

National Park Service

U.S. Department of the Interior

Mesa Verde National Park and Yucca House National Monument

Colorado



Invasive Plant Management Plan Environmental Assessment and Assessment of Effect



Cheatgrass invades
burned landscapes at
Mesa Verde National Park.



The establishment of
native plants after
wildfire, assisted here by
aerial seeding, can hinder
the establishment of
invasive weeds.

March 6, 2015

Summary

Mesa Verde National Park (MVNP) is developing a comprehensive plan and environmental assessment/assessment of effect (EA) for managing invasive plants throughout the park and nearby Yucca House National Monument (YHNM). Areas within MVNP and YHNM are infested with several species of invasive plants that require elimination or control under state and federal law. An invasive plant management plan is needed to guide park managers in dealing with invasive plant issues that continue to increase in complexity and scope at MVNP and YHNM. The purpose of the plan is to establish a strategy for preventing or managing invasive plant occurrences in order to protect natural communities, ecological processes, cultural resources, visitor enjoyment, and other park values.

Often the terms “invasive plant,” “exotic plant,” “non-native,” “noxious” and “weed” often are used interchangeably in common speech. For consistency, throughout most of this document the term “invasive plant” will be used in referring to plant species that are not native to the southwestern United States and that have the potential to invade and adversely affect natural communities.

The plan focuses on these broad objectives:

1. Identify and control priority infestations of invasive plants by eradicating them, reducing their size and density, or containing their spread following a strategy that incorporates an ecological rationale, cultural resource protection goals, and visitor enjoyment goals.
2. Identify best management practices to help detect and prevent the entry, establishment, and spread of new invasive plant species and infestations into the park and monument.
3. Use comprehensive decision-making tools and annual work plans to prioritize and select optimal integrated pest management techniques and treatment options.
4. Identify a process through which new herbicides, bio-controls, and other tools can be evaluated and added to the MVNP toolbox in the future for managing invasive plants.
5. Implement a monitoring and evaluation process that assesses the short- and long-term success, efficacy, and cost treatments; thereby encouraging adaptive management.

The EA evaluates two alternatives:

1. Alternative A: (No Action) To continue the current direction of invasive plant management, with no changes to the established strategy, techniques, or tools.
2. Alternative B: (Preferred) To fully implement integrated pest management using an expanded toolbox of techniques, equipment, and herbicides, with a proactive strategy that places greater emphasis on prevention, early detection, monitoring, treatment evaluation, and the restoration of native plant cover.

This EA includes a review of the affected environment, methods to be used to manage invasive vegetation, and information on potential impacts to park resources from implementing the plan. Resources evaluated in detail in the EA include soils, wetlands and water resources, vegetation,

wildlife, threatened and endangered species, Wilderness, archeological resources, health and human safety, visitor use and experience, and park operations. All other impact topics were dismissed because the potential effects of the alternatives under consideration to those resources would be negligible or minor. None of the alternatives under consideration are expected to result in major adverse impacts.

Development of this plan included review of past efforts and public comments received during the public scoping process. No major issues were raised related to the proposal and most comments were in support of the proposed plan.

This EA has been prepared in compliance with the National Environmental Policy Act and other associated laws and regulations 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 on the environment associated with the alternatives under consideration, and (3) identifies mitigation measures to lessen the degree or extent of these impacts.

Public Comment

Comments on this EA may be submitted through the National Park Service (NPS) Planning, Environment and Public Comment (PEPC) website ([http: //parkplanning.nps.gov/](http://parkplanning.nps.gov/)).

Please be aware that all of the information provided in comments, including your address, phone number, e-mail address, or other personal identifying information, may be made available for public review. You may request to have your personal identifying information withheld from public review; however, the provisions of the Freedom of Information Act prevent us from guaranteeing that your information will remain confidential.

This EA will be open to public review for 30 days. Comments are due by midnight, April 5, 2015.

Table of Contents

Purpose and Need, 1

Background, 1

Purpose, 3

Need, 4

Relationship to Other Plans and Policies, 8

Impact Topics Retained for Analysis, 9

Impact Topics Dismissed From Further Analysis, 9

Alternatives, 13

Alternative A (No Action), 13

Alternative B (Preferred Alternative), 14

Alternatives Considered and Dismissed, 15

Environmentally Preferable Alternative, 17

Alternative Summaries, 23

Affected Environment, 25

Natural Resources, 25

Cultural Resources, 43

Park Operations, 45

Visitor Experience, 46

Human Health and Safety, 46

Environmental Consequences, 48

Cumulative Methodology, 49

Compliance with Section 106, National Historic Preservation Act, 53

Soils and Native Vegetation, 54

Aquatic, Wetland and Riparian Communities, 64

Water Quality, 71

Wildlife, 75

Special Status Species, 80

Wilderness, 91

Cultural Resources, 96
Park Operations, 109
Visitor Experience, 112
Human Health and Safety, 116

Consultation and Coordination, 124

References, 131

Appendix A1, A2, A3: Invasive Plant Management Plan, Herbicide Safety and Spill Plan, IPMP Decision-making Trees, 135

Appendix B: Herbicide Risk Assessments, 165

Appendix C: Recent Herbicide Use and Target Species History, 222

Appendix D: Current Invasive Plant Control Priorities, 228

List of Maps and Tables

Map 1. Mesa Verde National Park, **5**

Map 2. Yucca House National Monument, **6**

Map 3. Mesa Verde National Park Management Zones, **7**

Table 0. Impact Topics Dismissed From Further Analysis, **10**

Table 1. The Degree to Which Each Alternative Meets Invasive Plant Management Plan Objectives, **18**

Table 2. Summary of Anticipated Environmental Impacts Under Each Alternative, **20**

Table 3. Threatened, Endangered, and Candidate Species within Montezuma County, Colorado, **39**

Table 4. List of Mesa Verde and Yucca House rare plants of highest conservation priority, **39**

Table 5. List of critically imperiled rare plants at Mesa Verde and their preferred habitats, **40**

Table 6. Special status wildlife species known from MVNP and YHNM, **41**

Table 7. Thresholds for Intensity, **50**

Table 8. Behavior of Herbicides in Soil and Effects on Target and Non-target Plants, **57**

Table 9. Behavior of Herbicides in Aquatic, Wetland, and Riparian Communities, **66**

Table 10. Impact of Herbicides on Threatened, Endangered, and Rare Species, **83**

Table 11. Impact of Herbicides on Human Health, **118**

Purpose and Need

Background

Mesa Verde National Park (MVNP), located in southwestern Colorado, encompasses 52,485 acres (191 acres of which are privately owned and 41 acres are other public acres, mostly State of Colorado lands). The park lies entirely within Montezuma County and is located near the towns of Mancos and Dolores and the city of Cortez. The park is bordered by state, local, tribal, and federally owned lands under the jurisdiction of the Bureau of Land Management. MVNP is easily accessible from U.S. Highway 160, from the Durango area, 35 miles to the northeast, and the city of Cortez, 7 miles to the west (see Map 1).

