wherever possible. If no trails exist, the project leader would determine whether single or multiple paths would be used depending on which would cause the least impact.
  - The minimum number of trips will be conducted into sensitive areas for follow-up treatments and/or monitoring.
  - If equipment such as an all-terrain vehicle (ATV), utility vehicle (UV), or tractor is used for invasive plant treatments or restoration the lightest/smallest equipment would be used. No such equipment will be used on wet soils that would be subject to compaction. Equipment will be cleaned on-site to prevent the transport of invasive species to uninfested areas.

- **Special Status Species**
  There are a number of special status species known or suspected to occur in the park units. A complete list is found in the Environmental Effects Chapter, Special Status Species. Park staff have been in ongoing informal consultation with the US Fish and Wildlife Service to ensure protection of these species (Appendix B).

  The following mitigation measures would be incorporated into all action alternatives:
  - The proposed project would include provisions for the discovery of previously unknown or undiscovered threatened, endangered, or special status species. These provisions require the cessation of project activities until park staff evaluates the project impact on the discovered species and conducts additional Section 7 consultation with the U.S. Fish and Wildlife Service if necessary.
  - All project participants would be informed about special status species and what actions should occur if a special status species is encountered.
  - Work involving string trimmers or chainsaws will not occur during breeding and dispersal periods for threatened, endangered, or special status species (in that particular species' habitat).
  - Southwestern willow flycatcher: No riparian treatments would be conducted in riparian areas during flycatcher nesting or migration.

- Yellow-billed cuckoo: This is a migratory species; therefore work in riparian gallery forests will be conducted in the winter/spring to avoid disturbing yellow-billed cuckoos when possible.

- **Best Management Practices (BMPs)**
  Best management practices for soil erosion control, as outlined in Director's Order 77 – *Natural Resource Protection,* and for protecting wetlands, as outlined in Director's Order 77-1 – *Wetlands Protection* will be adhered to in the implementation of all projects.

Mitigation Measures Common to Alternatives I & II

The monuments have adopted the policy of having trained and certified applicators on site during projects involving herbicides. Arizona State pesticide application certification, including herbicide training and safety, is renewed annually. All project participants would receive herbicide training from the certified project leader. Project participants would understand and abide by the established Personal Protective Equipment (PPE) requirements and rules outlined on the product label. Rubber gloves, long sleeve shirts, and goggles may be required PPE for application of herbicides. Job hazard analyses (JHA) for invasive plant removal and herbicide application have already been prepared and would be reviewed frequently with all project participants.

All information and instructions on the herbicide label will be strictly followed. All herbicide containers will show the product label and will be leak- and spill- resistant. All application equipment and chemicals will be stored in appropriate storage facilities. Material Safety Data Sheets (MSDS) will be maintained for all chemicals. The MSDS contains fire and explosive hazard data, environmental and disposal information, health hazard data, handling precautions, and first aid information. All participants will review the MSDS with the project leader and understand first aid instructions described on the MSDS. All herbicide and application equipment will be stored separately from food and personal items.

If the label instructions for the herbicide and application method recommend limiting exposure to humans and pets, the area will be closed during treatment. Treatments would occur when the least number of visitors would be impacted by the closure. Treatments that pose no risk to humans may be done at any time and may be interpreted for visitors. All herbicide mixing and loading of sprayer tanks will occur in designated staging areas. Field loading and mixing will not be permitted.

If invasive plant infestations occur in areas with archeological sites, the preferred control method may be chemical control to avoid disturbance of the artifacts. Because it is not known how these chemicals will react with historic and prehistoric materials, when chemical treatments are used, they will be applied in the most precise manner possible, for instance brushing onto the stumps of cut shrubs and tress to prevent resprouting. All mechanical treatments will be pre-approved by the park archeologist when used in areas with known cultural resources will be subject to monitoring by the park archeologist or other cultural resource specialist. Should any treatment be determined to potentially affect cultural resources, site specific compliance with section 106 of the National Historic Preservation Act will be initiated with the park's affiliated tribes as well as the state historic preservation office.

Environmentally Preferred Alternative

The environmentally preferred alternative is determined by applying the criteria suggested in the National Environmental Policy Act of 1969 (NEPA), which is guided by the Council on Environmental Quality (CEQ). The CEQ provides direction that "the environmentally preferable alternative is the alternative that will promote the national environmental policy as expressed in NEPA's Section 101" (Forty Most Asked Questions Concerning Council on Environmental Quality's National Environmental Policy Act Regulations, 1981).

Section 101 of the National Environmental Policy Act states that "…it is the continuing responsibility of the Federal Government to …

(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
(2) assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
(3) attain the widest range of beneficial uses of the environment without degradations, risk to health or safety, or other undesirable and unintended consequences;
(4) preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice;
(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

Based on these national environmental policy goals Alternative II is the environmentally preferable alternative for this project.

A discussion of how each alternative relates to these goals follows:

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

This alternative seeks to meet the environmental policy goals by using several, but not all, of the available IPM techniques to manage invasive plant species. With limited use of chemical treatments and biological control agents, certain invasive species are likely to be introduced and/or spread more widely throughout the monuments. Environmental degradation already occurring as a result of the spread and eventual dominance of several particular species is likely to increase, which fails to meet three of the environmental policy goals.

For example, Russian knapweed is currently known to infest Tavasci Marsh. This is a highly invasive species that prefers moist soil conditions. It is allelopathic, meaning the plant produces chemicals and sheds them into the environment where they inhibit growth or survival of other plant species. It will naturally form monocultures that are resistant to re-colonization by native species. It has the potential to spread to the riparian area of the Verde River, private land, Dead Horse State Park, and the Verde River Greenway. The most effective control technique is a combination of mechanical and chemical treatments, followed by reseeding of desirable species. New invasive species are expected to continue to appear on a regular basis (despite the use of spot control using mechanical and chemical techniques) as visitors, equipment, and animals visit, move, and migrate to and from places outside MOCA/TUZI.

Therefore, this alternative would not result in the same level of protection of natural and cultural resources and people over the long-term as would occur with the preferred alternative. Consequently, the continuation of the current management practices alternative does not satisfy provisions 1-5 of NEPA's Section 101.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

This alternative provides the greatest flexibility in mitigating and responding to the unique and individual nature of all invasive species problems that are present in MOCA/TUZI by using the full range of available IPM techniques, including those available now and yet to be shown as effective in the future. Using true integrated pest management strategies reduces dependence on one or few techniques to manage invasive species, thereby lessening any repetitive and potentially cumulative adverse impacts of those same techniques to the safety, health and integrity of resources, visitors, and staff.

This alternative provides opportunities for selecting and tailoring individual or combined treatments against invasive species, and thus should be most effective in managing the largest number of infestations. Using IPM to protect and restore native vegetative communities and natural processes altered by invasive

species will ultimately provide for better health, safety, and enjoyment of visitors and employees, and protect natural and cultural resources for succeeding generations. This alternative further provides for invasive species management prescriptions intended to contribute to the maintenance of long-term stability and diversity in native vegetation communities and will protect people and cultural and natural resources with minimum disturbance. This alternative would satisfy each of the provisions of the national environmental policy goals.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Like Alternative I, this alternative also seeks to meet environmental policy goals using a limited range of available IPM techniques to manage invasive plants. Several species currently exist across relatively large areas within the park units, and they dominate the communities in which they occur. The use of chemicals is eliminated under this alternative. This is considered the most useful and efficient for managing these large and/or widespread invasive plant infestations. Herbicide applications are also very useful when applied in spot treatments to small, isolated infestations for many species of new invaders.

This alternative limits the use of potentially controversial management techniques in recognition of their potential to damage resources and people if used or considered improperly. However, implementation of this alternative is expected to increase the rate of natural and cultural resource degradation and decrease visitor safety and enjoyment. New invaders will gain a foothold in the monuments, and already widespread invasive plant species will increase their range and amplitude both within and outside monuments boundaries. Consequently, Alternative III does not satisfy the provisions of NEPA's Section 101 as well as the preferred alternative.

Environmentally Preferred Alternative

The environmentally preferable alternative is Alternative II because it surpasses both the continuation of current management alternative (Alternative I) and Alternative III in realizing the full range of national environmental policy goals as stated in Section 101 of the National Environmental Policy Act. Alternatives I and III do not provide for comprehensive invasive plant management treatments on a large scale across the three park units. Invasive plant species populations are expected to continue to spread under these two alternatives. While Alternative III does result in the least amount of public controversy over perceived potential impact to resources and humans, it does not result in decreased risk to long-term health of native communities and natural processes in comparison with Alternative II.

Table 4: Invasive Plant Management Plan Objectives

Plan Objective	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Preserve, protect, and restore natural conditions and ecological processes of MOCA/TUZI by eradicating, significantly reducing, or	Some resources and natural processes will be protected and expansion of some invasive populations already present may be slowed, but likely only for the short term. The continuation of current management practices	The maximum number and type of resources and processes will be preserved, protected, and restored over the long-term through the implementation of a flexible and comprehensive invasive species management	Riparian resources would be at risk as existing invasive populations would not be effectively treated. Some resources and natural processes will be protected, and expansion of some invasive plant populations may be slowed, but only

Plan Objective	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
containing infestations of known invasive plants.	alternative does not provide the guidance for the long-term preservation, protection, and restoration of resources degraded by invasive species. Implementation of Alternative I will partially meet this objective.	planning process. Implementation of Alternative II will fully meet this objective.	for the short term. This alternative does not provide for the long-term preservation, protection, and restoration of resources degraded by invasives. Implementation of Alternative III will minimally meet this objective.
Prevent further introduction of invasive species already present in the monument as well as new species introductions by increasing visitor and staff awareness through education, by identifying mechanisms for cooperation among neighboring agencies and landowners, and by implementation of best management practices.	Prevention and education are a part of this alternative. It does not provide for integrated management using the most effective treatments for a number of invasive species. The lack of integrated methods would limit the cooperation with other neighbors and agencies. Implementation of Alternative 1 will partially meet this objective.	Prevention and education are a part of this alternative. Management activities and planning efforts would involve implementation of the most effective and efficient integrated treatment methods. The use of a full range of integrated pest management techniques would result in the fullest cooperation with neighbors and other agencies.	Prevention and education are a part of this alternative. It does not provide for integrated management using the most effective treatments for a number of invasive species. The lack of integrated methods would result in the spread of some species to adjacent lands interfering with cooperation with other neighbors and agencies. Implementation of Alternative III will minimally meet this objective.

Plan Objective	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Establish protocols, decision-making tools, schedules, and treatment methods for routine invasive plant management activities by park staff, volunteers, and NPS Exotic Plant Management Teams (EPMTs).	Annual operating plans under this alternative would guide and utilize staff and volunteers to the fullest extent possible. The full use of NPS EPMTs will be limited by restrictions on the use of herbicides and other integrated management techniques. Implementation of Alternative I will partially meet this objective.	Annual operating plans under this alternative would guide and utilize available staff, volunteers, and NPS EPMTs to the fullest extent possible using the full range of IPM management techniques and tools. Implementation of Alternative II will fully meet this objective.	Annual operating plans under this alternative would guide and utilize staff and volunteers to a limited extent. Mechanical treatments and the need to retreat areas would limit the efficiency of the use of staff and volunteers. NPS EPMTs would not be used effectively due to the lack of the use of herbicides and other integrated management techniques. Implementation of Alternative III would minimally meet this objective.

Table 5: Environmental Impact Summary by Alternative

Impact Topic	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Soils	This alternative is intermediate between the other two alternatives. In the short-term the treatments are primarily chemical, so soil disturbance is limited. Treatments in riparian areas quickly recover and stabilize the sites. Impacts are minor and adverse in the short-term from disturbance and minimal chemical persistence in the soil. In the long-term impacts will be minor and beneficial as areas revegetate and stabilize the soil resource.	This alternative results in minor, adverse short-term impacts due to mechanical treatments, pasture restoration, and minimal persistence of chemicals in the soil. Long-term impacts would be moderate and beneficial as more areas would be treated using chemical methods with less soil disturbance, and from the recovery of vegetation on these sites. Pasture restoration would result in additional long-term soil improvement.	Impacts to soils are greatest under this alternative. Short-term impacts to soils are expected to be minor and adverse. While mechanical methods result in soil disturbance, few areas would be treated due to the expense and ineffectiveness of this treatment on the species that are currently present. Long-term impacts would be moderate and adverse as soils are repeatedly disturbed from mechanical treatments and re-treatments.
Vegetation	This alternative is intermediate between the other two alternatives. Short-term impacts would be minor and beneficial as large populations of highly invasive plants would be treated and native plants (especially in riparian areas) are expected to re-colonize the sites. Long-term impacts would be minor and beneficial from treatment of the larger populations, but reduced due to the continued spread of smaller populations of less invasive species.	Benefits to vegetation would be greatest under this alternative. Implementation of integrated treatments would result in the most areas effectively treated, and revegetated by native species. Impacts to vegetation would be moderate and beneficial in the short and long-term. Restoration of the pasture at Montezuma Well would result in additional long-term benefits.	This alternative will result in the least benefits to native vegetation as the fewest invasive plant populations will be treated and many invasive populations are expected to continue to spread and displace native plants. Impacts under this alternative are adverse. Short-term impacts are minor as few areas will be treated, and moderate in the long-term as invasive populations spread.

Impact Topic	***Alternative I**: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative** – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:** Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Wildlife	The impacts of this alternative are intermediate between all alternatives. Short-term impacts would be minor and adverse from the displacement of wildlife during treatments and from the low possibility of herbicide drift into aquatic habitats. Long-term impacts would be minor and beneficial from improved wildlife habitat from the natural revegetation of native plant communities.	This alternative is most beneficial to wildlife. Short-term impacts are similar to Alternative I from displacement and chemical drift. Long-term impacts are moderate and beneficial because more areas will be treated and the pasture would be restored, resulting in greater wildlife habitat improvements.	This alternative would have moderate adverse impacts on wildlife species in the short and long-term. The use of only mechanical treatments would result in fewer areas treated and the spread of a number of invasive species that are not effectively treated using mechanical methods, especially in riparian areas that offer valuable wildlife habitat
Special Status Species	Impacts to special status species are intermediate of all alternatives. Short-term impacts would be minor and beneficial as riparian areas are the priority for treatments in order to maintain special status species habitats. Long-term benefits would continue for these species, but overall fewer areas would be treated due to the limited use of chemicals.	Benefits to special status species would be greatest under this alternative. Short-term impacts are minor and beneficial due to the focus on riparian habitats. Long-term benefits would be moderate as more areas and other less invasive species would be treated with integrated pest management techniques.	Special status species would be adversely impacted by this alternative. Ongoing chemical treatments in riparian areas would be discontinued and native habitats would decline resulting in minor adverse impacts. As invasive species continue to spread there would be a greater loss of native habitats resulting in moderate, adverse impacts.

Impact Topic	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Wetlands and Floodplains	The impacts to wetlands and floodplains from this alternative are intermediate. The short and long-term impacts are expected to be minor and beneficial. The removal of invasive species from these areas would favor native species that would enhance the function and condition of the wetlands and floodplains.	This alternative results in the greatest benefit to wetlands and floodplains. Short-term impacts would be minor and beneficial, similar to Alternative I. Long-term the impacts would increase to moderate as more areas would be treated and recolonized/restored to native species, including the floodplain at the Montezuma Well.	Adverse impacts to wetlands and floodplains are greatest under this alternative. Impacts are moderate and adverse in the short and long-term from mechanical treatments due to the need for repeated re-treatments, the lack of effectiveness of treatments resulting in the expansion of many invasive populations, and from the disturbance of wet and saturated soils.
Water Quality and Quantity	Impacts of this alternative are intermediate. Short-term impacts to water quality are minor and adverse from sedimentation that could result from soil erosion from mechanical treatments and from the potential for chemical drift into surface waters or leaching into ground water. Long-term impacts would be minor and beneficial as treated areas (especially in riparian zones) would revegetate resulting in reduced sedimentation. There would be no impact on water quantity.	Impacts from this alternative would benefit water quality in the long-term. Short-term impacts are similar to Alternative I from sedimentation and chemical drift or leaching. Long-term impacts would be moderate and beneficial as more areas would be treated with chemicals reducing the potential for sedimentation from repeated mechanical treatments. There would be no impact on water quantity.	Alternative III would have minor and adverse impacts to water quality. Mechanical treatments would be the primary treatment method and would result in increased risk of sedimentation. There would be no impact on water quantity.