Located approximately 7 miles west of the western border of MVNP, Yucca House National Monument (YHNM) encompasses approximately 34 acres (see Map 2). The monument lies entirely within Montezuma County and is located between the cities of Cortez and the town of Towaoc, 4 miles southwest of Montezuma County Airport. YHNM is accessed from County Road B off Highway 160/491. The monument is bounded by privately owned lands.

Congress established MVNP on June 29, 1906. The park's purposes, according to its enabling legislation and the 1928 addendum, include protecting unimpaired the cultural resources and values of the park for the enjoyment education and inspiration of current and future generations, and the preservation of forests, wildlife, and other natural features. MVNP is recognized for preserving and making available for public use and enjoyment some of the best preserved cultural sites and scenic features of the eastern Colorado Plateau region.

A Presidential Proclamation on December 19, 1919 established YHNM. The monument is significant because it "preserves a Montezuma Valley Ancestral Pueblo site and remains unexcavated, preserving its archeological integrity and beauty for future generations of scientists and visitors. As the science of archeology matures, it may contain keys to unlocking understanding of American Indian Heritage" (YHNM Strategic Plan, 2000).

The first non-native plants were likely introduced into the area before the park was established indirectly by early settlers, who planted non-native grasses as forage for domestic livestock. During post-fire seeding operations in the 1930s to 1950s, non-native grasses also were introduced into the park. Construction of park infrastructure, such as roads, trails, campgrounds, visitor centers, and picnic areas, further contributed to the establishment of non-native plant species as they were intentionally planted during site reclamation or when seeds were accidentally introduced on machinery, in gravel, or in contaminated seed mixes. In recent years, virtually all outdoor park activities have continued to contribute to the spread of invasive plants to various degrees. Unintentional invasive plant importation or spread occurs through contaminated topsoil, gravel, straw mulch, vehicles, equipment, even clothing. Visitors, too, have unknowingly introduced and transported seeds on vehicles, horses, pets, clothing, and by other means. People, machinery,

vehicles, livestock, wildlife, wind, and water contribute to the establishment and spread of invasive plant species.

Landscape management efforts that included hand-removal of unwanted vegetation, including some invasive plants such as cheatgrass, took place as early as the 1930s when the park had ample manual labor available. MVNP began controlling invasive plant species that were considered to be potentially invasive based on two management concerns: (1) maintenance of native vegetation and wildlife communities and (2) a desire to reduce the spread of park invasive plants onto adjacent public lands and communities. Modern invasive plant control in MVNP began in 1980. Efforts focused on mechanical control of musk thistle on Chapin Mesa and Wetherill Mesa roadside areas. In 1994 the park began using herbicides to control perennial pepperweed (*Lepidium latifolium*). By 1999, control efforts had expanded to include removal and mapping of Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), Dalmatian toadflax (*Linaria dalmatica*), diffuse knapweed (*Centaurea diffusa*), spotted knapweed (*Centaurea biebersteinii*), bull thistle (*Cirsium vulgare*), houndstongue (*Cynoglossum officinale*), whitetop (*Cardaria draba*), Russian olive (*Elaeagnus angustifolia*), Russian knapweed (*Acroptilon repens*), and tamarisk (*Tamarix ramosissima*). Since then, additional invasive plants have been discovered in the park, requiring additional resources and a more comprehensive strategy for dealing with an increasingly complex management issue. Consequently, in recent years, park staff members have implemented a wider range of integrated pest management (IPM) principles to manage invasive plant infestations, including mechanical removal, mowing, herbicide applications, biological control (bio-control) insects, planting, fertilizing, mulching, and seeding.

Bio-control of invasive plants in the park is accomplished through the release of various insects that act on target plants in ways that reduce their vigor or limit their propagation. Bio-control releases sometimes can be useful in controlling invasive plant populations in backcountry areas where time, money, and logistical problems do not permit herbicide applications. Approved insect releases to control musk thistle occurred annually from 1992 to 2011. Canada thistle bio-controls were introduced in 1997 and have occurred annually until 2012. Bio-controls for common mullein (*Verbascum thapsus*) were initiated in 2002, but discontinued by 2010. In addition, bio-controls were released to attack diffuse knapweed from 2001 to 2005 outside of the park along Highway 160.

In the 1990s, revegetation of disturbed areas using native plants and seed became an important component in efforts to reduce invasive plant infestations in the park. In particular, aerial re-seeding of native grasses was implemented to control erosion and minimize invasive plant establishment following large wildland fires that burned at MVNP in 1996, 2000, 2002, and 2003 as well as more recently at some smaller wildfires.

Invasive plant management efforts were initiated at YHNM by 1998 with restoration projects using native seed, fertilizer, and excelsior matting, and controlling a few species of invasive plants. In 1999, fencing was installed around a new acquisition of 26 acres. Diffuse knapweed bio-controls were released from 2000 to 2003. Starting in 2004 and continuing through the present, populations of Russian knapweed, cheatgrass (*Bromus tectorum*), and whitetop have been targeted for chemical treatment.

Systematic monitoring of vegetative resources has been ongoing since 1964. Various vegetation surveys and inventories have provided a baseline dataset for developing the MVNP and YHNM invasive plant control program. New research and on-the-ground surveys in the park continue to provide information to park managers on the ecological characteristics of invasive species, the extent of their infestations, and the most effective measures to control them. The results have been evaluated and integrated into invasive plant management in the park and monument.

MVNP staff members have worked closely with universities, the USGS Biological Resources Division, invasive plant management experts, Montezuma County, adjacent landowners, culturally affiliated tribes, and local communities to identify issues, concerns, and solutions to invasive plant management in MVNP and YHNM.

Purpose

This Invasive Plant Management Plan (IPMP) would provide park managers with a comprehensive strategy to prevent the establishment and to control the spread of invasive plant species throughout all of MVNP and YHNM. An invasive plant management plan is needed to provide MVNP managers with up-to-date, long-term, and consistent guidance in preventing, containing, suppressing, eradicating, and monitoring invasive plant populations in MVNP and YHNM.

The primary objectives of the Invasive Plant Management Plan are to:

1. Identify and control priority infestations of invasive plants by eradicating them, reducing their size and density, or containing their spread following a strategy that incorporates an ecological rationale, cultural resource protection goals, and visitor enjoyment goals.
2. Identify best management practices to help detect and prevent the entry, establishment, and spread of new invasive plant species and infestations into the park and monument.
3. Use comprehensive decision-making tools and annual work plans to prioritize and select optimal integrated pest management techniques and treatment options.
4. Identify a process through which new herbicides, bio-controls, and other tools can be evaluated and added to the MVNP toolbox in the future for managing invasive plants.
5. Implement a monitoring and evaluation process that assesses the short- and long-term success, efficacy, and cost treatments; thereby encouraging adaptive management.

The IPMP introduces the use of decision making processes that would help identify the highest priority populations of invasive plants to address and how to evaluate and approve new techniques and technologies for use at MVNP and YHNM. The NPS proposes to be proactive versus reactive by detecting and stopping invasive plants before they become a serious threat to the park's and monument's natural and cultural resources. This EA provides the park with environmental compliance clearance to implement the most effective invasive species management program available in order to meet this growing challenge.

In addition to the lands within MVNP and YHNM, the IPMP covers a few small parcels of land owned and administered by the National Park Service along MVNP's eastern boundary but which are not yet within the park's legal boundaries. In addition, the IPMP will cover a 160-acre parcel adjoining the current southeast boundary of YHNM that is in the process of being donated to NPS once the ownership transfer is completed. Furthermore, because integrated pest management practices are not applied exclusively to plant species that are not native to MVNP and YHNM, this plan also covers the use of herbicides and other techniques for removing or controlling native plants that pose minor park management problems (for example: Gambel oak growing in close proximity to overhead power lines, willows cracking concrete sidewalks, or watermilfoil and cattails growing in sewage lagoons).

Need

An invasive plant management plan is needed to guide park managers in dealing with invasive plant issues that continue to increase in complexity and scope at MVNP and YHNM. In the absence of a comprehensive approach to managing invasive plants, they may negatively affect natural resources, cultural resources, and the quality of park visitor experiences.

Invasive plants may alter natural plant communities by displacing native species, at times homogenizing natural park communities that were once rich in species into ones that have fewer species and resemble disturbed landscapes outside the park. Changes also may occur in soils and hydrology in infested areas. Similarly, ecological processes, such as the frequency or severity of wildfire, may be altered because of invasive plant infestations. In turn, changes in plant communities may have subsequent effects on native wildlife, including rare, threatened, or endangered species.

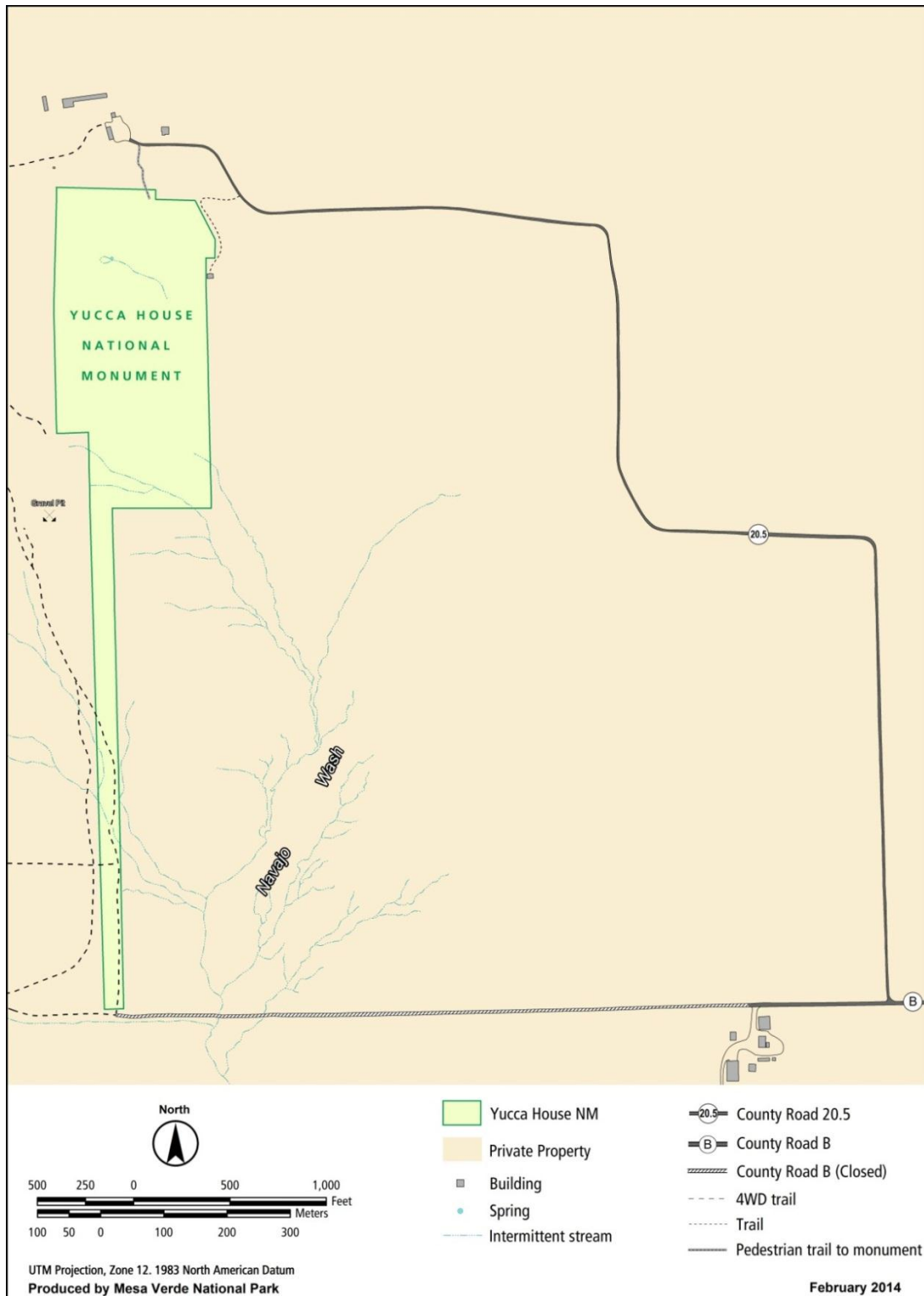
Invasive plants may alter the integrity and authenticity of historic or cultural landscapes – a major attribute for park and monument visitors. A severe example would be the potential effects on surface and subsurface archeological sites and artifacts that results from more frequent or severe wildfires and soil erosion that might follow some invasive plant infestations.

Visitor enjoyment of park and monument resources also could be diminished if invasive plants are not effectively controlled. For example, the campground at MVNP currently is infested by houndstongue, an invasive plant that contains toxic alkaloids and produces large quantities of seeds, each covered with hooked barbs that readily attach to clothing, hair, and fur. An encounter with houndstongue seeds can be inconvenient and cause discomfort as they are difficult to remove from clothing and particularly from pet fur.