Impact Topic	***Alternative I**: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative** – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:** Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Historic Structures	Removal of invasive species using these techniques would result in some level of improvement to soil and vegetation communities that supports historic structure preservation, but because of the lack of expanded prevention techniques or biocontrol agents, remaining techniques available would not be the most effective at adequately preventing new species introductions or managing range expansions of existing species that continue to destabilize and degrade structure context. Overall effects to resource would be minor, adverse, and long term.	Control of invasives would improve or restore conditions and context for historic structures. Techniques available are expected to most effectively and efficiently treat the most acres of species that compromise historic structures. Overall effects to resource would be long-term, moderate, and beneficial.	Likelihood of damage to structures is increased due to necessity of repeated control as well as the relative inability to treat species within culturally sensitive areas. Overall effects to resource would be moderate, adverse, and long term e.
Archeological Resources	Current management practices would help in preventing or reducing invasive species potential to destabilize and degrade archeological sites and artifacts, though effects may not be as long-lived or as widespread as in Alternative II. Overall effects to resource would be minor, adverse, long term.	Removal of invasive species using the full range of tools would have long-term benefits for the protection, stabilization, and context of archeological resources by enhancing pre-European plant and soil communities. Overall effects to resource would be long-term, moderate, and beneficial.	Potential for damage to archeological resources is increased due to necessity for more frequent treatments using available techniques. Mechanical treatments would be discouraged in culturally sensitive areas, allowing the overgrowth of invasive species. Maintenance or improvement of stabilizing environment is reduced. Overall effects to resource would be moderate, adverse, and long term.

Impact Topic	***Alternative I:*** *Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.*	***Alternative II: Preferred Alternative*** *– Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants*	***Alternative III:*** *Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.*
Visitor Use and Experience	Alternative I impacts are intermediate and beneficial. Short and long-term impacts are minor and beneficial as treatments would be conducted in the riparian/wetland visitor focal points. However, treatments to maintain native species in travel corridors would be limited. Interpretive and education opportunities would not be realized at the pasture.	This alternative would have the greatest visitor benefits. Short-term impacts would be minor and beneficial, similar to Alternative I. Long-term there would be moderate benefits as travel corridors would be treated and visitors would be able to enjoy the interpretive opportunities at the restored pasture at Montezuma Well.	Adverse impacts to the visitor experience would be greatest under this alternative in the short and long-term as visitors would be seeing a less natural landscape. Treatments in the riparian/wetland focal points would be much reduced resulting the viewing of vistas that include a substantial non-native component. In travel corridors, treatments would be limited and have little effectiveness. Interpretive and education opportunities would not be realized at the pasture.

ENVIRONMENTAL CONSEQUENCES

This chapter analyzes the potential environmental consequences, or impacts, that would occur as a result of implementing the *Exotic Plant Management Plan* (Mau-Crimmins et al 2005) and the 10 steps to implement integrated pest management described in the previous chapter. Topics analyzed in this chapter include soils, vegetation, wildlife, special status species, wetlands/floodplains, water quality and quantity, historic structures, archeological resources, and visitor use and experience. Direct, indirect, and cumulative effects, as well as impairment are analyzed for each resource topic that has been carried forward. Potential impacts are described in terms of type, context, duration, and intensity. Specific impact thresholds are given for each resource at the beginning of each resource section. General definitions are defined as follows:

- ***Type*** describes the classification of the impact as either beneficial or adverse, direct or indirect:
  Beneficial: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
  Adverse: A change that moves the resource away from a desired condition or detracts from its appearance or condition.
  Direct: An effect that is caused by an action and occurs in the same time and place.
  Indirect: An effect that is caused by an action but is later in time or farther removed in distance, but is still reasonably foreseeable.

- ***Context*** describes the area or location in which the impact will occur. Are the effects site-specific, local, regional, or even broader?

- ***Duration*** describes the length of time an effect will occur, either short-term or long-term:
  Short-term impacts generally last only during treatment, and the resources resume their pre-treatment conditions after completion of the project.
  Long-term impacts last beyond the treatment period, and the resources may not resume their pre-treatment conditions for a longer period of time following completion of the project. In the case of cultural resources, while damage that results in the loss of, or damage to historic fabric can be physically repaired, that loss or damage constitutes a permanent impairment of the resource.

- **Intensity** describes the degree, level, or strength of an impact. For this analysis, intensity has been categorized into negligible, minor, moderate, and major. Because definitions of intensity vary by resource topic, intensity definitions are provided separately for each impact topic analyzed in this Environmental Assessment.

Cumulative Effects:
The Council on Environmental Quality (CEQ) regulations, which guide the implementation the National Environmental Policy Act of 1969 (42 USC 4321 et seq.), require assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for both the No Action and Preferred Alternatives.

Cumulative impacts were determined by combining the impacts of the Preferred Alternative with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or reasonably foreseeable future projects within the parks and, if applicable, in the surrounding region. The geographic scope for this analysis includes elements within the Monuments' boundaries and areas adjacent to the monuments. The temporal scope includes projects within a range of approximately ten years. Given this, the following projects, listed from past to future, have been identified for the purpose of conducting this cumulative effects analysis:

Urbanization: The Verde Valley continues to experience rapid urban development; the population has doubled in the last 10 years and continues to grow. Growth has occurred in all towns and unincorporated areas adjacent to the park units including Camp Verde, Cottonwood, Clarkdale, Lake Montezuma and Rimrock. A number of landscaping ornamentals have 'escaped' and are now considered invasive species including toadflax and tamarisk. Residential and commercial development near park boundaries would increase the possibility for the introduction of additional invasive ornamentals. Ground disturbance associated with construction activities creates a suitable seedbed for invasive species. The Soda Springs Ranch adjacent to Montezuma Well is currently has recently been sold and there is a risk that it will be subdivided for residential or commercial development. Adjacent to Tuzigoot, mine spoils owned by the Phelps-Dodge Corporation were left barren for a number of decades after the mine closed. Those soils were too acidic to support vegetation, however, in 2006 a large restoration project was implemented and topsoil brought in to cover the spoils. A number of native grass and forb species, as well as sterile wheat, were planted to help stabilize the site. These more fertile soils may contain invasive species and may provide a suitable habitat for invasive species colonization on the reclaimed sites that could spread into Tuzigoot.

Roads: Roads are a major source of invasive species transport and invasion. In addition to the roads into the parks themselves, Montezuma Castle is adjacent to Interstate 17, and Tuzigoot is near the Cottonwood/Clarkdale historic Highway 89A, both major highways posing the risk of species transport. The road to Montezuma Well is only partially paved but plans are in place to pave the rest of the road. The resulting construction disturbance and additional future traffic may increase the risk of invasive species spread at the Well.

Flooding: Floodwaters carry invasive plant materials. Creeks in all three units are subject to frequent flooding. Additionally, Tavasci Marsh receives flow from Peck's Lake, an artificial lake that harbors aquatic invasive species such as Eurasian milfoil.

Grazing: Livestock grazing continues in areas adjacent to park units. Livestock are known to transport and spread invasive species. Trespass livestock in Tuzigoot and Montezuma Castle continue to be a problem.

Recreation: Recreation access provides a transport mechanism for invasive species. There are a number of existing trails in and adjacent to all three park units. Seeds often attach to hikers boots and pets, or may come from livestock such as horses. The Yavapai-Apache Nation owns land adjacent to Montezuma Castle and they continue to expand recreation and tourism opportunities including horseback rides, birding and hiking. The proposed Jackson Flat Trail would allow hiking and horse access along the northeast boundary of the Castle.

An interpretive trail at Montezuma Well pasture is part of this analysis under Alternative II and would increase visitation to that area. Dead Horse Ranch State Park is adjacent to Tuzigoot and a trail linking Tuzigoot and Dead Horse, as well as additional access trails into Tavasci Marsh are being discussed. Montezuma Well and Montezuma Castle attract a number of bird watchers and Tavasci Marsh, designated as an Important Bird Area by the Audubon Society, is a major destination for avid birders.

Park Construction: Construction projects within the park units creates disturbance that could, without proper precautions, enhance invasive species spread. An Environmental Assessment has been completed for the construction of an operations and utility building and associated septic system at Montezuma Well, while an additional proposal would upgrade the visitor contact station sometime in the future. Within the next ten years operations and utility buildings may also be constructed at both Montezuma Castle and Tuzigoot.

Non-native Aquatic Species: The introduction of a number of non-native aquatic species continues to have a substantial, detrimental impact on native aquatic species. A number of non-native, 'game' species have been introduced into the Verde River and Beaver Creek over the years that prey upon native fish species. This has resulted in the decline of all native fish populations and the subsequent listing of a number of native fish as threatened or endangered by the US Fish and Wildlife Service. Non-native species include but are not limited to: catfish, bass, sunfish, bullfrogs and crayfish.

Tavasci Marsh Restoration: Restoration of native plant communities is proposed for Tavasci Marsh in Tuzigoot National Monument and is now in the preliminary planning stages. Because the scope of work for this project has not been developed it is not possible to define it potential effects at this time. When the proposed scope of work is complete a separate environmental assessment will be prepared.

Impairment:
National Park Service's *Management Policies* (2006) require analysis of potential effects to determine whether or not actions would impair park resources (NPS 2006). The fundamental purpose of the national park system, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. National Park Service managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adversely impacting park resources and values. However, the laws do give the National Park Service the management discretion to allow impacts to park resources and values, when necessary and appropriate, to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values.

Although Congress has given the National Park Service the management discretion to allow certain impacts within parks, that discretion is limited by the statutory requirement that the National Park Service must leave park resources and values unimpaired unless a particular law directly and specifically provides otherwise. Prohibited impairments are impacts that, in the professional judgment of the responsible National Park Service manager, would harm the integrity of park resources or values. While any impact to any park resource or value may constitute an impairment, an impact would be more likely to constitute an impairment to the extent that it has a major or severe adverse effect upon a resource or value when the conservation of that resource 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
3. identified as a goal in the park's general management plan or other relevant National Park Service planning documents.

Impairment may result from National Park Service activities in managing the park, visitor activities, or activities undertaken by concessionaires, contractors, and others operating in the park. A determination on impairment is made in the Conclusion section for each of the resource topics carried forward in this chapter.

Impacts to Cultural Resources and Section 106 of the National Historic Preservation Act:
In this Environmental Assessment, impacts to historic properties are described in terms of type, context, duration, and intensity, as described above, which is consistent with the regulations of the Council on Environmental Quality (CEQ) that implement the National Environmental Policy Act (NEPA). This Environmental Assessment is intended, however, to comply with the requirements of both NEPA and §106 of the National Historic Preservation Act (NHPA). To achieve this, a §106 summary is included under the Preferred Alternative for each of the cultural resource topics carried forward including Historic Structures. The topics of cultural landscapes, ethnographic resources, and museum collections were dismissed from further consideration because none were identified in the project area. The §106 Summary is intended to meet the requirements of §106 and is an assessment of the effect of the undertaking (implementation of the alternative) on cultural resources, based upon the criterion of effect and criteria of adverse effect found in the Advisory Council on Historic Preservation's regulations. Should any treatment be determined to potentially affect cultural resources, site specific compliance with section 106 of the National Historic Preservation Act will be initiated with the park's affiliated tribes as well as the state historic preservation office.

Under the Advisory Council's regulations, a determination of either *adverse effect* or *no adverse effect* must be made for affected historic properties that are eligible for or listed on the National Register of Historic Places. An *adverse effect* occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualifies it for inclusion in the National Register (e.g. diminishing

the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association). *Adverse effects* also include reasonably foreseeable effects caused by the Preferred Alternative that would occur later in time; be farther removed in distance; or be cumulative (36 CFR Part 800.5, Assessment of Adverse Effects). A determination of *no adverse effect* means there is an effect, but the effect would not diminish in any way the characteristics of the cultural resource that qualify it for inclusion in the National Register of Historic Places.

In accordance with the Advisory Council's regulations implementing §106 of the NHPA (36 CFR Part 800, Protection of Historic Properties), impacts to historic properties for this project were identified and evaluated by (1) determining the area of potential effects; (2) identifying cultural resources present in the area of potential effects that were either listed in or eligible to be listed in the National Register of Historic Places; (3) applying the criteria of adverse effect to affected cultural resources either listed in or eligible to be listed in the National Register; and (4) considering ways to avoid, minimize, or mitigate adverse effects.

CEQ regulations and the National Park *Service's Conservation Planning, Environmental Impact Analysis and Decision-Making* (Director's Order #12) also call for a discussion of the appropriateness of mitigation, as well as an analysis of how effective the mitigation would be in reducing the intensity of a potential impact (e.g. reducing the intensity of an impact from major to moderate or minor). Any resultant reduction in intensity of impact due to mitigation, however, is an estimate of the effectiveness of mitigation under NEPA only. It does not suggest that the level of effect as defined by §106 is similarly reduced. Although adverse effects under §106 may be mitigated, the effect remains adverse.

In order for a historic property to be listed in the National Register of Historic Places, it must meet one or more of the following criteria of significance: A) associated with events that have made a significant contribution to the broad patterns of our history; B) associated with the lives of persons significant in our past; C) embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic value, or represent a significant and distinguishable entity whose components may lack individual distinction; D) have yielded, or may be likely to yield, information important in prehistory or history. In addition, the historic property must possess integrity of location, design, setting, materials, workmanship, feeling, association (*National Register Bulletin, How to Apply the National Register Criteria for Evaluation*).

Soils

Affected Environment

Soils on slopes in the Verde Valley are not well developed due to the region's semi-arid climate. Lindsay (2000a and 2000b) described the soils of all three park units as having developed in the Verde Formation of young lacustrine sediment with limestone, classic, and evaporitic facies. The Verde Formation was deposited when the drainage of the Verde Valley was dammed by volcanic lava, resulting in an internally closed basin. Basalts and tuff are interbedded with the limestone sediments (Lindsay 2000a). There are two general soils types at each unit; riverine bottomland soils composed of alluvium; and upland, rock

Table 6: Impact Intensities and Definitions - Soils

Impact Intensity	Intensity Definition
Negligible	Soils would not be affected or the effects to soils would be below or at the lower levels of detection. Any effects to soils would be slight and erosion would not be noticeable.
Minor	The effects to soils would be detectable. Effects to soil area, including soil disturbance and erosion, would be small and localized. Minimal soil loss would occur. Mitigation may be needed to offset adverse effects and would be relatively simple to implement and likely be successful.

Impact Intensity	Intensity Definition
Moderate	The effect on soils would be readily apparent and result in a change to the soil character over a relatively wide area, soil disturbance over a wide area, or erosion that extends beyond the project site and/or results in some soil loss. Mitigation measures would be necessary to offset adverse effects and likely be successful.
Major	The effect on soils would be readily apparent and substantially change the character of soils over a large area, and substantial erosion would occur resulting in a large soil loss. Mitigation measures to offset adverse effects would be needed, would be extensive, and their success could not be guaranteed.

calcareous soils composed of limestone-derived soils (Rowlands 1999). On steeper slopes soils tend to be shallow with poorly developed soil horizons and high calcium carbonates. The primary geological processes forming the present geomorphology of the Verde Valley have been erosion and fluvial downcutting.

Methodology and Intensity Thresholds

Analyses of the potential intensity of impacts to soils were derived from the available soils information (Lindsay 2002a and 2000b) and park staff's past observations of the effects on soils from visitor use, construction activities, and invasive plant removal. The thresholds of change for the intensity of an impact are defined as follows:

Soil impacts would be considered short term if the soils recover in less than three years and long term if the recovery takes longer than three years.

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

Impact Analysis: Limited mechanical and chemical treatments would be conducted under this alternative. Herbicides would be used on a limited basis, primarily in riparian areas, on highly invasive plants (such as Malta starthistle, Russian knapweed, tamarisk, and Russian olive) since mechanical methods are not effective.

When fully implemented, this alternative would primarily use mechanical treatment methods and areas of large infestations would receive soil disturbance. There would also be soil impacts on areas of species that re-sprout following treatment. These areas would need to be frequently retreated and there would be some soil instability until native plants have reestablished on these sites. On areas of small infestations, soil impacts would be mitigated by tamping the soil back into place.

Herbicides used for chemical control can bind with soils or impact soil microorganisms resulting in short-term, minor, localized, adverse impacts on soils. These impacts would be mitigated by using application methods like backpack sprayers and cut-stump treatments that minimize the amount of chemical that comes in contact with soils. Impacts to soils would also be mitigated by selection of herbicides that do not persist in the environment.

Cultural control could have a beneficial impact on soils by returning native vegetation. When prescribed fire is used as a cultural treatment there would be a short-term adverse impact to soils from removal of plant material and organic matter. Appropriate mitigation measures would be applied to reduce soil erosion and promote native plant establishment.

The invasive plant infestations would not be as effectively managed under this alternative because chemical treatments are limited and mechanical treatments are very time consuming and not effective on a number of invasive species currently present in the monuments. Over the long-term, infestations that are not treated could see changes in soil stability and nutrient availability when compared to soils with

native vegetation. These impacts are mitigated by the improvement expected as riparian treatment areas are expected to re-colonize with native plant species and result in soil condition improvements.

Cumulative Impacts: Rapid urban development adjacent to the park units is resulting in substantial soil disturbance and the potential for the spread of invasive species. Park construction projects would have localized impacts on soils. Increasing recreation and road traffic will continue to spread invasive species. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to soils, this alternative would have negligible short and long-term cumulative impacts to the soil resource.