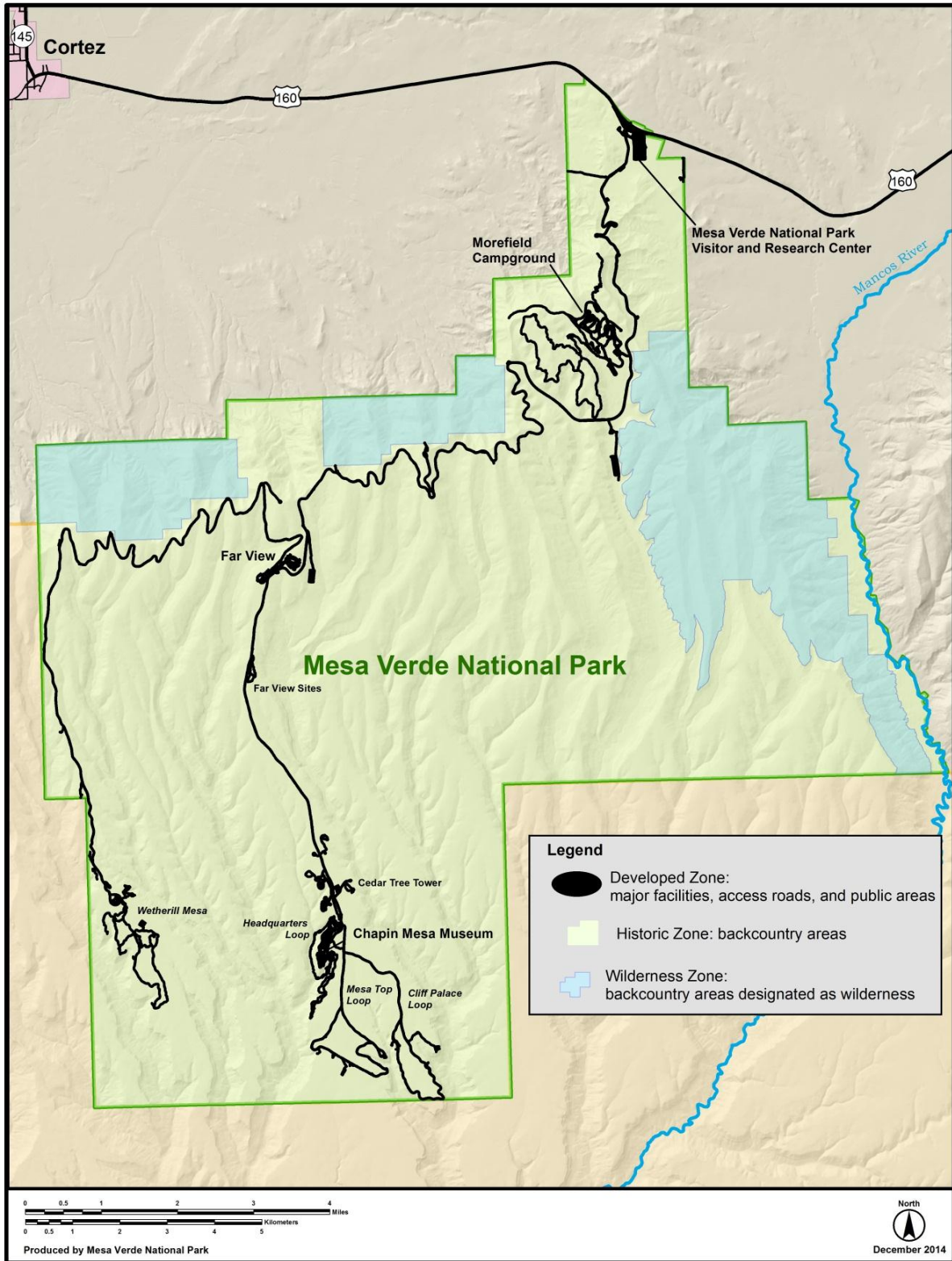
Invasive plants near park and monument boundaries threaten to infest neighboring lands and communities. Conversely, where neighboring landowners are not effectively controlling invasive plants, these invasive species can spread into the park and monument. A comprehensive invasive plant management plan would help park managers to work closely with local citizens, organizations, communities, local governments, the state, and adjacent federal and tribal landowners to achieve common goals of managing invasive plants.



Map 1. Mesa Verde National Park



Map 2. Yucca House National Monument



Map 3. Mesa Verde National Park Management Zones

Relationship to Other Plans and Policies

This plan, which proposes using the full range of IPM techniques to manage invasive plants, would be consistent with the following park documents, completed or in process:

- Strategic Plan for MVNP (2011)
- Strategic Plan for YHNM (2000)
- MVNP Mancos River Corridor Restoration Plan (1998)
- MVNP Fire Management Plan (1993)
- MVNP Fire Management Plan (2015)
- MVNP wildfires and burned area emergency rehabilitation plans (1996, 2000, 2002, 2003, future)
- MVNP Integrated Pest and Hazardous Wildlife Management Plan (in process)
- MVNP Visitor Distribution and Transportation Plan (in process)
- MVNP road construction and major maintenance projects (many)
- MVNP Integrated Pest and Hazardous Wildlife Management Plan (In process)
- MVNP livestock control efforts (in process)
- MVNP Long Range Interpretive Plan (2014)
- MVNP Concessions Contract (2014)

Sharing critically important vegetation management issues is the new Fire Management Plan (FMP) which has been in production simultaneously with the IPMP. While the IPMP would strive to enhance the qualities of the native vegetation of YHNM and MVNP, the FMP's primary focus has been on safety and promoting the protection of lives and property. However, wildfire, wildfire suppression, and fuels management activities all have or could have substantial new effects on the vegetation of YHNM and especially MVNP. The potential to alter long-term vegetation composition over large areas means that activities covered under the FMP also would have a profound influence over the spread of invasive plants and the work covered under the IPMP. Areas modified for fuels management objectives and post-wildfire areas would need to receive intense focus on invasive plant incursions. The two plans need to be consistent in promoting proactive procedures and applications to reduce infestations of invasive plants and ensuring the welfare of native plants and animals in fire and fuels management areas. Close cooperative interaction between the two programs is essential. Aerial activity related for wildfire detection and suppression, including over Wilderness areas, is covered separately in the FMP while post-fire aerial spraying and seeding are covered under the IPMP.

Two national policies were also taken into consideration:

- **2006 NPS Management Policies** (4.4.4—Management of Exotic Species) requires national parks to prevent the displacement of native species by non-native species.
- **Executive Order 13112** states that a federal agency cannot “authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions

clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.” This Executive Order requires federal agencies to identify invasive species and develop a plan to prevent their introduction and reduce the risk of their spreading.

Impact Topics Retained for Analysis

Issues and concerns affecting the proposed action were identified by National Park Service specialists. Impact topics are the resources of concern that could be affected by the alternatives.

- Soils and Native Vegetation
- Aquatic, Wetland, and Riparian Communities
- Water Quality
- Wildlife
- Special Status Species
- Wilderness
- Archeological Resources
- Ethnographic Resources
- Park Operations
- Visitor Experience
- Human Health and Safety

Impact Topics Dismissed From Further Analysis

In this section of the EA, the NPS provides a limited evaluation and explanation as to why some topics are not evaluated in more detail. The following topics were dismissed from further evaluation in this EA for one or more of the following reasons:

- They do not exist in the analysis area.
- They would not be affected by either of the proposed alternatives, or impacts are not expected.
- Through application of mitigation measures, the effects of implementing the alternatives would be minor or less.
- There is little controversy on the subject.

The impact topic of Human Health and Safety was retained for analysis in the EA even though it meets the third dismissal criteria above; effects would be minor or less. This is because the focus and application of the program would be expected to draw concern for this topic. Table 0 indicates which impact topics were dismissed from further analysis with a brief explanation why. The table also includes the law, regulation, and/or policy that govern the compliance for that particular impact topic and a brief description of the affected environment, or baseline conditions, in the project area.

Table 0. Impact Topics Dismissed From Further Analysis.

Topic	Law, Regulation, Policy	Affected Environment / Reason Dismissed
Land Use Conflicts	NPS Management Policies	Although the alternatives may have negligible effects on land use, overall land use would not change as a result of their implementation. Because the impacts on land use would be negligible, this topic has been dismissed from further analysis.
Indian Trust Resources	Secretarial Order 3175	Implementation of this plan would not have a measurable effect on Indian trust resources on the neighboring Ute Mountain Indian Reservation. Therefore, the proposed actions would have negligible effects on Indian trust resources and, thus, this impact topic was dismissed from further analysis.
Museum Collections	Director's Order 24: Museum Collections	The proposed actions would have no impacts on museum collections; therefore, this topic has been dismissed from further analysis.
Floodplains	Executive Order 11988 Floodplain Management, 2006 Management Policies and Director's Order 77-2 Floodplain Management	No proposal under this plan includes construction within a 100-year floodplain, affect the park's or monument's floodplain values, or contribute to hazardous floodplain conditions. Therefore a Statement of Findings for floodplains would not be prepared and the topic of floodplains has been dismissed from further analysis.
Air Quality	Clean Air Act; NPS Director's Order 77: Natural Resource Protection	MVNP is a designated Class I air quality area and YHNM is a designated Class II air quality area under the Clean Air Act. There is the potential to have negligible to minor, short-term, localized impacts to air quality from actions ranging from the use of chemical treatments on invasive plants to using motorized vehicles and equipment in applying IPM treatments. For the use of prescribed burning in preparing an area for invasive plant treatments, potential impacts are addressed in the park's Fire Management Plan. Because these impacts are expected to dissipate rapidly, the air quality topic will not be analyzed in detail.
Soundscapes	NPS Director's Order 47: Soundscape Preservation and Noise Management	The activities proposed in this EA would result in the generation of noise from utility terrain vehicles and hydraulic sprayers. On a very infrequent, incidental basis, post-fire invasive plant control and seeding may use a helicopter for brief periods. However,

Topic	Law, Regulation, Policy	Affected Environment / Reason Dismissed
		because the impacts of these activities on the soundscape would be short-term and minor or less, this topic has been dismissed from further analysis.
Natural Lightscares	NPS Management Policies	Invasive plant management activities would not be conducted at night, so there would be no impacts to the natural lightscape associated with any of the IPM techniques. This impact has been dismissed from further analysis.
Energy Requirements and Conservation Potential	NPS Management Policies	Implementation of the proposed actions would not cause measurable increases or decreases in the overall consumption of electricity, propane, wood, fuel oil, gas, or diesel associated with visitation or for park operations or maintenance. As a result, this topic has been dismissed from additional analysis.
Wild and Scenic Rivers	Wild and Scenic Rivers Act, NPS Director's Order 46: Wild and Scenic Rivers	There are no Wild and Scenic Rivers in the project area.
Geologic Resources	NPS Director's Order 77: Natural Resource Protection	The geologic resources of the park would not be affected by any of the proposed alternatives to any more than a negligible level. Therefore, this impact topic has been dismissed from further analysis.
Paleontological Resources	NPS Director's Order 77: Natural Resource Protection	If any invasive plant management actions were to take place in known fossil resource areas, mitigation measures would be put in place to reduce or eliminate resource impact risks. Therefore, the extent and intensity of proposed actions in this plan that would impact paleontological resources in the parks would not exceed minor. As a result, this topic has been dismissed from further assessment.
Historic Structures	National Historic Preservation Act; NPS Director's Order 28: Cultural Resources Management	The proposed actions of the IPMP would have no impacts on the MVNP's 20 th Century historic structures except as they are part of cultural landscapes; therefore, this topic has been dismissed from further analysis.
Cultural Landscapes	Director's Order-28 <i>Cultural Resource Management Guideline</i>	The proposed actions of the IPMP would have no greater than minor impacts on the MVNP's identified and potential cultural landscapes; therefore, this topic has been dismissed from further analysis.

Topic	Law, Regulation, Policy	Affected Environment / Reason Dismissed
Socioeconomics	NPS Management Policies	Because the impacts to the socioeconomic environment would be negligible, this topic has been dismissed from further analysis.
Prime and Unique Farmlands	Farmland Protection Policy Act	There are no prime or unique farmlands in MVNP. Although lands around YHNM are used for farming, according to the NRCS, the project area does not contain prime or unique farmlands. Additionally, the monument is only 34 acres and farming is not an action that is approved for lands within YHNM or MVNP. Therefore, the topic of prime and unique farmlands has been dismissed as an impact topic in this EA.
Environmental Justice	Executive Order 12898 General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	The proposed action would not have disproportionate health or environmental effects on minorities or low-income populations or communities as defined in the Environmental Protection Agency's Environmental Justice Guidance (1998). Therefore, environmental justice was dismissed as an impact topic in this document.
Visual Quality	NPS Management Policies	None of the actions under consideration in this plan would affect visual quality within the parks to a level greater than minor, including viewsheds; therefore, this topic has been dismissed from further analysis.
Climate Change	NPS Management Policies	Although the planet is experiencing a warming trend, it would be speculative to predict localized changes in temperature, precipitation, or other weather changes, in part because there are many variables that are not fully understood and there may be variables not currently defined; therefore, the effects of future climate changes are not discussed further.

Alternatives

The Council on Environmental Quality's (CEQ) regulations (40 C.F.R. Parts 1500-1508) set the standard for compliance with the National Environmental Policy Act including those for developing reasonable alternatives. CEQ has defined reasonable alternatives as those that are economically and technically feasible and that show evidence of common sense. The alternatives that would be carried forward for analysis in this EA also would need to meet the purpose and need identified for the IPMP. This chapter describes the alternatives being considered to manage invasive plants in MVNP and YHNM. Elements used in the selection of reasonable alternatives include:

- Potential for protecting the park's and monument's natural and cultural resources
- Effectiveness at preventing, controlling, or eradicating invasive plant infestations
- Potential for ensuring positive visitor experiences
- Ability to ensure human health and safety

Two alternatives were identified for detailed analysis. Both alternatives involve the use of effective invasive plant management techniques to eradicate or reduce invasive plant infestations in MVNP and YHNM. Alternative A would continue the use of a limited range of equipment, herbicides, bio-controls, and techniques, restricted primarily to frontcountry and easily accessible sites. In contrast, Alternative B would allow for the use of a more expansive and comprehensive IPM approach to address invasive plants throughout the park and monument.

Alternatives Carried Forward

Alternative A

Alternative A: (No Action) To continue the current direction of invasive plant management, with no changes to the established strategy, techniques, or tools.

MVNP is currently using a strong but limited integrated plant management approach to control invasive plant infestations within the park and monument. If Alternative A were selected, MVNP staff would use IPM principles and techniques to manage invasive plants under an approved Invasive Plant Management Plan. Actions under this alternative would include:

- Use of manual, mechanical, and chemical treatments to eradicate, suppress, or contain small to medium occurrences of invasive plants, primarily along road corridors, trails, developed areas, park facilities, and other easily accessible sites.
 - A majority of treatments would involve application of herbicides using hand bottle sprayers, backpack sprayers, and hydraulic spot sprayers mounted to a trailer or UTV.
 - Chemical applications would be restricted to currently approved herbicides listed in Appendix C of the Invasive Vegetation Management Plan/EA. No other herbicides would be approved.