Conclusion: Overall the impacts to the soil resource from the implementation of this alternative are expected to be minor, adverse and direct in the short-term on localized areas from soil disturbance associated with the mechanical treatments, and from minimal persistence of herbicides in the soils. Long-term impacts are expected to be minor and beneficial as mechanical treatment areas eventually stabilize and as soil conditions improve in riparian treatment areas, resulting in indirect benefits to the soil resource. Cumulative impacts would be negligible when considered in the context of ongoing disturbances in the vicinity of the monuments, primarily from rapid urban development and agricultural activities. There would be no impairment of the soil resource from the implementation of this alternative.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

Impact Analysis: Using an integrated approach to manage invasive plant infestations will allow the park to minimize the amount of soil impact caused by mechanically treating invasive populations. The amount of soil disturbance will be less for the preferred alternative when compared to Alternatives I and III because mechanical control methods would be reduced under this alternative. The potential for herbicide persistence in the soil would be greater under this alternative due to increased use of chemical control.

Mechanical control can be very effective for new infestations of invasive plants and when plants are few in number. The localized soil disturbance from mechanical removal of invasive plants could reduce soil stability until plants have reestablished on the disturbed sites. This would be minimized by tamping the soil back into place after removal of the invasive plants, and seeding when appropriate.

Chemical control can be very effective for large infestations of invasive plants and for plants with growth habits that make mechanical control methods ineffective. Herbicides used for chemical control can bind with soils or impact soil microorganisms and could have short-term, minor, localized, adverse impacts on soils. This would be mitigated by using application methods like backpack sprayers and cut-stump treatments to minimize the amount of chemical that comes in contact with soils. Impacts to soils would also be mitigated by selection of herbicides that do not persist in the environment. See the *EPMP* (Appendix A) for information regarding herbicide properties and the mitigation section of the previous Alternatives Chapter for further details. An integral part of the preferred alternative is the selection of the most appropriate and least toxic method to control an invasive plant infestation.

Cultural control could have a beneficial impact on soils by returning native vegetation. When prescribed fire is used as a cultural treatment there would be a short-term adverse impact to soils from removal of plant material and organic matter. Appropriate mitigation measures would be applied to reduce soil erosion and promote native plant establishment.

Biological control is not likely to be used, but could include introducing insects or pathogens to reduce invasive plant infestations. Insects and pathogens would have no impacts on soils. Low-risk methods are not likely to be used, but could include hot water/steam, vinegar or sugar compounds, or covering plants with plastic sheeting. These methods will not impact soils if applied properly. Soil microorganisms may be negatively impacted (especially with the plastic sheeting), but the impacts would be short-term, localized, and negligible.

The pasture restoration at Montezuma Well would result in initial soil disturbance as the pasture will be tilled in order to incorporate surface organic material, reduce invasive plants, and prepare a seedbed for native plant seeding. Impacts to the soil resource from the pasture restoration will be moderate, localized short-term, and adverse. In the long-term soil impacts from restoration are expected to be moderate and beneficial as the organic matter and stability of soils would improve over time.

Cumulative Impacts: Cumulative impacts are similar to Alternative I.

Conclusion: Short-term impacts to the soil resource from the implementation of the preferred alternative are expected to be minor, adverse and direct; primarily due to the localized impacts of seedbed preparation that will be required to implement pasture restoration at Montezuma Well. The short-term impacts from mechanical and chemical treatments are expected to be minimal due to the mitigation practices. In the long-term, impacts to soils would be less under the preferred alternative due to the ability to select the invasive plant control method that is best for each individual infestation and site. Long-term soil impacts are expected to be moderate and beneficial as more areas would be treated using chemical methods that result in reduced soil disturbance. Because chemical treatments are more effective and less expensive, we expect more populations would be treated and restored to beneficial plant populations, resulting in indirect benefits to the soil resource from increased soil organic matter and stability. Cumulative impacts would be negligible when considered in the context of ongoing disturbances in the vicinity of the monuments, primarily from rapid urban development and agricultural activities. There would be no impairment of the soil resource from the implementation of this alternative.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Impact Analysis. Under this alternative, invasive plant species would be primarily controlled by mechanical methods, some using cultural methods such as prescribed burning. The treatment of larger areas would be very limited due to the labor intensiveness of mechanical treatments. Soil disturbance and potential for erosion would be high. The localized soil disturbance from mechanical removal of invasive plants would reduce soil stability until plants have reestablished on the disturbed sites. This would be minimized by tamping the soil back into place after removal of the invasive plants. Mechanical treatments are not effective on a number of species (i.e. tamarisk and Russian knapweed) and this could result in the need to retreat some populations several times in order to reduce (and probably never eliminate) these populations, resulting in recurring disturbance to the soil resource.

Most invasive plant infestations would not be effectively managed under this alternative because of the large amount of time it takes to mechanically remove populations; therefore locations that did not receive treatment would continue to experience reduced soil stability and nutrient availability when compared to soils with native vegetation. Some of our most serious infestations would not be effectively treated because mechanical methods are not effective on these species (tamarisk and Russian knapweed) and because of the amount of time needed to conduct treatments. These species would be expected to re-sprout and need repeated treatments. Opportunities to restore native vegetation and the subsequent improvement in soil condition would be reduced as many of the larger infestations would not be effectively treated such as the pasture at Montezuma Well and Tavasci Marsh at Tuzigoot. Several of the invasive species currently present exhibit allelopathic characteristics and inhibit the growth of vegetation in adjacent areas. Allelopathic species with large areas of current infestations include Russian knapweed and tree-of-heaven. These species are not effectively treated with mechanical methods. These populations would continue to spread and displace native species and impact soil chemistry.

Cumulative Impacts: Cumulative impacts are similar to Alternative I.

Conclusion: The impacts of implementing this alternative would be adverse and direct in the short-term from soil disturbance resulting from mechanical treatments. Impacts are expected to be minor and localized as few areas would be treated due to the high cost of treatments. Impacts in the long-term would be moderate and adverse as soils are repeatedly disturbed from re-treatments and many populations would not be treated and would continue to spread, including allelopathic species.

Restoration of native plant communities would be less than with other alternatives. The short and long-term impacts of this alternative would have negative, direct impacts on the soil resource resulting from frequent retreatments and the spread of allelopathic species. Cumulative impacts would be negligible when considered in the context of ongoing disturbances in the vicinity of the monuments, primarily from rapid urban development and agricultural activities. There would be no impairment of the soil resource from the implementation of this alternative.

Vegetation

Affected Environment

Montezuma Castle NM. Vegetation of the Montezuma Castle and Montezuma Well have scattered juniper at higher elevations, and mesquite-acacia-creosote in associations at lower elevations. Riparian areas support gallery forests of cottonwood, sycamore and willow. Rowlands (1999 as reported in Schmidt et al 2006) classified the vegetation after Brown et al (1980) to include the following:

Montezuma Castle:

- Plains grassland containing broom-snakeweed-catclaw acacia-velvet mesquite association
- Sonoran riparian and oasis forest containing velvet mesquite association
- Sonoran savanna grassland containing threeawn-mixed shrub association
- Chihuahuan desert scrub containing mariola-creosote bush association
- Sonoran desert scrub containing creosote bush-mixed shrub association, creosote bush association, and crucifixion thorn association
- Southwestern riparian deciduous forest and woodland containing Arizona sycamore-green ash association
- Scrub-grassland containing New Mexico feathergrass-mixed scrub association
- Interior southwestern swamp and riparian scrub containing desert willow association

Montezuma Well Unit

- Interior chaparral containing Sonoran scrub oak-skunkbush sumac association
- Plains grassland containing broom-snakeweed-catclaw acacia association
- Scrub grassland containing New Mexico feathergrass-mixed scrub association
- Sonoran desert scrub containing crucifixion thorn association
- Southwestern riparian deciduous forest and woodland containing Arizona sycamore-green ash-Freemont cottonwood association
- Sonoran riparian and oasis forest containing velvet mesquite association, velvet mesquite-catclaw acacia-broom-snakeweed association, and fourwing saltbush-velvet mesquite association
- Sonoran interior marshland containing softstem bulrush-beaked spikerush association

There have been 404 plant species documented at Montezuma Castle and 57 (14%) are non-native; at Montezuma Well 338 species have been documented with 61 (18%) being non-native (Schmidt et al (2006). The number of non-native species is relatively high at both park units compared to other southwestern national parks because these areas have undergone extensive disturbance since prehistoric times. Much of these areas were farmed during prehistoric times by the Sinagua and, during historic times, were farmed and grazed by European settlers (Rowlands 1999). Schmidt et al (2006) provides a complete list of all plant species, native and non-native, that have been recorded at both units of the Castle.

Tuzigoot NM. Vegetation of Tuzigoot is characterized as Upper Sonoran desert and includes yucca, velvet mesquite, and saltbush. Vegetation along the Verde River is composed of large stands of Fremont cottonwood and Goodding's willow. Tavasci Marsh contains these two trees as well as dense stands of cattail. The vegetation of the monument has been described by TNC (1996) as reported in Schmidt et al (2005) to include:

- Evergreen woodland containing redberry juniper/crucifixion thorn woodland
- Deciduous woodland containing Fremont cottonwood/Goodding's willow woodland, Fremont cottonwood/foxtail barley woodland, and Fremont cottonwood/velvet mesquite woodland
- Mixed evergreen-deciduous woodland containing netleaf hackberry/Sonoran scrub oak woodland
- Evergreen shrubland containing creosote bush/purple threeawn shrubland and fourwing saltbush/bush muhly shrubland
- Deciduous shrubland containing desert willow shrubland, velvet mesquite/netleaf hackberry shrubland, velvet mesquite/broom snakeweed shrubland and velvet mesquite/foxtail barley shrubland
- Perennial graminoid containing Lehmann lovegrass herbaceous, scratchgrass/Parish's spikerush herbaceous, narrowleaf cattail herbaceous, and Bermudagrass herbaceous
- Perennial forb vegetation
- Annual graminoids or forbs

The area around Tuzigoot has also experienced long-term disturbances from the time the Sinagua using the area for farming and subsistence activities to historic times where it was farmed and grazed. Tavasci Marsh has been heavily manipulated throughout this time being drained, dammed, flooded, farmed, built upon, and grazed. Consequently, there are a number of non-native species present at the monument. A total of 264 plant species have been reported at Tuzigoot and 44 (17%) are non-native. Schmidt et al (2005) provides a complete list of all plant species native and non-native that have been recorded at the monuments.

Riparian Vegetation. All three units have diverse, high condition riparian gallery forests along stream corridors. Riparian overstory species include: Fremont cottonwood, Arizona sycamore, netleaf hackberry, velvet ash, boxelder, Arizona walnut, Arizona alder, and several willow species including Goodding's willow. Shrub canopies are a diverse mix of soapberry, coyote willow, golden currant, skunkbush sumac, and other species. The herbaceous layer is dominated by a number of rush, scirpus, sedge, and grass species. Some areas are dominated by narrowleaf cattail, including an extensive area at Tavasci Marsh.

Invasive Species. A list of invasive species adapted from the *Exotic Plant Management Plan* is found in the previous chapter. Additional sources of information on invasive species at the monuments can be found in Halvorson and Guertin (2003) and Mau-Crimmins et al (2005). There appear to be some discrepancies when looking strictly at the 'number' of invasive plants between these authors and Schmidt et al (2005 and 2006). Some of these apparent discrepancies are due to differences in sampling methods and objectives, and in the definition of an invasive/non-native/exotic species. Halvorson and Guertin (2003) went through an iterative process and focused their inventory on a list of 50 non-native species that had been identified as the most problematic species in southern Arizona parks. Some of the 50 species are actually considered to be native to Arizona but considered 'invasive plants' due to their invasive nature in agricultural setting. Mau-Crimmins et al (2005) focused their inventory on locating, mapping, and making recommendations on the management and treatment of approximately 85 invasive species. Schmidt et al (2005 and 2006) provided a list of all species documented and recorded in the monuments based on the literature and on their own field surveys.

Methodology and Intensity Thresholds

Analyses of the potential intensity of impacts to vegetation were derived from the available scientific data and literature and park staff's past observations of the effects on vegetation from visitor use, construction activities, prescribed fires, wildfires, and invasive plant removal. The thresholds of change for the intensity of an impact are defined as follows:

Table 7: Impact Intensities and Definitions - Vegetation

Impact Intensity	Intensity Definition
Negligible	No native vegetation would be affected or some individual native plants could be affected as a result of the alternative, but there would be no effect on native plant species' populations. The effects would be on a small scale.
Minor	The alternative would affect some individual plants and would also affect a relatively limited portion of that species' population. Mitigation to offset adverse effects could be required and would be effective.
Moderate	The alternative would affect some individual native plants and would also affect a sizeable segment of the species' population over a relatively large area within the park. Mitigation to offset adverse effects could be extensive, but would likely be successful.
Major	The alternative would have a considerable effect on individual native plants and affect a sizeable segment of the species' populations over a relatively large area in and out of the park. Mitigation measures to offset the adverse effects would be required, extensive, and success of the mitigation measures would not be guaranteed.

Duration of vegetation impacts is considered short term if vegetation recovers in less than three years and long term if the vegetation takes longer than three years to recover.

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

Impact Analysis: Mechanical methods would be the primary treatment method when this alternative is fully implemented. There would be beneficial impacts from mechanical treatments on small responsive populations. These are predicted to be minor because of the limited areas that would be treated due to the expense of treatments. Impacts to non-target plant species would be negligible.

Chemical treatments under this alternative are limited to large populations of highly invasive species that are not effectively treated with other methods, primarily in riparian areas. Malta starthistle, Russian knapweed, tamarisk, and Russian olive are examples of such species. By using herbicides that are selective (that target the specific characteristics of the invasive plant such as broadleaves, monocots, etc.) and by using hand application methods that minimize chemical drift, the impacts to non-target species would be reduced. Smaller populations of less invasive species would not be treated with chemical methods and would continue to spread.

Some native plant species may be damaged or killed using herbicide treatments on floodplains and wetlands. An example is the current infestation of Russian knapweed at Tavasci Marsh. The knapweed forms an understory in the mesquite bosque. Herbicides are the most effective Russian knapweed treatment. The herbicides currently available for use have the potential to impair or kill both the knapweed and some of the overstory mesquite trees. Initial experimentation using herbicides on knapweed at Tavasci have not resulted in the mortality of overstory mesquite, however, this potential exists. These impacts are expected to be minor, adverse and short-term as mesquite is expected to re-colonize the site within two years. In the future, the potential to impact other overstory riparian species exists should these areas become infested with understory invasive species. The risk is reduced because we would treat these areas while infestations are still small reducing the amount of chemical used, and riparian species adjacent to treatment areas are expected to re-colonize the treatment areas within two years. The use of backpack sprayers to target the application would also help mitigate risks as little chemical would contact foliage or reach the ground to be taken up by the mesquite.

Limited cultural treatments would be implemented. Prescribed fire may be applied in limited areas including the cattails in Tavasci Marsh, the grasslands adjacent to the marsh, and to burn piles of cut wood in the pasture at Montezuma Well. Impacts to vegetation would be short-term, minor and adverse, but native species adapted to fire would quickly recover. Treated areas would be restored by natural revegetation or by active restoration techniques. Under this alternative, the pasture at the Well will not be restored. Small treatment areas are expected to naturally revegetate and other areas may be actively restored.

Cumulative Impacts: Rapid urban development adjacent to the park units is resulting in the loss of native plant communities and the introduction of a number of potentially invasive ornamental plants. Park construction projects would have localized impacts on native vegetation. Increasing recreation and road traffic will continue to spread invasive species and potentially impact native plant communities. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to native plant species, all three alternatives would have negligible short and long-term cumulative impacts to the vegetation resource.

Conclusion: Impacts to vegetation under this alternative would be minor and beneficial in the short-term as large populations of highly invasive species would be effectively treated and native riparian plants are expected to re-colonize many of the treated areas. The beneficial impacts are minor in the long-term. While large populations of highly invasive species would continue to be treated using chemicals, small populations of less invasive species would continue to spread. This alternative would directly benefit the vegetation of the monuments reducing competition and displacement from non-native species. Benefits are less than Alternative II because the pasture at Montezuma Well would not be restored and fewer acres would be treated. Cumulative impacts would be negligible when considered in the context of ongoing loss of native plant communities in the vicinity of the monuments, primarily from rapid urban development and agricultural activities. There would be no impairment of the vegetation resource from the implementation of this alternative.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

Impact Analysis: Using an integrated approach to manage invasive plant infestations will allow the park to maximize the areas treated using the most effective methods including: mechanical, chemical, cultural and biological.

Mechanical control can be very effective for new infestations of invasive plants and when plants are few in number. The localized soil disturbance from mechanical removal of invasive plants could impact adjacent native plants by disturbing underground root systems. This impact would be minimized by tamping the soil back into place after removal of the invasive plants. Overall, the impacts to non-target species are expected to be negligible.

Chemical control can be very effective and efficient for large infestations of invasive plants and for plants with growth habits that make mechanical control methods ineffective. There is the risk of herbicide drift similar to that described under Alternative I. This would be minimized by the application methods, chemical selected for use, and by the implementation of a number of mitigation measures (Alternatives Chapter). An integral part of the preferred alternative is the selection of the most appropriate and least toxic herbicide to control an invasive plant infestation. The potential loss of overstory species due to treatment of understory species would be similar to Alternative I.

Prescribed fire would be used as a cultural control method on some invasive populations in limited areas including the cattails in Tavasci Marsh, the grasslands adjacent to the marsh, and to burn piles of cut wood in the pasture at Montezuma Well. Native vegetation adapted to fire is expected to recover. Restoration is an important aspect of this alternative. Small treatment areas may be reseeded. The pasture at Montezuma Well would be treated using herbicides and restored using native plant species. Since more areas are expected to be treated under this alternative, more areas (including the pasture) would be restored to native species. This alternative is expected to maximize the stability of restored sites to increase the resistance of native vegetation to reinvasion by invasive species.

Biological control is not likely to be used, but could include introducing insects or pathogens to reduce invasive plant infestations. All biological control methods would be carefully selected to ensure they do not impact non-target plant species. Low-risk methods are not likely to be used, but could include hot water/steam, vinegar or sugar compounds, or covering plants with plastic sheeting. These methods will not impact native vegetation if applied properly.

Cumulative Impacts: Impacts are similar to Alternative I.

Conclusion: The benefits to the vegetation resource are greatest under this alternative as the most effective, integrated treatment methods would be implemented. This alternative would treat the most acres of invasive plants. Impacts to vegetation would be moderate and beneficial in the short and long-term as the most acres of invasive plant populations would be treated and restored under this alternative, including the pasture at Montezuma Well. Restored areas would require less re-treatment due to the ecological integrity of the restored native plant community. This alternative would directly benefit the vegetation of the monuments reducing competition and displacement from non-native species. Cumulative impacts would be negligible when considered in the context of ongoing loss of native plant communities in the vicinity of the monuments, primarily from rapid urban development and agricultural activities. There would be no impairment of the vegetation resource from the implementation of this alternative.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Impact Analysis. Under this alternative, invasive plant species would be primarily controlled by mechanical methods, some using cultural methods. Most invasive plant infestations would not be effectively managed under this alternative because of the large amount of time it takes to mechanically remove populations; therefore populations not treated could spread to adjacent areas further reducing native plant communities. Some of our most serious infestations would not be effectively treated because mechanical methods are not effective on these species (tamarisk and Russian knapweed). These species are stimulated to sprout with mechanical disturbance and would require numerous re-treatments. Opportunities to restore native vegetation would be reduced as many of the larger infestations would not be effectively treated such as the pasture at Montezuma Well and Tavasci Marsh at Tuzigoot. No chemical herbicides would be used and therefore the risk of killing non-target overstory species would not occur.

The allelopathic effects of some invasive species such as Russian knapweed and tree-of-heaven, would be greatest under this alternative as these species would not be effectively controlled with mechanical and cultural methods. Allelopathic species would continue to spread, and would displace native species and inhibit their growth in the vicinity of the infestation.

Prescribed fire would be used as a cultural control method on some invasive populations. Native vegetation adapted with fire and is expected to recover. Restoration is limited under this alternative to small treatment areas to be reseeded by hand after mechanical removal of invasive plants. The invasive species in the pasture at Montezuma Well would not be effectively treated under this alternative, therefore, no large active restoration projects would be implemented. No biological controls would be used under this alternative.

Cumulative Impacts: The cumulative impacts are similar to Alternative I.

Conclusion: The impacts of implementing this alternative would be minor and adverse in the short-term as few invasive populations would be treated. Impacts would be moderate and adverse in the long-term as many invasive plant populations would continue to increase due to the lack of time and money to implement mechanical treatments. Many highly invasive species that are not effectively treated with mechanical methods (Russian knapweed and tamarisk) would continue to spread and reduce native vegetation. The pasture at Montezuma Well would not be restored as the invasive populations currently occupying the site would not be adequately treated to allow for restoration. Implementation of this alternative would have direct adverse impacts on the native vegetation of the monuments from the continued displacement and competition from invasive species, and the allelopathic effect of some invasive species. Cumulative impacts would be negligible when considered in the context of ongoing loss of native plant communities in the vicinity of the monuments, primarily from rapid urban development and agricultural activities. There would be no impairment of the vegetation resource from the implementation of this alternative.

Wildlife

Affected Environment

Wildlife resources at Montezuma Castle and Tuzigoot N.M. are diverse, reflecting the parks' strategic location in the Upper Sonoran Desert and at the base of the Mogollon Rim. Varied habitats ranging from juniper woodlands, desert scrublands, semi-desert grasslands and interior riparian deciduous forests contribute to the diversity of wildlife in this area. The number of vertebrate species shown below is from Schmidt et al (2005 and 2006).

Table 8: Vertebrate Species Count

	MOCA/MOWE	TUZI
Fish	9	11
Amphibians	5	2
Reptiles	30	26
Birds	211	127
Mammals	58	27

FISH
Montezuma Castle And Montezuma Well – Beaver Creek and Wet Beaver Creek provide aquatic habitat for nine fish species. Four species are native and all are federally listed as Special Status Species. Five non-native fish species are also present. There has been a shift in the composition of fish species over the last 60 years to domination by non-native species that have been introduced by humans for recreational fishing (Schmidt et al 2006). Declines in native species are attributed in part to competition for resources and consumption by predatory, non-natives fishes such as bass and carp.

Tuzigoot – Eleven fish species were captured at Tuzigoot, all were non-native. The decline in native species here is also partially attributed to the introduction and success of predatory non-native fish species.

AMPHIBIANS AND REPTILES
Montezuma Castle And Montezuma Well – Drost and Nowak (1998) conducted an amphibian and reptile survey at the two units from 1993 to 1994. Amphibian diversity at these two units is low with only four species recorded in this inventory. Lowland leopard frog was recorded for the first time at Montezuma Well in 2006, which brings the amphibian total to five. Lizard diversity is high with 13 species recorded. One reptile population of special note is a high density population of the Sonoran mud turtle in Montezuma Well. Snake data is less complete. There are six species that may occur at the park units based on information available for the Verde Valley.

Tuzigoot – 28 species of amphibians and reptiles have been recorded: one toad, one frog, one turtle, 11 lizards, and 14 snakes. Woodhouse's toad and the American bullfrog are the only two amphibians recorded. The western whiptail lizard was the most common lizard recorded. The western diamond-backed rattlesnake is the most common snake. The lowland leopard frog was conspicuously absent from the inventory despite considerable sampling effort to find it. This may be due to the presence of non-native predators, habitat alteration, drought, or other factors.

BIRDS
Montezuma Castle And Montezuma Well - Bird diversity is considered to be exceptionally high at both Montezuma Castle and Montezuma Well with a total of 211 species. There are 41 species that require open water found at Montezuma Well: 22 species of ducks and geese, one species of grebe, four species of egrets and heron, four species of rail, seven species of shore birds, and three other species. The riparian habitat associated with Beaver and Wet Beaver Creeks also contributes to high diversity of riparian obligate species such as summer tanager, song sparrow, Albert's towhee, yellow warbler, yellow breasted

chat; and a number of species listed as Arizona State Wildlife Species of Concern including: black-hawks, kingfishers and yellow-billed cuckoos. Cuckoos have been proposed as a USFWS candidate for listing under the Endangered Species Act.

Tuzigoot – Bird diversity is also high at Tuzigoot and the surrounding area with 248 species recorded. There are 65 species that require open water and/or marsh habitat (at Tavasci Marsh and nearby Peck's Lake): 22 species of ducks, three species of grebe, nine species of heron and egret, three species of rail, 16 species of shorebirds, seven species of gulls, and five other species. The bald eagle was recently de-listed by the US Fish and Wildlife Service, and yellow-billed cuckoo is a candidate for listing under the Endangered Species Act. Tavasci Marsh is included in the recently designated Tuzigoot Important Bird Area by the Audubon Society.

MAMMALS
Montezuma Castle And Montezuma Well - Of the 58 species of mammals recorded at the two park units, there are 18 bats, 15 small terrestrial mammals (primarily rodents), and 25 medium to large mammals. The aquatic habitats of Beaver and Wet Beaver Creeks provide habitat for several mammals that are relatively rare in Arizona: American beaver, muskrat, and river otter.

Tuzigoot – There are 25 species of mammals documented at Tuzigoot: 16 species of bats, 13 rodent species, and several larger mammals including the common grey fox, collard peccary, and mule and white-tailed deer.

Methodology and Intensity Thresholds

Analyses of the potential intensity of impacts to wildlife were derived from park staff's past observations of the effects on wildlife from visitor use, construction activities, prescribed fires, and invasive plant removal. The thresholds of change for the intensity of an impact are defined as follows:

Table 9: Impact Intensities and Definitions - Wildlife

Impact Intensity	Intensity Definition
Negligible	No native animal species would be affected or some individuals could be affected as a result of the alternative, but there would be no effect on native animal species populations. Impacts would be well within natural fluctuations.
Minor	The alternative would affect some individual animals and could also affect a limited portion of that species' population. Mitigation measures, if needed to offset adverse effects, would be simple and successful.
Moderate	The alternative would affect some individual animals and would also affect a sizeable segment of the species' population over a relatively large area within the park. Mitigation measures, if needed to offset adverse effects, would be extensive and likely successful.
Major	The alternative would have a considerable effect on individual animals and affect a sizeable segment of the species' population over a relatively large area in and out of the park. Extensive mitigation measures would be needed to offset any adverse effects and their success would not be guaranteed.

The duration of wildlife impacts is considered short term if the recovery is less than one year and long term if the recovery is longer than one year.

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

Impact Analysis: There could be displacement of wildlife when working in the area from both mechanical and chemical treatments. It is unlikely that wildlife would permanently abandon an area from the noise or disturbance; mitigation measures would ensure breeding birds with special status would not be disturbed.

Mechanical control methods may impact small vertebrate or invertebrate species that may be on individual invasive plants. Mechanical treatments have the potential to contribute sediment to aquatic habitats. Erosion would be limited by the mitigation measures; however repeated mechanical treatments in riparian areas could have a minor, adverse, short-term impact on aquatic species habitat.

The chemical herbicides proposed for use as a method of control act upon plant-specific enzyme pathways; therefore the impact to wildlife under normal application conditions would be negligible. Long-term persistence of herbicides in the food chain, and subsequent toxic effects, is not expected to occur due to the nature of the chemicals proposed for use, the low rates at which they would be applied, and the small quantities of herbicide to be used. The chemicals proposed for use do not contain organo-chlorines that can cause egg-shell thinning and other harmful effects to wildlife. Specific mitigation measures have been developed to minimize any herbicide contamination of surface water. It is unlikely, but trace amounts of chemical could drift and reach surface waters, potentially causing an impact to aquatic species. Chemicals that may reach surface waters are expected to be rapidly diluted, minimizing impacts.

Prescribed fire may be applied as a cultural treatment method under this alternative. Impacts are expected to be minor in the short-term due to the displacement of some animals during the burn and subsequent habitat recovery. Some treatment areas are expected to naturally revegetate and others would be actively planted and restored to native species. Under this alternative, wildlife habitat on the pasture at Montezuma Well would not be restored. No biological controls would be used under this alternative.

Cumulative Effects: Rapid urban development adjacent to the park units is resulting in loss of wildlife habitat across the Verde Valley. Proposed park construction projects would take place in areas already disturbed by facilities. Increasing recreation has the potential to displace wildlife species. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to wildlife, these alternatives would have negligible short and long-term cumulative impacts to the wildlife resource.

Conclusion: The impacts this alternative to wildlife species are expected to be minor and adverse in the short term from the displacement of wildlife during treatments and from the possibility of herbicide drift into surface waters. The long-term impacts to wildlife are predicted to be minor and beneficial from the maintenance and restoration of native wildlife habitat resulting from the reduction of invasive species populations, particularly in riparian areas. Impacts to wildlife would be indirect and result from improvement of habitat, not from direct impacts to individual animals. Cumulative impacts would be negligible when considered in the context of ongoing loss of wildlife habitat in the vicinity of the monuments; primarily from rapid urban development, and agricultural activities; and from wildlife disturbances from increasing human recreation. There would be no impairment of wildlife resources from the implementation of this alternative.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

Impact Analysis: This alternative allows for the full use of integrated pest management and the most efficient and effective treatment method, it is expected that additional acres of invasive species would be treated under this alternative. The pasture at Montezuma Well would be restored to primarily native species and result in improved wildlife habitat.

The impacts to wildlife species from chemical treatments are expected to be similar to those described under Alternative I. The least toxic herbicides would be used and impacts to wildlife species would be minimal. The potential for chemical drift into aquatic habitats is somewhat greater under this alternative than Alternative I as more areas would be treated with herbicides. These impacts would be mitigated by implementation of mitigation measures in the Alternatives Chapter, and from hand application of the least amounts of the least toxic herbicides.

Mechanical treatments would be similar to those described for Alternative I where species may be directly impacted by pulling of inhabited plants. The potential for sediment impacting aquatic habitats is reduced under this alternative as fewer mechanical treatments would be implemented.

Prescribed fire could be used under this alternative. Impacts to wildlife species would be indirect from the short-term displacement and loss of habitat. Cultural control would have a beneficial impact on native wildlife species by restoring previously infested areas with native vegetation, such as the pasture at Montezuma Well and other treated areas. There would be a benefit to a number of wildlife species from the restoration of the pasture that would connect riparian habitats along Wet Beaver Creek to the irrigation ditch.

Biological control is not likely to be used, but could include introducing insects or pathogens to reduce invasive plant infestations. No biological control methods will be implemented without additional consultation with the US Fish and Wildlife Service. Low-risk methods are not likely to be used, but could include hot water/steam, vinegar or sugar compounds, or covering plants with plastic sheeting. Low-risk methods are not anticipated to affect wildlife species.

Cumulative Impacts: The cumulative impacts would be similar to Alternative I.

Conclusion: The application of integrated pest management treatments could have minor, short-term, localized, adverse impacts on wildlife species due to displacement during treatments and/or the low possibility of herbicides reaching aquatic habitats. Long-term impacts to wildlife are expected to be moderate and beneficial because using the most effective and efficient treatment method and active restoration projects would result in more acres of wildlife habitat maintained or restored. Impacts to wildlife would be indirect and result from improvement of habitat, not from direct impacts to individual animals. Cumulative impacts would be negligible when considered in the context of ongoing loss of wildlife habitat in the vicinity of the monuments, primarily from rapid urban development, and agricultural activities; and from wildlife disturbances from increasing human recreation. There would be no impairment of wildlife resources from the implementation of this alternative.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Impact Analysis: Invasive plants would be primarily treated using mechanical methods and some cultural treatments, integrated pest management practices would not be implemented under this alternative. Invasive species are expected to continue spread and result in the greatest reduction of wildlife habitat.

Mechanical control methods would result in the need for repeated re-treatments and the greatest disturbance to wildlife species, especially in riparian areas. The repetition required for the success of many mechanical treatments would cause repeated disturbances to wildlife species, and fewer acres of invasive species would be treated. Mechanical methods are not effective on a number of highly invasive riparian species and there would be a continued degradation of valuable riparian wildlife habitat. Soil disturbance is greatest under this alternative and would have the most potential for sedimentation of aquatic habitats.

Using mechanical and cultural techniques for invasive plant management could indirectly affect the desired condition, which is to have all native wildlife and their habitats maintained as part of the monument's natural ecosystem. Mitigation measures would reduce the adverse impacts of the techniques themselves, but not the impacts of the accelerated rate of spread of existing and new invasive plant populations. The current ongoing herbicide treatments to highly invasive species would be discontinued and these species are expected to quickly spread and displace native plant communities, especially in riparian areas.

Prescribed fire could be used under this alternative. Impacts to wildlife species would be indirect from short-term displacement and loss of habitat. The pasture at Montezuma Well would not be restored as

the dense population of invasive plant species would not be effectively controlled, therefore, the planting of native species would not be successful.

Eliminating chemical controls from use would eliminate the potential exposure of wildlife to herbicides. However, it would substantially reduce control of invasive species and there would be continued degradation of wildlife habitat particularly in riparian areas. The potential impacts to wildlife from the introduction of biocontrols would be eliminated.

Cumulative Impacts. The cumulative impacts of this alternative are similar to Alternative I.

Conclusion: Impacts of using only mechanical and cultural techniques for invasive plant management to wildlife would be moderate and adverse in the short and long-term because current efforts using herbicides would be discontinued and these populations would quickly spread, fewer acres would be treated because of the expense and labor involved in mechanical treatments, and restoration would be very limited. The lack of effective control would indirectly impact wildlife through the continued loss of quality habitat. Impacts to wildlife would be indirect and result from degradation of habitat, not from direct impacts to individual animals. Cumulative impacts would be negligible when considered in the context of ongoing loss of wildlife habitat in the vicinity of the monuments, primarily from rapid urban development, and agricultural activities; and from wildlife disturbances from increasing human recreation. There would be no impairment of wildlife resources from the implementation of this alternative.