- Use of bio-controls to reduce the vigor and/or reproductive success of musk thistle and Canada thistle. No other bio-control agents would be approved.
- Use of cultural treatments, primarily involving reseeding, mulching, and fertilizing disturbed sites following park projects that disturb soil and remove vegetation.
- A limited monitoring program that provides some information on invasive plant infestation trends, treatment efficacy, and treatment costs.
- Annual recordkeeping and reporting to meet Colorado and NPS requirements for tracking pesticide use, and NPS requirements for tracking acres of invasive plants treated.

Alternative A would allow for the treatment of a majority of accessible small to medium high-priority invasive plant infestations. However, tactics under Alternative A alone would not allow for expanded treatment capacity of large or widespread backcountry infestations. For example, this alternative would not provide a mechanism for preventing or controlling widespread infestations of cheatgrass or similar species, either through new bio-controls, as they become available, or aerial herbicide applications. Alternative A alone would not provide as comprehensive a process through which new techniques, equipment, herbicides, bio-controls, or other tools could be evaluated against a standard set of criteria for determining whether a tool is appropriate for future use to manage invasive plant infestations.

Alternative B

Alternative B: (Preferred Alternative) To fully implement integrated pest management using an expanded toolbox of techniques, equipment, and herbicides, with a strategy that places greater emphasis on prevention, early detection, monitoring, treatment evaluation, and the restoration of native plant cover.

Alternative B proposes to fully implement throughout the park and monument as needed an enhanced integrated pest management approach to managing invasive plants, expanding on practices described in Alternative A. NPS Management Policies (NPS 2006) instructs each park to implement IPM, which is described as “a decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage by cost-effective means while posing the least possible risk to people, resources, and the environment.”

IPM includes these steps:

1. Identify invasive plant species.
2. Establish action thresholds for new and established invasive plant species and infestations.
3. Identify invasive species management priorities.
4. Evaluate and select treatment techniques appropriate to the species and the site.
5. Confirm that compliance and required approvals have been obtained for proposed actions.
6. Implement selected treatments.
7. Monitor the site to evaluate the efficacy of treatments.
8. Prescribe revised treatment actions as needed.

This approach begins with identifying invasive plant species and infestations, then assessing their potential ecological, economic, operational, and human impacts. Action thresholds would be identified for each species and/or infestation. Invasive plant species and infestations may be prioritized for treatment based on potential impacts (often weighing impacts of treatment vs. impacts of failure to treat), action thresholds, probability of success, and operational considerations. These factors help to determine treatment objectives, such as whether an invasive plant infestation should be suppressed, contained, eradicated, or potentially not managed. Benchmarks for success would be clearly identified on a case by case basis using the above factors. Subsequently, treatment methods would be selected, often including more than one cultural, mechanical, chemical, or biological treatment. After being implemented, infestations and the efficacy of treatments would be monitored and thoroughly evaluated. As needed, new treatments would be prescribed, with potential changes in technique, equipment, frequency, timing, and other prescription variables.

Under Alternative B, the Invasive Plant Management Plan would be more comprehensive and adaptive than Alternative A by including these broad components:

1. An invasive plant prevention program that strengthens early detection surveys; reduces the opportunities for new infestations to establish following park operations that cause ground disturbance (e.g., construction, utility upgrades, fuels management projects); enforces compliance for weed-free equipment, gravel, seed, mulch, and other materials brought into the park or monument; and improves the understanding among park staff and visitors of the issues relating to invasive species.
2. A decision-making framework for prioritizing invasive plant infestations for management and determining the appropriate treatment methods.
3. Use of additional herbicides, biological control agents, and equipment could be approved following a thorough review process.
4. A monitoring and evaluation process that assesses the short- and long-term success, efficacy, and cost of treatments; thereby encouraging adaptive management.

The complete Invasive Plant Management Plan for Alternative B is located in Appendix A1, A2, and A3 starting on page 147 including a list of standard mitigation measures applicable to both alternatives.

Alternatives Considered and Dismissed

Alternative C: (Dismissed) No invasive plant management or control

This alternative was excluded from further consideration because it does not meet the requirements of the park's enabling legislation, the NPS Organic Act, or NPS Management Policies. Although this alternative was considered and is useful for comparison with the other alternatives, it is unacceptable.

Alternative element combinations

Developing substitute combinations of elements already found in Alternative B were considered. For example, only using non-traditional herbicides (such as acetic acid) and only using mechanical and biological control methods, or not using aircraft to apply herbicide, seed or biological controls. These kinds of strategies simply limit the tools available for meeting the IPM objectives for MVNP and YHNM. They do not improve program capabilities under the IPMP; rather they would prevent the achievement of many of the plan's objectives without substantially reducing the environmental impacts expected from applying them. For example, under technical methods available at this time, many invasive plants cannot be controlled effectively without using chemical herbicides. The complement of tactics prescribed under Alternative B offers the most effective tools with the greatest level of flexibility within an acceptable level of risk and cost commensurate with the expected invasive plant challenge. Formulating an alternative that does not meet the IPMP's objectives for the purpose of increasing the analysis diversity under this EA was rejected.

Browsing by livestock

The use of livestock in invasive plant control is not a stand-alone plan alternative, but an optional tool that was potentially available under Alternative B. Using herded flocks of livestock, typically goats and sheep, to consume certain kinds of invasive plants has been successfully used under controlled conditions in some places including a few NPS areas under limited circumstances. However, those circumstances generally are not present at MVNP or YHNM or the benefits of using livestock are exceeded by the risks in the park that livestock would have on the high density of sensitive cultural resources, by trampling, and rare plants, by consumption and trampling, which make this option highly impractical. Goats or sheep would be expected to consume first the most palatable plant species available to them, primarily native forbs and shrubs. Weedy species such as cheatgrass and thistles would be left largely intact, thus offering the invasive plants an additional competitive edge. Even livestock thoroughly conditioned to consume some invasive plant species, such as leafy spurge, also would be expected to have native plants make up a large proportion of their diets as well as to spread weed seeds through the landscape as they browse because some seeds would stick to their coats and others would pass unscathed through their digestive tracts, dispersing the seeds from their points of origin. Furthermore, the logistics of operating flocks of domestic livestock in the park would place a high degree of difficulty on park operations. As a result of these limitations, this tool does not properly meet the Purpose and Need of the IPMP and, thus, it was dismissed from further consideration.