Special-Status Species (Threatened, Endangered, and Species of Concern)

Affected Environment

Threatened, Endangered, and Species of Concern

Under the Endangered Species Act there are five species listed as Endangered, two Threatened species, one Candidate, and three Species of Concern (hereafter referred to as special status species) that are known to occur or have been recorded at the three park units as shown below. All are either aquatic or known to depend on riparian areas for habitat or foraging. Currently, the most highly invasive plant species in the monuments are in the riparian areas and threaten these habitats, highlighting the need to actively manage invasive populations in order to preserve habitat for these animal species of concern. There are no known Threatened/Endangered/Species of Concern plants in any of the three park units.

Threatened/Endangered/Species of Concern (TES) to be evaluated in the Invasive Plant Management Plan Biological Assessment for Montezuma Castle and Tuzigoot National Monuments are shown in the Table 10 below.

Table 10: Threatened/Endangered/Species of Concern

Species	Status	MOCA	MOWE	TUZI
Razorback Sucker (*Xyrauchen texanus*)	Endangered	X	X	CH
Gila Chub (*Gila intermedia*)	Endangered	X	X	
Spikedace (*Meda fulgida*)	Threatened			CH
Colorado Pike Minnow *(Ptychocheilus lucius)*	Endangered*			X
Southwestern Willow Flycatcher (*Empidonax traillii extimus)*	Endangered	X	X	X

Yuma Clapper Rail *(Rallus longirostris yumanensis)*	Endangered			X
Bald Eagle (*Haliaeetus leucocephalus*)	Threatened	X	X	X
Yellow-billed Cuckoo (*Coccyzus americanus*)	Candidate	X	X	X
Roundtail Chub (*Gila robusta*)	Species of Concern **	X	X	X
Northern Mexican Garter Snake (*Thamnophis eques megalops*)	Species of Concern **			X
Lowland Leopard Frog *(Rana yavapaiensis)*	Species of Concern **		X	

X indicates this species may be present in the park unit.
CH indicates proposed or designated critical habitat present within park unit.
*Experimental nonessential population in the Verde River.
** Currently this species has no protection under ESA.

There have been limited treatments of highly invasive plant species in the park units and ongoing informal consultation with the US Fish and Wildlife Service (USFWS) on these activities. A Biological Assessment was prepared on January 26, 2007: *Implementation of the Exotic Plant Management Plan for Montezuma Castle and Tuzigoot National Monuments* (Appendix B). This BA was prepared to address the effects of the **Preferred Alternative II** that proposes the full use of IPM techniques: mechanical, cultural, biological, and chemical. Prior to preparation of the BA, consultation with USFWS was fragmented and project specific. NPS and USFWS discussions resulted in concerns over the sum of the effects of these different treatment activities. If biological treatments are selected, consultation will be reinitiated.

On March 1, 2007, FWS concurred with the effects determinations in the Biological Assessment (Appendix B). Implementation of the Preferred Alternative II may affect, but is not likely to adversely affect the razorback sucker and its critical habitat, the Gila chub, the threatened spikedace and its proposed critical habitat, the Colorado pikeminnow, or other fish and aquatic species. It may affect, but is not likely to adversely affect the southwestern willow flycatcher, Yuma clapper rail and yellow-billed cuckoo. There would be no effect to the bald eagle. The BA contains a more complete description of each of the TES species and their habitat requirements. Although the BA addresses full implementation of the Preferred Alternative II, only very limited treatments are currently being implemented on specific highly invasive plant species. If the alternative selected for implementation as part of this analysis concludes the effects are outside of those disclosed in the BA, we will immediately reinitiate consultation with USFWS.

Methodology and Intensity Thresholds

Analyses of the potential intensity of impacts to special-status species were derived from USFWS Recovery Plans, available literature, park staff's past observations, and in consultation with the USFWS. The thresholds of change for the intensity of an impact are defined as follows:

Table 11: Impact Intensities and Definitions - Threatened, Endangered, and Species of Concern

Impact Intensity	Intensity Definition
Negligible	No special-status species would be affected or some individuals could be affected as a result of the alternative, but there would be no effect on special-status species' populations. Impacts would be well within natural fluctuations.
Minor	The alternative would affect some special-status individuals and would also affect a limited portion of that species' population. Mitigation measures, if needed to offset adverse effects, would be simple and successful.
Moderate	The alternative would affect some special-status individuals and would also affect a sizeable segment of the species' population over a relatively large area within the park. Mitigation measures, if needed to offset adverse effects, would be extensive and likely successful.
Major	The alternative would have a considerable effect on special-status individuals and affect a

	sizeable segment of the species' population over a relatively large area in and out of the park. Extensive mitigation measures would be needed to offset any adverse effects and their success would not be guaranteed.

Special-status species' impacts are considered short term if the species recovers in less than one year and long term if it takes longer than one year for the species to recover.

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

Impact Analysis: Impacts to special status wildlife species are similar to those described in the Wildlife Section. Many of the potential impacts to special status species would be addressed through mitigation measures and terms of the informal consultation with USFWS (Appendix B).

Mechanical treatments have been limited and have not been implemented in special status species habitats because mechanical treatments are not effective on these invasive species. If mechanical treatments are used they have the potential to produce sediment, especially from repeated treatments, and could impact special status aquatic species.

Most treatments have used herbicide applications on highly invasive riparian species, and were designed to limit their spread and their impacts on special status species habitats. The herbicides proposed for use as a method of chemical control act upon plant-specific enzyme pathways; therefore the impact to special-status wildlife species under normal application conditions would be negligible to minor. Long-term persistence of herbicides in the food chain, bioaccumulation, and subsequent toxic effects are not expected to occur at the monuments. This is due to the chemicals proposed for use, the low rates at which they would be applied, and the small quantities of herbicide to be used. The chemicals proposed for use do not contain organo-chlorines that can cause egg-shell thinning and other harmful effects to wildlife. In the unlikely event of herbicide drift or runoff into aquatic habitats, the flow volumes through all water bodies are expected to immediately dilute the chemical, minimizing/eliminating any impacts to aquatic species. Treatments have been applied in areas of special status species habitats and the existing, native riparian species have effectively re-colonized the treated areas. Therefore, active restoration has been limited. It is expected that in the future, active restoration would continue to be limited because of the success of past re-colonization of riparian species.

Displacement of special status species would be limited by not applying treatments in riparian areas during times when southwest willow flycatchers and yellow-billed cuckoos would be nesting in or migrating through the area, as per the terms of the informal consultation with USFWS (Appendix B). Herbicides would not be applied during times of high stream flow to reduce the likelihood of contaminating surface waters and impacting aquatic species. Herbicides selected for use and the application methods would reduce the impacts as described in the Wildlife Section. In the unlikely event of herbicide drift or runoff into aquatic habitats, the flow volumes through all water bodies are expected to rapidly dilute the chemical, minimizing/eliminating adverse, short-term impacts to aquatic species.

The cultural treatment of prescribed fire may be used under this alternative. Additional consultation would be conducted with USFWS to discuss the specifics of the Prescribed Burn Plan prior to implementation to ensure no negative impacts to these species. Most areas treated using herbicides are expected to revegetate naturally thus improving special status species habitats. The pasture at Montezuma Well would not be restored under this alternative and would result in less special status species habitat improvement than Alternative II. No biological controls would be implemented under this alternative.

There are a number of invasive species in riparian habitats that are not being treated with mechanical or chemical methods. Their treatment is a lower priority at this time because they do not spread as rapidly as target species and/or their distribution is less wide-spread. Left untreated, these species have the potential to impact special status species habitat in the future.

Cumulative Impacts: Rapid urban development adjacent to the park units and across the Verde Valley is resulting in loss of riparian areas and habitats that are essential to the survival of most of the special status species. Past stocking of non-native fish, crayfish and bullfrogs that prey upon native fish species has had a substantial impact on native fish populations. Increasing recreation has the potential to displace special status species, especially since much recreation is focused in riparian areas. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to special status species, these alternatives would have negligible short and long-term cumulative impacts to the special status species.

Conclusion: Current treatments are targeted for riparian areas where special status species habitats are concentrated. This alternative would have short-term, minor, beneficial impacts to special status species as these are the habitats being targeted for priority treatments and restoration/maintenance of native plant communities. Since treatments have been ongoing, the invasive populations have been treated before large scale conversion of native habitat. The long-term impacts will be minor and beneficial as there will be continued chemical treatments in riparian areas, but overall fewer areas will be treated and less invasive species will continue to spread and degrade habitat. Impacts to special status species would be indirect and result from degradation of habitat, not from direct impacts to any special status species. Cumulative impacts would be negligible when considered in the context of ongoing loss of special status species habitats, primarily in riparian areas, in the vicinity of the monuments. Rapid urban development, impacts from introduced non-native aquatic species, and disturbances from increasing human recreation in the Verde Valley are causing the greatest impacts special status species. There would be no impairment of special status species from the implementation of this alternative.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

Impact Analysis: Short-term impacts to special status species from the implementation of mechanical and chemical treatments are very similar between this alternative and Alternative I. All ongoing treatments have been targeted to protect special status species habitats. The preferred alternative would have additional benefits from its ability to integrate treatment methods and to treat additional, less invasive species that are not currently being treated, but are present and slowly spreading in riparian habitats. This alternative would allow treatment of more species with the most effective and efficient treatment methods.

The impacts of chemical applications to special status species are similar to Alternative I. Although additional acres would be treated under this alternative, no additional impacts are predicted due to the mitigation measures that would be implemented during application. The least amount of the least toxic chemical would be applied.

Cultural treatments would be enhanced under this alternative as more acres would be treated and restored, and this alternative would restore important wildlife habitat in the pasture at Montezuma Well which a number of special status terrestrial species are expected to use. Prescribed fire may be used under this alternative. To ensure no negative impacts to these species, additional consultation would be conducted with USFWS on the site specific Prescribed Burn Plan.

Biological control is not likely to be used, but could include introducing insects to reduce invasive plant infestations. Using biological control could have minor, short-term, adverse impacts on special-status wildlife (e.g. through competition for food) if the method is not selected and monitored very carefully. No biological controls would be implemented without further consultation with USFWS. Low-risk methods are not likely to be used, but could include hot water/steam, vinegar or sugar compounds, or covering plants with plastic sheeting and would not be implemented if there is a risk of negatively impacting a special status species population or their habitat.

All of the methods described under the preferred alternative will have moderate, long-term, beneficial impacts to special-status species and their habitats when applied and monitored as prescribed in this plan. Native plant communities will be maintained or restored by removing invasive plant species.

Cumulative Impacts: The cumulative impacts are similar to Alternative I.

Conclusion: The preferred alternative would have short-term, minor, beneficial impacts to special-status species as treatment of riparian areas will continue to be a high priority to protect these habitats. The long-term impacts would be moderate and beneficial as integrated treatment methods will be used to treat more species, more populations using the most effective and efficient methods. The pasture at Montezuma Well would be restored, improving habitat for a number of special status species along Wet Beaver Creek. Impacts to special status species would be indirect and result from improvement of habitat, not from direct impacts to any special status species individuals. Cumulative impacts would be negligible when considered in the context of ongoing loss of special status species habitats, primarily in riparian areas, in the vicinity of the monuments. Rapid urban development, competition from non-native aquatic species, and disturbances from increasing human recreation in the Verde Valley are causing the greatest impacts special status species. There would be no impairment of special status species from the implementation of this alternative.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Impact Analysis: Alternative III has the most potential to impact special status species as all are dependent on riparian and/or aquatic habitats, and that is where the monument's most highly invasive species predominate. Mechanical and cultural treatments are not effective on many of these invasive species, and the inability to use chemical treatments would result in the spread of invasive plants and the loss of special status species habitats. Mechanical control methods have the greatest risk of soil erosion and sediment delivery to aquatic habitats, particularly from the need to frequently re-treat a number of species.

The lack of chemical treatments under this alternative would eliminate the risk of herbicide drift into aquatic habitats.

It is unlikely that prescribed fire would be used as an invasive plant control method under this alternative. Fire it is not an effective stand-alone treatment for the invasive species currently present, but is most effective in combination with chemical treatments. Since chemical treatments would not be implemented, prescribed fire would not be an effective treatment. Restoration would be limited under this alternative and the pasture at Montezuma Well would not be restored. Mechanical and cultural methods are not sufficient to remove the invasive populations present in the pasture and restoration would be ineffective without these treatments.

Cumulative Impacts: The cumulative impacts would be similar to Alternative I.

Conclusion: This alternative would have minor, adverse impacts as chemical treatments would no longer be an option to control invasive populations in riparian habitats used by special status species. Long-term impacts would be moderate and adverse as invasive riparian species would expand because mechanical and cultural methods are not effective treatments for these species. Impacts to special status species would be indirect and result from degradation of habitat, not from direct impacts to any special status species. Cumulative impacts would be negligible when considered in the context of ongoing loss of special status species habitats, primarily in riparian areas in the vicinity of the monuments. Rapid urban development and disturbances from increasing human recreation in the Verde Valley are causing the greatest impacts special status species. There would be no impairment of special status species from the implementation of this alternative.

Wetlands and Floodplains

Affected Environment

All three park units contain important water bodies that contribute to biological diversity, and enhance the visitor experience. While the parks' cultural resources are outstanding, the water bodies are also focal points of the visitor experience.

Montezuma Castle
There is a 2.5 mile ephemeral reach of Beaver Creek that flows through Montezuma Castle. Because this reach of Beaver Creek is ephemeral the aquatic systems are more limited. Median flow at the USGS gage on Beaver Creek is 42 CFS, but is highly variable. The picnic area and part of the main trail at Montezuma Castle are in the shade of the riparian gallery forest supported by Beaver Creek.

Montezuma Well
Montezuma Well unit of Montezuma Castle was established to protect Sinagua and Hohokam sites and a large, spring-fed limestone sink. This sink, known as Montezuma Well, is the focal point for visitors to this park unit. The Well has no known parallel anywhere in the world. It is unique in its depth, its highly carbonated waters, and its uniquely adapted endemic invertebrate community (Blinn and Oberlin 1996). Wet Beaver Creek is a high quality perennial stream that flows through the Well Unit for approximately 0.65 miles. The typical discharge on Wet Beaver Creek is about 10 CFS, but the creek is subject to occasional, intense flood events. One of the main trails parallels Wet Beaver Creek and the alignment of a prehistoric irrigation ditch.

Tuzigoot
The Verde River flows through the southern edge of Tuzigoot for approximately 0.4 miles. The Verde River is a major river system, one of few remaining free-flowing rivers in Arizona. The river provides habitat for a number of aquatic species, including several threatened and endangered fish species. The average flow volume is 82 CFS at Clarkdale. Tavasci Marsh, which was recently added to the monument, is located in a portion of an abandoned ox-bow meander of the Verde River. The marsh provides freshwater wetland/marsh habitat that is unique in this desert climate. Prehistorically and historically the marsh was maintained by flow from Shea Springs. In the last ten years additional flow has been routed through the marsh from the Verde River via Peck's Lake. This additional flow has resulted in the loss of much of the diversity of the site and the old cottonwoods and willows that once occupied the area. Most of the marsh is now dominated by cattails.

Methodology and Intensity Thresholds

Analyses of the potential intensity of impacts to wetlands and floodplains were derived from the available scientific data and literature and park staff's past observations of the effects on wetlands and floodplains from previous invasive plant removal projects. The thresholds of change for the intensity of an impact are defined as follows:

Table 12: Impact Intensities and Definitions – Wetlands and Floodplains

Impact Intensity	Intensity Definition
Negligible	Any effects to would be below or at the lower levels of detection. Any detectable effects would be slight.
Minor	Effects would be detectable, site specific and relative small and short-term.
Moderate	The effects would be detectable and readily apparent. The effect could be site-specific or monument-wide.
Major	Effects would be observable over a relatively large localized or regional area. The character of the wetland or floodplain would substantially change.

Duration of wetland/floodplain impacts is considered short term if wetland/floodplain recovers in less than three years and long term if the wetland/floodplain takes longer than three years to recover.

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

Impact Analysis: Alternative I continues current management practices. Mechanical treatments would be implemented in smaller, less invasive plant populations. Mechanical treatments when fully applied could require frequent re-treatment in wetland and floodplain areas where soils are moist or saturated and subject to erosion or compaction from disturbance. As described in the Soil Resource section, mechanical treatments can result in soil erosion. A number of mitigation practices would be implemented to reduce these impacts as described in the Alternatives Chapter.

Chemical herbicide treatments are being conducted at all three units on highly invasive species in floodplains, riparian areas, and in Tavasci Marsh. These treatments are designed to reduce/eliminate highly invasive species and promote native plant communities. Maintenance of native plant communities will enhance the function of the wetlands and floodplains.