Burning invasive plants

Fire can be an effective tool in supporting invasive plant control work; however, the kinds of invasive plants targeted for control at MVNP and YHNM either are not killed by fire or they are stimulated by the post-fire conditions. Fire application also is a blunt tool that only could be applied safely in limited areas and seasons and only by specially trained and equipped staff. Even so, fire applied as a hazardous fuels reduction tactic could benefit invasive plant control objectives in some areas under limited conditions. When there is a nexus of fuels management and invasive plant management objectives, the Fire Management Office could design a fuels management application that prepares

the site for subsequent treatment of invasive plants. The best example of this would be the burning of patches or fields of smooth broom in and around developed areas. The resprouting plants later could be opportunistically sprayed by the Vegetation Management Crew, partner or contractor. It must be emphasized that the application of fire would be covered under the Fire Management Plan, not the IPMP. Because fire alone would be an ineffective strategy with a significant potential for damaging desirable native vegetation, cultural resources, and air quality, it was dismissed as a separate alternative under the IPMP. The impacts of prescribed burning are covered under the EA for the Fire Management Plan.

Environmentally Preferable Alternative

According to the NPS regulations for implementing National Environmental Policy Act (NEPA; 43 CFR 46.30), the environmentally preferable alternative is the alternative “that causes the least damage to the biological and physical environment and best protects, preserves, and enhances historical, cultural, and natural resources. The environmentally preferable alternative is identified upon consideration and weighing by the Responsible Official of long-term environmental impacts against short-term impacts in evaluating what is the best protection of these resources.”

Based on these criteria, Alternative B is the environmentally preferable alternative. Efforts would be increased to detect invasive plant infestations before they spread and harm natural communities. A comprehensive decision-making process would help to select optimal treatments and best management practices that maximize treatment efficacy while minimizing impacts to natural resources, cultural resources, and visitors’ experiences. More effective monitoring would provide critical information on treatment efficacy and non-target impacts, thus allowing for adaptive management and improvement of treatments. Alternative B would provide the widest range of management options for controlling invasive plants in the park. Therefore, Alternative B is the park’s Preferred Alternative.

Alternative Summaries

Table 1 compares how each alternative would meet invasive plant management objectives identified in the Purpose and Need section. Table 2 summarizes the anticipated environmental impacts of each alternative. The Environmental Consequences chapter provides a detailed explanation of impacts. In short, the NPS proposes that the elements in Alternative B are superior to current methods because it:

- Builds further on many years of experiences and the strengths of Alternative A
- Provides flexibility to use new tactics, techniques and procedures
- Incorporates some of the latest IPM strategies and tools
- Is current with NPS IPM policy
- More fully integrates IPM across the spectrum of park operations
- Would ensure that all NPS acreages at MVNP and YHNM are managed in compliance with NEPA, NHPA, and ESA

Table 1. The Degree to Which Each Alternative Meets Invasive Plant Management Plan Goals (See the Plan Summary on page 2.)

Plan Objective	Alternative A (No Action)	Alternative B (Preferred)
Identify and control priority infestations of invasive plants by eradicating them, reducing their size and density, or containing their spread following a strategy that incorporates an ecological rationale, cultural resource protection goals, and visitor enjoyment goals.	Existing prevention practices (e.g., checking construction equipment for weeds/seeds prior to entering the park, reseeding and mulching manmade soil disturbances) include inspection of construction equipment prior to entering the park. Natural Resource staff members conduct searches for new infestations, primarily along roads and in developed areas. Effective manual, mechanical, and chemical treatments are used, primarily along roads, in developed areas, and in easily accessible backcountry sites. Limited use of bio-controls.	Early detection and prevention practices are strengthened. Practices include regular searches for new invasive species and infestations, consistent inspection of construction equipment, gravel sources, mulch, and other materials to ensure that they are weed-free. Park staff, researchers, concessionaires, and contractors are all involved in prevention best management practices. Treatment options increase, including use of high-capacity equipment, additional herbicides, and additional bio-controls (following thorough review). Ability to treat large and widespread backcountry infestations is enhanced. Aerial spraying is allowed under restricted circumstances.
Identify best management practices to help detect and prevent the entry, establishment, and spread of new invasive plant species and infestations into the park and monument.	Park workers, partners and contractors are asked to not enter the park or weed-free areas of the park with weed-contaminated vehicles, equipment, or seeding mixes. Efforts are largely held to an honor system with only periodic inspections. Monitoring for new invasions is largely incidental during treatment work as time allows.	Greater accountability is instituted among park staff, partners, and contractors to ensure the prohibition from using and quarantining of weed-contaminated vehicles, equipment, or seeding mixes. Monitoring for new invasions becomes a routine part of the seasonal work schedule.
Use comprehensive decision-making tools and annual work plans to prioritize and select optimal integrated pest management techniques and treatment options.	Treatment priorities are developed each spring from recommendations made in the annual report from the previous year's program. Less than the full range of IPM techniques are available for use. Treatment options are limited.	A comprehensive decision-making process guides staff in selecting priority targets and optimal IPM techniques. Projects are planned, prioritized, and scheduled annually. A full range of IPM techniques and treatments are available for selection.

Identify a process through which new herbicides, bio-controls, and other tools can be evaluated and added to the MVNP toolbox in the future for managing invasive plants.	Staff investigates new treatment options on a case by case basis and obtains approval for use from NPS IPM specialists at the Regional and Washington levels.	In addition to the current procedures used under Alternative A, staff also screens their proposals through a decision tree flow chart process (see Appendix A3).
Implement a monitoring and evaluation process that assesses the short- and long-term success, efficacy, and cost of treatments; thereby encouraging adaptive management.	Treatment of weed infested areas takes a higher priority than monitoring treatment efficacy and evaluating long-term costs. Short-term adaptive responses can be based on visual conditions observed annually using best professional judgments.	Mapped infestations and treatments are consistently monitored following a standard protocol. Treatment efficacy is evaluated for all high-priority infestations and treatment prescriptions are subsequently revised. Treatment costs are tracked, calculated, and reported annually. Invasive plant management is adapted to meet changing conditions detected through systematic monitoring.