Cultural treatments such prescribed fire may be applied to treat invasive plant populations. Mitigation measures specific to the proposed burn area would be developed as part of the Prescribed Fire Plan to mitigate adverse impacts to floodplains and wetlands, particularly from soil erosion following the burn. Restoration of the pasture at Montezuma Well would not be implemented under this alternative and any benefits to wetlands and floodplains would not be realized. Biological treatments are not currently being applied.

Cumulative Impacts: Rapid urban development adjacent to the park units and in riparian areas is resulting in loss of floodplain habitat across the Verde Valley. Recreation is increasing in the Verde Valley and much of the increase is in riparian/floodplain habitats for hiking, fishing, hunting bird watching and camping. Recreation is a source of riparian area disturbance. When combined with other past, present, and foreseeable future actions that would result in impacts to wetlands and floodplains, these alternatives would have negligible short and long-term cumulative impacts to wetlands and floodplains.

Conclusion: Impacts from chemical treatments in the short and long-term are expected to be minor, beneficial because of the reduction of invasive species on these areas, favoring native species that enhance the function of wetlands and floodplains. A number of mitigation measures are implemented to reduce negative impacts from treatments. The condition and function of wetlands and floodplains would not be directly impacted from implementation of this alternative. Benefits would be indirect from the improvement of the condition of vegetation and soils. Cumulative impacts would be negligible when considered in the context of ongoing loss of wetlands and floodplains in the vicinity of the monuments. Much of the urban development and agriculture is taking place on upper terraces of the floodplain. There would be no impairment of the wetlands or floodplains from the implementation of this alternative.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

Impact Analysis: The short-term impacts from the use of chemical treatments on wetlands and floodplains from Alternative II are similar to those described for Alternative I. The use of mechanical treatments would be reduced resulting in reduced impacts to the functioning of wetlands and floodplains from ground disturbance. The full use of integrated pest management techniques would result in additional treatments in floodplain/wetland areas in the long-term. The most effective and efficient treatment methods would be implemented increasing the ability to treat 'lower priority' invasive species, and other understory floodplain/wetland invasives such as kochia and Dalmatian toadflax that are not currently being treated.

This alternative would implement the restoration of the pasture at Montezuma Well which is on the floodplain of Wet Beaver Creek. Native vegetation would be restored, and floodplain function would be improved on approximately 10-12 acres along this reach. Prescribed fire may be used as a management tool at Tavasci Marsh and at the pasture at Montezuma Well. The use of fire would strictly follow the Prescribed Burn Plan and would not impact the function of the wetland and floodplain resources. Biological control is not likely to be used, but could include introducing insects or herbivory to reduce invasive plant infestations. Insects would have no impacts on floodplains or wetlands. Low-risk methods

are not likely to be used, but could include hot water/steam, vinegar or sugar compounds, or covering plants with plastic sheeting. These methods will not impact floodplains or wetlands if applied properly.

Cumulative Impacts: These impacts would be similar to Alternative I.

Conclusion: More acres would be treated under this alternative than under Alternatives I and III. Impacts are predicted to be minor, beneficial, and localized in the short-term from the restoration and maintenance of native plant communities that enhance the function of floodplains and wetlands. Application of mitigation measures and use of the most appropriate application techniques would reduce the impacts of this alternative. The long-term impacts are expected to be moderate and beneficial because additional areas and populations would be treated over time. Additional long-term benefits are realized under this alternative from the restoration of the pasture on the floodplain at Montezuma Well. The condition and function of wetlands and floodplains would not be directly impacted from implementation of this alternative. Benefits would be indirect from the improvement of the condition of vegetation and soils. Cumulative impacts would be negligible when considered in the context of ongoing loss of wetlands and floodplains in the vicinity of the monuments. Much of the urban development and agriculture is taking place on upper terraces of the floodplain. There would be no impairment of the wetlands or floodplains from the implementation of this alternative.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Impact Analysis: Adverse impacts to floodplains and wetlands are expected to be greatest under this alternative. Mechanical methods would be the primary treatment used and would result in greater soil disturbance and a greater risk of soil erosion and sediment delivery, particularly due to the repeated mechanical treatments. Most of the invasive species currently on floodplains and wetlands are not effectively treated using mechanical methods and repeated treatments would be required to try to reduce their populations. Mechanical treatments are labor intensive and expensive to implement, reducing the areas that would be treated under this alternative. Mechanical treatment in saturated soils of wetlands would not meet the objectives of the mitigation measures and would result in a loss of soil stability. Invasive species are expected to continue to expand and adversely impact additional wetland and floodplain areas as mechanical and cultural treatments are not effective on many of these species. There would be a continued loss of native vegetation degrading floodplain and wetland condition and function.

Restoration would be limited under this alternative to fewer, smaller treatment areas. The floodplain pasture at Montezuma Well would not be restored under this alternative. The use of prescribed fire would be limited under this alternative as it is most effective when used in combination with other treatments, especially chemical methods. Low-risk methods are not likely to be used, but could include hot water/steam, vinegar or sugar compounds, or covering plants with plastic sheeting. These methods will not impact floodplains or wetlands if applied properly.

Cumulative Impacts: Cumulative impacts would be similar to Alternative I.

Conclusion: Impacts to wetlands and floodplains from this alternative are predicted to be moderate and adverse in the short and long-term due to the need for repeated mechanical treatments, the lack of effectiveness on many invasive species, disturbance of wet and saturated soils by mechanical treatments, and expansion of invasive species populations. The condition and function of wetlands and floodplains would not be directly impacted from implementation of this alternative; however, there would be indirect impacts from the continued loss of native vegetation and degradation of soil condition. Cumulative impacts would be negligible when considered in the context of ongoing loss of wetlands and floodplains in the vicinity of the monuments. Much of the urban development and agriculture is taking place on upper terraces of the floodplain. There would be no impairment of the wetlands or floodplains from the implementation of this alternative.

Executive Orders 11988 and 11990

Executive Order 11988 (*Floodplain Management*) requires an examination of impacts to floodplains and the potential risk involved in placing facilities in floodplains. None of the alternatives would change the ability of a floodplain to convey floodwaters or its values and functions, nor would it contribute to a flood. Executive Order 11990 (*Protection of Wetlands*) requires an examination of impacts to wetlands and that there be no net loss of wetland habitat by the project. None of the alternatives would result in the loss of wetland habitat.

Water Quality and Quantity

Affected Environment

All three park units contain important water bodies that are described in the Wetlands and Floodplains section above. The Arizona Department of Water Quality (ADEQ 2002) has assessed the water quality of the stream reaches flowing through all three park units. Most water bodies are fully attaining their designated use. Those that are not are listed below:

Verde River/Oak Creek/Beaver Creek (Tuzigoot): Results were inconclusive and this reach was added to the Planning List for future sampling due to missing core parameters at one of three sampling events.

Beaver Creek/Dry Beaver/Verde River (Montezuma Castle and Well): This reach was assessed as 'impaired' due to turbidity. It was added to the Planning List for future sampling due to missing core parameters.

Montezuma Well: This is considered an unusual water body and is not sampled by ADEQ. Sampling by various investigators in the past has found high concentrations of carbon dioxide and high levels of arsenic (Blinn 2004).

Additional water quality sampling specific to the park units, including Montezuma Well and Tavasci Marsh, is ongoing by the Sonoran Desert Inventory and Monitoring Network. However, no results are available at this time.

The primary water quality and water quantity concerns at all water bodies are the high rates of withdrawal of surface water for irrigation and ground water for irrigation and domestic use. There are also concerns over non-point source pollution from urban development and agricultural and livestock runoff (Sprouse et al. 2002).

Methodology and Intensity Thresholds

Analyses of the potential intensity of impacts to water quality and quantity were derived from park staff's past observations of the effects on water quality and quantity from visitor use, and in consultation with the US Fish and Wildlife Service. The thresholds of change for the intensity of an impact are defined as follows:

Table 13: Impact Intensities and Definitions – Water Quality and Quantity

Impact Intensity	Intensity Definition
Negligible	There would be no observable or measurable impacts to water quantity or quality. Impacts would be well within natural fluctuations.
Minor	Impacts would be detectable and/or localized, but they would not be expected to be outside the natural range of variability. Mitigation measures, if needed to offset adverse effects, would be simple and successful.
Moderate	The impact to water quality or quantity would be readily apparent and result in a change over a relatively wide area. Mitigation measures would be necessary to offset adverse effects and likely be successful.
Major	The impact to water quality or quantity would be readily apparent and substantially change over a wide area. Mitigation measures to offset adverse effects would be necessary, extensive, and their success could not be guaranteed.

Duration of water quality impacts is considered short term if the resource in less than one year and long term if the water quality takes longer than one year to recover.

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

Impact Analysis. Under this alternative, mechanical and chemical treatments would be the primary methods used. The soil disturbance from mechanical removal of invasive plants could reduce soil stability until plants have reestablished on the disturbed sites, which could result in sedimentation and reduced water quality in water bodies after rain events. This potential impact would be reduced by tamping the soil back into place after removal of the invasive plants and implementation of other mitigation practices. Mechanical treatments are not effective on many of the highly invasive riparian species such as tamarisk resulting in the need to retreat populations in these areas. This would result in additional soil disturbance and the risk of soil erosion that could impact water quality with each treatment. Mechanical treatments on saturated soils such as those at Tavasci Marsh could result in a loss of soil stability and increased sediment in the water.

Chemical treatments are being used in riparian areas and at Tavasci Marsh to treat highly invasive riparian species. A number of mitigation measures including the use of the most effective application method and least harmful herbicide are being applied and reduce the potential impacts of this treatment method (Alternatives Chapter). However, there would always be the risk of drift or runoff of chemicals when applied near water even with the most careful application methods. In the unlikely event that this would happen, the flow volumes of the streams and water bodies in the park units are expected to quickly dilute the chemical and have negligible to minor short-term impacts.

Cultural treatments such as prescribed fire could have an adverse, short-term impact on water quality following run-off events. Site specific mitigation measures to reduce soil erosion would be developed and implemented through the prescribed fire burn plan. Restoration of the pasture at Montezuma Well would not be implemented under this alternative and any benefits to water quality would not be realized.

Cumulative Impacts: Rapid urban development adjacent to the park units and in riparian areas of the Verde Valley is resulting in an overall reduction of water quality and water quantity. Ground and surface water are being used at an increasing rate. Water quality is at risk from soil erosion from construction sites, septic systems, and other urban contaminants. Recreation is increasing in the Verde Valley and the waste from recreational users and their pets poses a threat to water quality. When combined with other past, present, and foreseeable future actions that would result in impacts to water quality and quantity, these alternatives would have negligible short and long-term cumulative impacts to water resources.

Conclusion: The impacts of this alternative are predicted to be minor and adverse in the short-term from the soil erosion resulting from mechanical treatments and the potential risk for herbicide drift and leaching from chemical treatments. Long-term impacts are expected to be minor and beneficial as treated areas would be restored or quickly re-vegetate resulting in improved soil stability and reduced sedimentation. Any chemical contamination would be quickly diluted and not be a long-term concern. No changes to water quantity are expected under this alternative because invasive species would be quickly replaced by native species that are expected to have similar evapo-transpiration rates. Water quality would not be directly impacted from implementation of this alternative as no chemicals would be applied to surface waters. There may be indirect effects to water quality from chemical drift and leaching, and from sedimentation that results from soil erosion. Cumulative impacts would be negligible when considered in the context of ongoing urbanization and agricultural activities such as farming and grazing that are ongoing in the watershed that are impacting water quality and quantity. There would be no impairment of the water quality or quantity from the implementation of this alternative.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

Impact Analysis: Using an integrated approach will allow the parks to use the most appropriate treatment methods and minimize the adverse impacts of the treatments. The short-term impacts of this alterative are similar to Alternative I.

Long-term impacts of the preferred alternative would result in the additional use of chemical herbicides and less soil disturbance than the other two alternatives. The risks associated with the use of herbicides would be offset by a decrease in the amount of soil disturbance from mechanical treatments and the careful selection of the appropriate herbicides and application methods to minimize impacts to water quality.

Cultural treatments such as prescribed fire would have an adverse, short-term impact on water quality following run-off events. Site specific mitigation measures to reduce soil erosion would be developed and implemented through the prescribed fire burn plan. Restoration of the pasture at Montezuma Well is expected to reduce sediment delivery to Wet Beaver Creek by improving vegetative ground cover and soil stability near the stream. However, it is unlikely that this will result in a measurable improvement in water quality. Biological control is not likely to be used. Low-risk methods are not likely to be used, but could include hot water/steam, vinegar or sugar compounds, or covering plants with plastic sheeting. These methods will not impact water quality or quantity if applied properly.

Cumulative Impacts: The cumulative impacts of this alternative are similar to Alternative I.

Conclusion: The impacts of this alternative are predicted to be minor in the short-term from the risk of soil erosion from mechanical treatments and the potential for herbicide drift that could adversely affect water quality. Application of a number of mitigation measures will serve to reduce or eliminate these risks. Long-term impacts are expected to be moderate and beneficial as more areas would be treated and restored, reducing the potential for soil erosion. Any chemical contamination would be quickly diluted and not detectable in the system in the long-term. No changes to water quantity are expected under this alternative because invasive species would be quickly replaced by native species that are expected to have similar evapo-transpiration rates. Water quality would not be directly impacted from implementation of this alternative as no chemicals would be applied to surface waters. There may be indirect effects to water quality from chemical drift and leaching, and from sedimentation that results from soil erosion. Cumulative impacts would be negligible when considered in the context of ongoing urbanization and agricultural activities such as farming and grazing that are ongoing in the watershed that are impacting water quality and quantity. There would be no impairment of the water quality or quantity from the implementation of this alternative.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Impact Analysis: Reliance on only mechanical and cultural treatment methods could result in an adverse impact to water quality from soil disturbance and erosion. Many of the most highly invasive species are found in riparian areas, and mechanical treatment methods are not effective against these species as they resprout following disturbance. While mechanical treatments would result in a loss of soil stability on the treated areas, this would be offset by the small areas that would be treated under this alternative due to the high expense.

The risk of chemical drift would be eliminated under this alternative.

Cultural treatments such as prescribed fire would have an adverse, short-term impact on water quality following run-off events. The use of fire would be limited under this alternative as this method is most successful when used in an integrated method with other treatments, such as herbicides. Cultural treatments such as restoration of native plant communities would be limited under this alternative. Few areas would be restored as mechanical methods would not effectively remove many of invasive species populations, however, limited restoration of treated areas may be applied under this alternative. Low-risk methods are not likely to be used, but could include hot water/steam, vinegar or sugar compounds, or covering plants with plastic sheeting. These methods will not water quality if applied properly.

Cumulative Impacts: These impacts are similar to Alternative I.

Conclusion: The short and long-term impacts of this alternative are expected to be minor and adverse as mechanical methods would increase the risk of sediment delivery to the water bodies, however, few areas would be treated reducing the impacts from sedimentation on water quality. No impacts to water quantity are expected. Water quality would not be directly impacted from implementation of this alternative as no chemicals would be applied. There may be indirect effects to water quality from sedimentation that results from soil erosion. Cumulative impacts would be negligible when considered in the context of ongoing urbanization and agricultural activities such as farming and grazing that are ongoing in the watershed that are impacting water quality and quantity. There would be no impairment of the water quality or quantity from the implementation of this alternative.

Historic Structures

Affected Environment

All three park units contain historic structures, encompassing both prehistoric ruins and historic resources. Prehistoric structures with standing architecture will be addressed in this section while archeological resources in general will be addressed in the Archeological Resources section.

Montezuma Castle
Montezuma Castle contains four historic structures and numerous prehistoric ruins with standing architecture. Historic structures include two adobe residences, a masonry storage shed and the park's visitor center, a Mission 66 building.

Montezuma Well
Montezuma Well contains three historic structures and numerous prehistoric ruins with standing architecture. Historic structures include the Back family cabin and adjacent smokehouse as well as a historic alignment of the prehistoric irrigation ditch.

Tuzigoot
Tuzigoot National Monument contains four historic structures and three prehistoric sites with standing architecture. Historic structures include the Civil Works Administration constructed visitor center, storage shed, and pump house, as well as a historic masonry retaining wall. Prehistoric structures with standing architecture include Tuzigoot Pueblo consisting of 86 ground floor rooms as well as two fieldhouses located on the rocky slopes above Tavasci Marsh.

Methodology and Intensity Thresholds

Analyses of the potential intensity of impacts to historic structures were derived from the available scientific data and literature and park staff's past observations of the effects on historic structures during past stabilization and mitigation projects. The thresholds of change for the intensity of an impact are defined as follows:

Table 14: Impact Intensities and Definitions – Historic Structures

Impact Intensity	Intensity Definition
Negligible	Any effects to would be below or at the lower levels of detection. Any detectable effects would be slight.
Minor	Effects would be detectable, site specific and relatively small and short-term.
Moderate	The effects would be detectable and readily apparent. The effect could be site-specific or monument-wide.
Major	Effects would be observable over a relatively large localized or regional area. The character of the historic structure would substantially changed.

Duration of all historic structures impacts are considered long term (permanent) because, even if the physical damage can be repaired, damage to, or loss of historic fabric from a historic structure cannot be adequately mitigated.

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

Impact Analysis: Under this alternative, mechanical and cultural treatments would be the primary methods used. Neither mechanical nor cultural treatments are to be implemented adjacent to historic structures, and chemical treatments would only be employed on large infestations of highly invasive plants. As a result, only a limited number of infestations will be treated both because of the labor intensiveness of mechanical removal and the restrictions on mechanical and cultural treatments around historic structures. Historic structures not treated would have adverse, moderate, long-term, direct impacts because of the increased risk of bioturbation and because of the risk of wildfires in areas that do not normally have fires. Overall, this alternative would have minor, adverse, long term impacts on historic structures.

Cumulative Impacts: Rapid urban development in the Verde Valley is resulting in the loss of historic and prehistoric structures. In addition, the loss of natural landscapes and viewsheds compromise the "setting" of the remaining structures. Within the park, proposed construction projects would take place in areas already disturbed by facilities and would neither disturb historic structures nor further impact their viewsheds. Growing recreational pressures throughout the Valley will result in increased visitation to the remaining historic structures resulting in additional damage to standing architecture. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to historic structures, this alternative would have negligible short and long-term cumulative impacts to the park's historic structures.

Conclusion: Continuing current treatment methods would have moderate, adverse impacts on historic structures since there is the potential for bioturbation and wildfire impacts. Cumulative effects would be negligible. There would be no impairment to historic resources from implementation of this alternative.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

Impact Analysis: Using an integrated approach to manage exotic plant infestations will allow the park to utilize the greatest number of options to treat these species while minimizing impacts to historic structures. Compared to Alternative 1, impacts are minimized because mechanical control methods like digging plants, mowing, or using string trimmers to cut back plants would be used primarily on small exotic plant infestations. When these treatments, or the cutting of woody invasive species, occur near historic structures they will be monitored by a cultural resource specialist to ensure no damage is done to the standing architecture. Prescribed burns in areas containing historic structures would only be undertaken after developing site specific burn plans in cooperation with the Saguaro National Park Fire Management staff and additional consultation with the US Fish and Wildlife Service.

Chemical control, which can be very effective for large infestations of exotic plants and for plants with growth habits that make mechanical control methods ineffective, can also be an effective control method adjacent to historic structures where the use of hand tools and ground disturbance is restricted or prohibited. Through careful, controlled application, the use of herbicides to control exotic plants would have a negligible impact on historic structures.

Cultural control could have an adverse impact on historic structures through the ground-disturbing activities associated with native plant revegetation. Any revegetation activity would require cultural clearance and supervision by a cultural resource specialist to reduce the likelihood of adverse impacts on historic structures. The removal of exotic plant species will enhance the restoration of native plant

communities reducing the risk of wildfire in the parks. Overall, the preferred alternative will have long-term, moderate beneficial impacts on historic structures.

Cumulative Impacts: These impacts would be identical to Alternative I.

Conclusion: The preferred alternative will have moderate beneficial impacts on historic structures as infestations would be treated using the most effective treatment method(s) with the least impact to historic resources. The cumulative effects on these resources would be negligible and long term. Implementation of this alternative would not result in impairment of historic resources.

§106 Summary: Montezuma Castle, Montezuma Well, and Tuzigoot all contain numerous archeological sites, many of which do not retain, or never had, standing architecture. All of these sites are included as contributing sites on the National Register of Historic Places nomination and are covered by the provisions of §106 of the National Historic Preservation Act. Any action taken under this project which has the potential to affect either archeological or historic sites on or eligible for the National Register will be subject to individual and separate §106 compliance.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Impact Analysis: Adverse impacts to historic structures are expected to be greatest under this alternative. Mechanical methods would be the primary treatment used and would result in limited ability to control invasive species around prehistoric structures. The overgrowth of invasive species in culturally sensitive areas would result in increased bioturbation of sites, mechanical damage from plant growth, and risk of wildfires in areas that do not normally have fires. Overall, this alternative would have moderate, adverse, long term impacts on historic structures.

Cumulative Impacts: These impacts would be identical to Alternative I.

Conclusion: Impacts to historic structures from this alternative are predicted to be moderate and adverse in the short and long term from increased bioturbation and increased risk of wildfire. The cumulative effects on these resources would be negligible. This alternative would not result in impairment of historic or prehistoric resources.

Archeological Resources

Affected Environment

All three park units contain archeological resources including pueblo ruins, rock shelters, lithic scatters, lithic quarries, cliff dwellings, fieldhouses and isolated agricultural features. Montezuma Castle was 100% surveyed by the National Park Service's Western Archeological and Conservation Center (WACC) in 1988 while Tuzigoot was 100% surveyed by WACC in 1986. There are a total of 66 prehistoric sites identified at Montezuma Castle National Monument and six sites identified within Tuzigoot National Monument.

Montezuma Castle
Montezuma Castle contains 28 archeological sites, many of which lie in close proximity to large populations of invasive flora.

Montezuma Well
Montezuma Well contains 38 archeological sites.

Tuzigoot
Tuzigoot National Monument has six archeological sites.

Methodology and Intensity Thresholds

Table 15: Impact Intensities and Definitions – Archeological Resources

Impact Intensity	Intensity Definition
Negligible	Any effects to would be below or at the lower levels of detection. Any detectable effects would be slight.
Minor	Effects would be detectable, site specific and relatively small and short-term.
Moderate	The effects would be detectable and readily apparent. The effect could be site-specific or monument-wide.
Major	Effects would be observable over a relatively large localized or regional area. The character of the archeological resource would substantially changed.

Duration of all archeological resource impacts are considered long term (permanent) because, even if the physical damage can be repaired, damage to an archeological site cannot be adequately mitigated.

Analyses of the potential intensity of impacts to archeological resources were derived from the available scientific data and literature and park staff's past observations of the effects on archeological resources during past stabilization and mitigation projects. The thresholds of change for the intensity of an impact are defined as follows:

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

Impact Analysis: Under this alternative, mechanical and cultural treatments would be the primary methods used. Neither mechanical nor cultural treatments are to be implemented at archeological sites, and chemical treatments would only be employed on large infestations of highly invasive plants. As a result, only a limited number of infestations will be treated both because of the labor intensiveness of mechanical removal and the restrictions on mechanical and cultural treatments around archeological resources. Sites not treated would have adverse, moderate, long-term, direct impacts because of the increased risk of bioturbation and because of the risk of wildfires in areas that do not normally have fires. Overall, this alternative would have minor, adverse, long term impacts on archeological resources.

Cumulative Impacts: Rapid urban development in the Verde Valley is resulting in the loss of archeological. In addition, the loss of natural landscapes and viewsheds compromise the "setting" of the remaining sites. Within the park, proposed construction projects would take place in areas already disturbed by facilities and would neither disturb archeological sites nor further impact their viewsheds. Growing recreational pressures throughout the Valley will result in increased visitation to the remaining archeological sites resulting in additional damage to, and destruction of these resources. In addition, the increasing value of archeological artifacts is resulting in increased incidences of pot hunting further contributing to the destruction of archeological sites. Thus, when combined with other past, present, and foreseeable future actions that would result in impacts to historic structures, this alternative would have negligible short and long-term cumulative impacts to the park's archeological resources.

Conclusion: Continuing current treatment methods would have moderate, adverse, long-term impacts on archeological resources as infestations of invasive species would not be adequately treated to protect the archeological resources. The cumulative effects on these resources would be negligible. -There would be no impairment of archeological resources from implementation of this alternative.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

Impact Analysis: Using an integrated approach to manage exotic plant infestations will allow the park to utilize the greatest number of options to treat these species while minimizing impacts to archeological resources. Compared to Alternative 1, impacts are minimized because mechanical control methods like digging plants, mowing, or using string trimmers to cut back plants would be used primarily on small

exotic plant infestations. When these treatments, or the cutting of woody invasive species, occur near archeological resources they will be monitored by a cultural resource specialist to ensure no damage is done to the standing architecture.

Chemical control, which can be very effective for large infestations of exotic plants and for plants with growth habits that make mechanical control methods ineffective, can also be an effective control method around archeological sites where the use of hand tools and ground disturbance is restricted or prohibited. Through careful, controlled application, the use of herbicides to control exotic plants would have a negligible impact on archeological resources.

Cultural control could have an adverse impact on archeological resources through the ground-disturbing activities associated with native plant revegetation. Any revegetation activity would require cultural clearance and supervision by the park archeologist to reduce the likelihood of adverse impacts on historic structures. The removal of exotic plant species will enhance the restoration of native plant communities reducing the risk of wildfire in the parks. Overall, the preferred alternative will have long-term, moderate beneficial impacts on archeological resources.

Cumulative Impacts: These impacts would be identical to Alternative I.

Conclusion: The preferred alternative will have moderate beneficial short and long –term impacts on archeological resources as the most effective treatment method(s) would be used to reduce impacts. The cumulative effects on these resources would be negligible. This alternative would not result in impairment to archeological resources.

§106 Summary: Montezuma Castle, Montezuma Well, and Tuzigoot all contain numerous archeological sites, many of which do not retain, or never had, standing architecture. All of these sites are included as contributing sites on the National Register of Historic Places nomination and are covered by the provisions of §106 of the National Historic Preservation Act. Any action taken under this project which has the potential to affect either archeological or historic sites on or eligible for the National Register will be subject to individual and separate §106 compliance.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Impact Analysis: Adverse impacts to archeological resources are expected to be greatest under this alternative. Mechanical methods would be the primary treatment used and would result in limited ability to control invasive species around archeological sites. The overgrowth of invasive species in culturally sensitive areas would result in increased bioturbation of sites, mechanical damage from plant growth, and risk of wildfires in areas that do not normally have fires. Overall, this alternative would have moderate, adverse, long term impacts on archeological resources.

Cumulative Impacts: These impacts would be identical to Alternative I.

Conclusion: Impacts to archeological resources from this alternative are predicted to be moderate and adverse in the short and long-term from bioturbation and the increased risk of wildfire. The cumulative effects on these resources would be negligible. There would be no impairment of archeological resources from implementation of this alternative.

Visitor Use and Experience

Affected Environment

Table 16: Impact Intensities and Definitions – Visitor Use and Experience

Impact Intensity	Intensity Definition

Negligible	Visitors would not be affected or changes in visitor use and/or experience would be below or at the level of detection. Any effects would be short-term. The visitor would not likely be aware of the effects associated with the alternative.
Minor	Changes in visitor use and/or experience would be detectable, although the changes would be slight and likely short-term. The visitor would be aware of the effects associated with the alternative, but the effects would be slight.
Moderate	Changes in visitor use and/or experience would be readily apparent and likely long-term. The visitor would be aware of the effects associated with the alternative, and would likely be able to express an opinion about the changes.
Major	Changes in visitor use and/or experience would be readily apparent and have substantial long-term consequences. The visitor would be aware of the effects associated with the alternative, and would likely express a strong opinion about the changes.

Duration of visitor experience impacts is considered short term if the viewshed recovers in less than three years and long term if the viewshed takes longer than three years to recover.

Montezuma Castle National Monument was established to protect its Sinaguan cliff dwellings; the most notable being the five-story, 20 room structure known as Montezuma Castle that is perched on a limestone cliff above Beaver Creek. The Montezuma Well unit protects additional Sinagua and Hohokam sites and a large, spring-fed limestone sink that has no known parallel anywhere in the world (Blinn and Oberliln 1996). Tuzigoot National Monument was established to preserve Tuzigoot pueblo, a multi-story, 110-room structure occupied from approximately AD 1125 to 1450. The methodology used for assessing impacts to visitor use and experience is based on how invasive plant treatments and restoration of native plant communities would affect the visitor, particularly with regards to the visitors' enjoyment of the monuments' primary resources. This analysis will also focus on how visitor use and experience would be affected. The thresholds for this impact assessment are as follows:

Alternative I: Continuation of Current Management Practices – Mechanical and cultural treatments would be used to manage invasive plants. Limited chemical treatments would be used on large populations of highly invasive plant species.

Impact Analysis: The location and extent of the invasive species populations treated is more important to the visitor experience than the treatment method. There are a number of invasive plant species in high visibility areas such as roads, trails, walkways, and the riparian and areas. Current management practices treat only the highly invasive, large populations of invasive species in the riparian areas and wetland habitats, maintaining the viewshed in these visitor focal points in the short-term. Less invasive species along roads and trails are a lower priority for treatment because of the cost of implementing mechanical methods, so visitors are not afforded the opportunity to view these native plant communities in a 'natural' setting. There will be a continuing, gradual loss of the view of 'natural' plant communities at all focal points as not all of the invasive species will be treated in these areas.

Treatments done in sight of visitors will be posted with interpretive signs explaining the objectives of the project. Additional educational materials will be supplied to visitors and adjacent land owners on the importance of planting non-invasive species and treating invasive species to maintain native plant communities. The pasture at Montezuma Well would not be restored under this alternative, reducing the opportunities for hiking trails and interpretation at this location. Visitors would continue to avoid this area because of the difficulty in crossing the area due to invasive plants with numerous spines and seeds that stick to clothing.

Some areas may be closed to visitors during treatment implementation, resulting in a reduced experience during the visit.

Cumulative Impacts: Rapid urban development adjacent to the park units is impacting the natural settings of the park units and the overall viewshed. Recreation is increasing in the Verde Valley and park visitation is increasing at these park units reducing the feeling of solitude and nature. When combined with other past, present, and foreseeable future actions that would result in impacts to visitor use and

experience, this alternative would have negligible short and long-term cumulative impacts to the visitor's experience.

Conclusion: The impacts of this alternative to visitor use and enjoyment would be minor, beneficial in the short and long-term as treatments are being conducted at the riparian/wetland visitor focal points. Treatments along travel corridors would be very limited resulting in long-term minor and adverse impacts to the visitor experience from the loss of the natural vegetation and setting in these areas; and because the benefits of native plant restoration, the creation of trails, and new opportunities for interpretation would not be realized in the pasture at Montezuma Well. There may be direct, short-term impacts to the visitor experience if areas are closed to visitation during treatment implementation and recovery. The long-term impacts to the visitor experience would be indirect by providing a more natural setting and improved viewsheds. Cumulative impacts from this alternative would be negligible due to the increasing urbanization in areas adjacent to the park that impact the viewshed and solitude of visitors.

Alternative II: Preferred Alternative – Full use of Integrated Pest Management techniques (mechanical, cultural, chemical, and biological control) to manage invasive plants.

Impact Analysis: Alternative II would continue to treat large populations of highly invasive plants at visitor focal points, similar to Alternative I. Additional treatments along roads, trails and walkways would be conducted under this alternative. By using the most effective treatment methods, additional acres of invasive plant species would be treated and more acres would be restored to native vegetation, thus enhancing both the natural setting and the visitor experience.

The pasture at Montezuma Well would be restored to native vegetation, and interpretive displays and signs would be posted. These areas would be available for interpretive and educational programs resulting in an enhanced visitor experience.

Cumulative Impacts: The cumulative impact of this alternative is similar to Alternative I.

Conclusion: This alternative would result in the greatest improvement to the visitor experience because more areas would be treated (especially travel corridors) and the pasture at Montezuma Well would be restored and available for the enjoyment of visitors. The short-term impacts of this alternative would be minor, and beneficial from treatments along corridors and focal points. There may be direct, short-term impacts to the visitor experience if areas are closed to visitation during treatment implementation and recovery. Impacts would be moderate and beneficial in the long-term from ongoing treatments that improve the travel corridors and viewsheds, and the added benefits from restoration of the pasture at Montezuma Well. Long-term impacts would indirectly benefit the visitors by providing a more natural setting and additional interpretive opportunities. Cumulative impacts from this alternative would be negligible due to the increasing urbanization in areas adjacent to the park that impact the viewshed and solitude of visitors.

Alternative III: Limited use of IPM techniques (mechanical and cultural) to manage invasive plants. No use of chemical or biological treatments.

Impact Analysis: This alternative has the potential to adversely impact the visitor use and experience more than other alternatives. Mechanical treatments would be the primary method used for invasive treatments resulting in soil disturbance in view of roads, walkways, trails and in the visitor focal points. Treatments along these visitor access corridors would be limited, in order to focus efforts on 'highly' invasive plant species in riparian and wetland habitats. The amount of area treated under this alternative would be the least due to the cost and labor intensiveness of mechanical treatments. Invasive species populations would continue to increase and impact the native vegetation and 'natural' setting of the parks, thus reducing the visitor experience. The pasture at Montezuma Well would not be restored and the opportunities for interpretation, educational programs and visitor access would not be realized.

Cumulative Impacts: The cumulative impact of this alternative is similar to Alternative I.

Conclusion: The impacts of this alternative are expected to be minor and adverse in the short and long-term due to the lack of treatments and loss of native vegetation along visitor access corridors and focal points. There may be direct, short-term impacts to the visitor experience if areas are closed to visitation during treatment implementation and recovery. The long-term impacts are predicted to be moderate and adverse as the ability of visitors to view natural setting and native plant communities would be diminished from the continued spread of invasive plants. The pasture would not be restored and be available for the visitors enjoyment. The long-term impacts of this alternative indirectly impact visitors by resulting in a diminished experience and lack of additional interpretive opportunities. Cumulative impacts from this alternative would be negligible due to the increasing urbanization in areas adjacent to the park that impact the viewshed and solitude of visitors.

CONSULTATION AND COORDINATION

External Scoping

External (public) scoping was conducted to inform various agencies and the public about the proposal to implement invasive plant management and restoration at Montezuma Castle and Tuzigoot National Monuments, and to generate input on the preparation of this Environmental Assessment.

External scoping was initiated with the distribution of a scoping letter to inform the public of the proposal to implement invasive plant management and restoration, and to generate input on the preparation of this Environmental Assessment. The scoping letter dated March, 18, 2007 was mailed to 63 addressees including landowners adjacent to the Monuments, various federal and state agencies, affiliated Native American tribes, local governments, and local news agencies. Information on the environmental assessment was also posted on the National Park Service Planning, Environment, and Public Comment website (PEPC) at http://parkplanning.nps.gov/. The public was given 30 days to comment on the project beginning March 18, 2007. No comments were received from either the mailing or the internet posting. Addressees included:

Federal Agencies
U.S. Forest Service

State Agencies
Arizona State Parks
Arizona Department of Game and Fish

Affiliated Native American Groups
Ak-Chin Indian Community
Gila River Indian Community
Hopi Tribe
Pueblo of Zuni
Tohono O'odham Nation
Yavapai-Apache Nation
Yavapai-Prescott Tribe
Salt River Pima-Maricopa Indian Community

A meeting was held on June 1, 2007, with members of Friends of the Well to discuss invasive species treatments, restoration of native species, and provide additional interpretive opportunities at the pasture at Montezuma Well as part of a grant proposal being prepared to seek additional funds from Arizona Water Protection Fund (AWPF). In response to this meeting and overwhelming support from the group, a local newspaper - *Camp Verde Bugle* - published a page-one article (6/3/07) in support of the project. AWPF received 15 letters supporting this project.

A second letter was sent to affiliated Native American groups on July 15, 2007, that included additional information on the proposal. No comments were received.

Internal Scoping

Internal scoping was conducted by an interdisciplinary team of professionals from Montezuma Castle/Tuzigoot National Monuments, Southern Arizona Office, NPS Integrated Pest Management Staff, and professionals from the Lake Meade and Petrified Forest Exotic Plant Management Teams. Interdisciplinary team members first met on October 31, 2006 to discuss the purpose and need for the project; various alternatives; potential environmental impacts; past, present, and reasonably foreseeable projects that may have cumulative effects; and possible mitigation measures. The team also gathered background information and discussed public outreach for the project. Over the course of the project,

team members have conducted individual site visits to view and evaluate the proposed construction site, and discussed the impact analyses associated with this assessment. The results of multiple meetings are documented in this Environmental Assessment.

Other internal meetings involving the environmental assessment of the invasive plant management program include the following:

- May 8, 2006—meeting with USFWS; attending were Shaula Hedwall, Michele Girard, and Dennis Casper
- July 20, 2006—meeting with LAME-EPMT; attending were Kurt Deuser, Michele Girard, Dennis Casper
- October 31, 2006—IDT for MOWE maintenance facility and Invasives EA/Pasture Restoration; attending were John Schroeder, Michele Girard, Dennis Casper
- February 21, 2007—meeting with Dick Hauser regarding pasture restoration methods; attending were Dick Hauser, Kathy Davis, and Dennis Casper
- March 29, 2007---IDT meeting for Invasives EA; attending were Kathy Davis, John Schroeder, Michele Girard, Dennis Casper
- June 1, 2007—Pasture restoration grant and invasive species treatments; attending were Michele Girard and Kathy Davis
- July 10 & 11, 2007—EA writing meeting; attending were Michele Girard, John Schroeder(10^{th} only), Jenny Shrum (10^{th} only), and Dennis Casper

Environmental Assessment Review and List of Recipients

The Environmental Assessment will be released for public review on August 27, 2007. To inform the public of the availability of the Environmental Assessment, the National Park Service will publish and distribute a letter or press release to various agencies, tribes, and members of the public on the National Monument's mailing list, as well as place an ad in the local newspaper. Copies of the Environmental Assessment will be provided to interested individuals upon request. Copies of the document will also be available for review at the Monument's visitor center and on the internet at www.nps.gov/moca.

The Environmental Assessment is subject to a 30-day public comment period ending September 25, 2007. During this time the public is encouraged to post comments online at http://parkplanning.nps.gov/ or mail comments to Superintendent; Montezuma Castle National Monument; P.O. Box 219, Camp Verde, Arizona 86322. Following the close of the comment period, all public comments will be reviewed and analyzed prior to the release of a decision document. The National Park Service will issue responses to substantive comments received during the public comment period, and will make appropriate changes to the Environmental Assessment as needed.

List of Preparers

Preparers (developed EA content):

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- Michele Girard, Ecologist, National Park Service, Southern Arizona Office, Phoenix, AZ
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Consultants (provided information):

National Park Service, Montezuma Castle/Tuzigoot National Monuments, Camp Verde, AZ

- Ed Cummins, Chief Ranger
- Richard Fournier, Interpretive Ranger

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APPENDICES

Appendix A: Exotic Plant Management Plan for Montezuma Castle and Tuzigoot National Monuments

Click on Document Cover Below – The Exotic Plant Management Plan Will Open in a New Window

National Park Service
U.S. Department of the Interior

Intermountain Region
Sonoran Desert Network
Tucson, Arizona

Exotic Plant Management Plan for Montezuma Castle and Tuzigoot National Monuments

Natural Resources Report NPS/IMR/SODN-001

SONORAN DESERT NETWORK
Inventory and Monitoring Program

Appendix B: U.S. Fish and Wildlife Service Consultation Letter

United States Department of the Interior
U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 Fax: (602) 242-2513

In Reply Refer to:
AESO/SE
22410-2007-I-0066

March 1, 2007

Memorandum

To: Superintendent, Montezuma Castle & Tuzigoot National Monuments, Camp Verde, Arizona

From: Field Supervisor

Subject: Informal Consultation on Exotic Plant Management Plan for Montezuma Castle and Tuzigoot National Monuments

Thank you for your correspondence of January 26, 2007, received on January 31, 2007. This letter documents our review of the proposed Exotic Plant Management at Montezuma Castle and Tuzigoot National Monuments, in Yavapai County, in compliance with section 7 of the Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 et seq.). Your letter concluded that the proposed project may affect, but is not likely to adversely affect the endangered razorback sucker (*Xyrauchen texanus*) and its critical habitat, endangered Gila chub (*Gila intermedia*), the threatened spikedace (*Meda fulgida*) and its proposed critical habitat, the 10j experimental population of Colorado pikeminnow (*Ptychocheilus lucius*), endangered southwestern willow flycatcher (*Empidonax traillii extimus*), the endangered Yuma clapper rail (*Rallus longirostris yumanensis*), and the candidate yellow-billed cuckoo (*Coccyzus americanus*).

The same determination was made for the roundtail chub (*Gila robusta*), Mexican garter snake (*Thamnophis eques*), and lowland leopard frog (*Rana yavapaiensis*). Although we will review your project for potential effects to these species, there is currently no requirement under section 7 of the ESA for you to consult on these sensitive species. We concur with your determinations and provide our rationales below. You also concluded there would be "no effect" to the threatened bald eagle (*Haliaeetus leucocephalus*). Species with "no effect" determinations do not require review from the Fish and Wildlife Service, and are not addressed further.

Description of the Proposed Action

A complete description of the proposed action is found in your January 26, 2007, biological assessment (BA) and the *Exotic Plant Management Plan for Montezuma Castle and Tuzigoot National Monuments*.

The National Park Service (NPS) proposes to implement the *Exotic Plant Management Plan for Montezuma Castle and Tuzigoot National Monuments*. The plan includes cultural (e.g, burning, tillage, seeding, and interseeding), mechanical (e.g., pulling, cutting, mowing, and tilling), chemical (herbicide application), and biological treatments (e.g, insects, mold, and microbes) to reduce or eradicate currently present invasive species and those that may colonize the monuments in the next ten years. Per the NPS, biological treatments will not be addressed in this consultation. If biological treatments are proposed for an invasive species, the NPS will conduct additional consultation and prepare a project specific BA. NPS based the plan on extensive field work and thorough literature reviews. The plan contains the results of research, management recommendations, detailed information regarding recommended treatments, and measures to minimize effects to aquatic and riparian habitats and species. This information is incorporated here by reference. The exotic plant species with the highest priority for treatment are: Russian knapweed (*Acroptilon repens*), Malta starthistle (*Centaurea melitensis*), tamarisk (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*) and tree of heaven (*Ailanthus altissima*). The project area includes Tuzigoot and Montezuma Castle National Monuments, including the Montezuma Well Unit at Montezuma Castle National Monument.

Initial treatments for high priority species will begin in the spring of 2007. These areas will be monitored each year for effectiveness and re-treatment will be conducted as necessary. Treatments may include planting and/or seeding of native and/or non-invasive plant species following treatments.

Included in the proposed action are the following measures to protect aquatic species:

- Herbicides will be applied by hand to minimize drift.
- A dye will be added to all herbicide solutions in order to visually ascertain the application site.
- No treatments will be applied in the vicinity of the Verde River, Wet Beaver Creek, and Beaver Creek during high flows to reduce the likelihood of chemical getting into the water.
- Cost-effective herbicides with the lowest known toxicity to aquatic species will be used in the vicinity of open water. Current examples include the use of Garlon 3A for woody species, aminopyralid for herbaceous forbs, and glyphosate for grass species.
- Best management practices will be followed to ensure proper application of chemicals (e.g., all herbicide treatments will be conducted by licensed herbicide applicators, all mixing will occur within administrative areas, the minimal amount of herbicides will be used, etc.).

DETERMINATION OF EFFECTS

Razorback sucker and critical habitat, Gila Chub, Spikedace and proposed critical habitat, Colorado Pikeminnow, and other fish and aquatic species

We concur with your determination that the proposed action may affect, but is not likely to adversely affect, the razorback sucker and its critical habitat, the Gila chub, the threatened spikedace and its proposed critical habitat, the Colorado pikeminnow, or other fish and aquatic species. We base our determinations on the following:

- All herbicides will be applied by certified, experienced staff. Restrictions on chemical application methods, best management practices to prevent soil erosion and sedimentation, and implementation of the aquatic species mitigation measures described above will protect the aquatic habitats these species either occupy or could occupy during the life of your project. Only cost-effective herbicides with the lowest known toxicity to aquatic species will be used in the vicinity of water.

- The use of cultural treatments in riparian areas will be limited. Treatments, such as prescribed burning will be applied only with an approved burn plan and on a case-by-case basis. Soil erosion control such as straw wattles, sediment fencing, and other treatments will be applied if needed to reduce the potential of sediment reaching riparian areas and water.

- Ground disturbing activities from mechanical and cultural treatments will be limited and soil erosion mitigation measures will be applied to reduce the amount of potential soil disturbance, soil erosion, and sedimentation. The use of digging and pulling invasive species in riparian areas may be the preferred method provided the population is relatively small and that mechanical treatment is appropriate for the species.

- The likelihood of any direct or indirect interaction between the proposed action and primary constituent elements associated with both designated razorback sucker critical habitat or proposed spikedace critical habitat are extremely low; therefore, any effects to critical habitat are assumed to be discountable.

Southwestern willow flycatcher

We concur with your determination that the proposed action may affect, but is not likely to adversely affect, the endangered southwestern willow flycatcher. We base our determination on the following:

- Currently, we do not know of any flycatcher nests within the project area. Tamarisk scheduled for treatments are found as scattered individuals or small patches and do not constitute suitable flycatcher nesting habitat. Flycatchers are not known to nest in the other invasive species proposed for treatment.

- When possible, treatments will be avoided completely during the migration and nesting season. If treatments are applied during this time, they will be limited to open areas and not conducted in riparian woodland or shrubland habitats.

Yuma clapper rail

We concur with your determination that the proposed action may affect, but is not likely to adversely affect, the endangered Yuma clapper rail. We base our determination on the following:

- The Yuma clapper rail was last sighted at Tavasci Marsh over ten years ago. The habitat has changed considerably since that time due to the increase in cattail density and it no longer provides suitable habitat for the rail (D. Van Gausig, personal communication, 2006). Surveys conducted over the last ten years have not detected rails in the area. Since the species and its habitat are not currently present within the action area, effects from the proposed action are insignificant and discountable.

Yellow-billed cuckoo

We concur with your determination that the proposed action may affect, but is not likely to adversely affect, the candidate yellow-billed cuckoo. We base our determination on the following:

- Invasive tree species proposed for treatment are not known to provide cuckoo habitat. Therefore, we do not expect adverse effects to cuckoo habitat.

- When possible, all treatments will be avoided in riparian habitat during the migration and nesting of cuckoos. If treatments are applied during this time, they will be limited to open areas and not conducted in riparian woodland or shrubland habitats.

Thank you for your continued coordination. No further section 7 consultation is required for this project at this time. Should project plans change, or if information on the distribution or abundance of listed species or critical habitat becomes available, these determinations may need to be reconsidered. In all future correspondence on this project, please refer to consultation number 22410-2007-I-0066. We also encourage you to coordinate the review of this project with the Arizona Game and Fish Department. Should you require further assistance or if you have any questions, please contact Shaula Hedwall (x103) or Brenda Smith (x101) of our Flagstaff Suboffice at (928) 226-0614.

Debra T. Bills

for Steven L. Spangle

cc: Chief, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ
Regional Supervisor, Arizona Game and Fish Department, Flagstaff, AZ
Michele Girard, Ecologist, National Park Service, Southern Office, Phoenix, AZ
Randy Skeirik, Resource Division Chief, Montezuma Castle, Camp Verde, AZ

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Appendix C: Mitigation Check List

HERBICIDE APPLICATION METHODS: Herbicide application methods are designed to use the least, most effective amount of herbicide with the most effective method of application. Methods selected will reduce impacts to non-target plant and animal species, T&E species, water quality, and air quality.
☐ Label directions are strictly followed.
☐ Appropriate adjuvants are used if necessary.
☐ Approval has been received through the PUPS system.
☐ The most appropriate application technique is used: painting, wicking, squirting, and/or spraying.
☐ The most appropriate form of herbicide is used: liquid or granular.
☐ The most effective, least impacting application tools are used: backpack, ATV. No aerial application will be used.
☐ Application methods will be selected to minimize impacts to non-target plant and wildlife species.
☐ Herbicides would have low volatility and be applied under the appropriate weather conditions and wind speeds.
SOILS: Treatment methods minimize soil compaction, disturbance and erosion
☐ Soils are not wet and susceptible to compaction during treatments.
☐ Equipment and crews follow existing routes as much as possible.
☐ The smallest possible effective equipment is used.
☐ Surface treatments are used on erosive soils when appropriate.
☐ Erosion controls such as: erosion fabric, re-contouring, mulch, silt fencing, and revegetation are used when necessary to reduce erosion.
VEGETATION: Treatment methods minimize seed dispersal and impacts to non-target species
☐ Invasive plant material is removed from the site if it poses a fire hazard or provides a seed source.
☐ Treatments are timed to avoid seed spread and germination.
☐ Sites requiring revegetation are restored as quickly as possible.
☐ Off-site seed is certified weed free.
WILDLIFE: Treatments and application methods will be selected to minimize impacts to wildlife species.
☐ Herbicides have a low toxicity rating for wildlife.
☐ Treatments will be applied outside 'critical times' such as nesting, whenever possible.
☐ Bio-control will only be considered when the risks to wildlife are low and their application has been approved by APHIS and FWS.
☐ All treatments will be applied in accordance with FWS stipulations for special status species.
WATER QUALITY: Treatments minimize overspray, drift and spills near surface waters.
☐ Herbicide treatments within 50 feet of water will be applied by hand.
☐ No open containers of herbicides are allowed in riparian areas or near open water. All refilling and repairs will take place at a designated staging area.
☐ Treatments will be timed to avoid high stream flows, as much as possible.
CULTURAL RESOURCES Treatments and application methods will be selected to minimize impacts to cultural resources and conducted with the approval of the park archeologist.
☐ Consult with park archeologist before implementing any treatments.
☐ All ground disturbing and chemical treatments in the vicinity of archeological resources will be approved and monitored by the park archeologist.
☐ If previously unknown archeological resources are encountered during treatments all work will stop and the park archeologist will be notified.
☐ Any trimming or cutting of trees in the vicinity of standing historic or prehistoric architecture will be monitored by the park archeologist or other cultural resource specialist.