Table 2. Summary of Anticipated Environmental Impacts Under Each Alternative

Impact Topic	Alternative A (No Action)	Alternative B (Preferred)
Soils and Native Vegetation	<p>Long-term beneficial impacts on the soil are expected as invasive plants are controlled and native communities are restored. Mechanical removal of invasive plants is expected to have negligible to minor localized adverse impacts on soil and native vegetation. Mowing or using a string trimmer causes short-term minor adverse impacts to soil, and would have a minor adverse impact on native species growing amongst the invasives by cutting them. Cultural control is expected to have minor beneficial long-term effects on soil and native vegetation. Minor short-term adverse effects may result as competition from seeded native grasses may suppress native pioneer forb species. The biological control organisms expected to be proposed for use in MVNP should have no direct adverse impact on soil or native vegetation, and would have a minor long-term benefit to soil and native vegetation as invasive plant species are replaced with healthy native plant communities. The use of herbicide is expected to have a minor localized short-term adverse impact to native vegetation and soils. Driving UTVs in approved areas would have a short-term localized minor impact on soils and native plants.</p>	<p>The environmental consequences of using mechanical and biological methods are the same as Alternative A. Long-term benefits to soils and vegetation associated with controlling invasive plants and restoring native communities would be maximized. With large-scale aerial applications of Imazapic, short-term adverse impacts on vegetation may increase to moderate. While interfering with natural post-fire succession results from dropping grass seeds onto the burned landscape, past experience has shown that doing so greatly reducing the presence of invasive plants with minor short-term and long-term adverse effects on native forbs. This impact can be mitigated by not using western wheatgrass in most post-fire seeding mixes. Therefore, long-term beneficial effects on soil and native vegetation are increased as more acres are treated and restored through aerial application of pre-emergent herbicide, native seeds, and potentially biological control organisms.</p>
Aquatic, Wetland, and Riparian Communities	<p>Negligible to minor, long-term beneficial impacts on the aquatic, wetland, and riparian resources are expected as invasive plants are controlled and native communities are restored. Removing invasive plants by hand and with tools is expected to have short-term adverse negligible to minor impacts to aquatic, wetland and riparian communities. Cultural control through native plant restoration would result in a minor benefit to aquatic, wetland and riparian communities. The use of biological control agents proposed for use in MVNP and YHNM should have no direct impact on aquatic, wetland or riparian communities. With the implementation of standard operating procedures and the mitigation measures, the use of herbicides near water could result in only negligible to short-term adverse impacts to aquatic, wetland and riparian communities. Herbicides applied in accordance with label restrictions are expected to have negligible impacts on fishes or aquatic organisms because concentrations are so dilute.</p>	<p>Because aerial applications of herbicides would not be permitted in close proximity to aquatic, wetland and riparian communities, the environmental consequences of using mechanical, cultural, biological IPM methods are the same as Alternative A. Mitigation measures would ensure this evaluation. Long-term benefits associated with controlling invasive plants and restoring native communities would be maximized.</p>
Water Quality	<p>Negligible long-term beneficial impacts on the water quality are expected as invasive plants are controlled and native communities are restored. Mechanical controls are expected to have negligible, short-term and site specific adverse impacts. Restoration activities such as reseeding and irrigation would have a minor long-term beneficial effect of promoting the reestablishment of native vegetation, which could help reduce erosion and sedimentation. The impacts of herbicide use on water resources would therefore be adverse, site-specific, short-term and negligible.</p>	<p>The environmental consequences of using mechanical and biological methods are the same as Alternative A. Long-term benefits to water quality associated with controlling invasive plants and restoring native communities would be magnified. Specific mitigation measures for aerial spraying have been developed to minimize potential negligible to minor adverse impacts to water quality.</p>

Impact Topic	Alternative A (No Action)	Alternative B (Preferred)
Wildlife	<p>Long-term beneficial impacts on wildlife are expected as invasive plants are controlled and native communities are restored. Removing invasive plants by using tools (including mowing and the use of string trimmers) would have a negligible adverse impact on wildlife. Minor short-term effects may result as competition from seeded native grasses may suppress native pioneer forb species. The presence of humans in the work area also can temporarily frighten off animals. The biological control organisms proposed for use in MVNP should have no impact on wildlife and the long-term benefit of using biological controls should enhance wildlife habitat. There is a possible long-term risk that some biological control organisms could evolve and have a negative impact on native flora and fauna. Some native insects may be displaced from the use of biological control insects, but there is no documentation to indicate that this will occur. The NPS would use the least toxic herbicide to manage prioritized invasive plant species. Herbicide use has the potential to create a short-term minor impact to wildlife species. Herbicides have the potential to enter systems.</p>	<p>The environmental consequences of using mechanical, cultural, biological and chemical methods are the same as in Alternative A with additional consequences associated with the use of aerial herbicide spraying and seeding. Long-term benefits to wildlife associated with controlling invasive plants and restoring native communities would be magnified. Because of the large-scale nature of aerial spraying, adverse effects to the native vegetation of wildlife habitat would be minor to moderate and short-term and be restricted to areas already seriously impacted by invasive annual weeds such as cheatgrass and high intensity wildfire.</p>
Special Status Species	<p>Long-term beneficial impacts on T&E habitat are expected as invasives are controlled and native communities are restored. Removing invasive plants using tools would have negligible, short-term adverse impacts on federally or state listed threatened, endangered or rare species. The introduction of undesirable species through contaminated equipment, seed mixes, or through the improper selection of species for revegetation could impact sensitive plant species. Restoration activities could damage listed plants or disturb listed wildlife. Mitigation and conservation measures would keep these effects site-specific and of no consequence to T&E species. Aerial seeding by helicopter would have short-term negligible impacts to threatened and endangered species. Potential impacts to Mexican spotted owl would be the temporarily flushing of the birds. Restoring disturbed plant communities to natural conditions through revegetation efforts would provide a long-term benefit to T&E or rare species. The impacts of biological treatments on T&E wildlife would therefore be indirectly beneficial, site-specific to park and monument-wide, long-term and minor. With the implementation of mitigation measures, the risk of impacting T&E species and rare plants with chemical control would be reduced to a negligible level.</p>	<p>In conjunction with conservation, mitigation, and minimization measures, the environmental consequences of using mechanical, cultural, biological and chemical methods are the same as Alternative A with the addition of aerial spraying of herbicides, biological organisms developed in the future, and the possibility of additional aerial seeding after wildfire.</p>
Wilderness	<p>Long-term beneficial impacts on the Wilderness are expected as invasive plants are controlled and native communities are restored. In the event invasive plants are detected and targeted for treatment in Wilderness, removal would be completed with the minimum tool necessary. Short-term negligible impacts may occur with the implementation of appropriate invasive plant management techniques. Restoring disturbed plant communities to natural conditions by revegetating disturbed sites would have a long-term</p>	<p>The environmental consequences of using cultural, biological, and mechanical methods would be the same as Alternative A including aerial seeding. If cheatgrass becomes a problem in Wilderness, aerial spraying of herbicides and biological control organisms would be considered. Aerial application of herbicide and biological control organisms would have similar impacts as aerial seeding, which would continue to be available as it is under Alternative A. Aerial applications in Wilderness would follow a minimum tool analysis</p>

Impact Topic	Alternative A (No Action)	Alternative B (Preferred)
	minor benefit on Wilderness. Aerial applications of seed would have short-term minor effects, temporarily diminishing Wilderness values. Negligible to minor short-term adverse effects may result as competition from seeded native grasses may suppress native pioneer forb species. Using biological control organisms to control some invasive plants in MVNP could result in long-term benefits to Wilderness. There is a potential risk that some biological control organisms could evolve over the long-term and have a negative impact on native flora and fauna and consequently on Wilderness.	which MVNP would complete on a project-by-project basis for all aircraft operations over Wilderness.
Archeological Resources	Short-term negligible to minor adverse impacts to archeological sites could be caused by mechanical control techniques, such as hand pulling or digging. Cultural control techniques (revegetation) would be cleared by an archeologist before work occurs, and known cultural sites would be avoided. The park archeologist would be consulted prior to any herbicide application using a sprayer mounted on a truck or a UTV and cultural resources would be avoided. Minor to moderate long-term benefits to archeological resources associated with controlling invasive plants and reestablishing native vegetation would be expected.	IPM efforts would be expanded with the most appropriate IPM control technique selected to protect sensitive cultural resources from invasive plants. The ability to treat substantially more acres of invasive plants would allow for increased protection of cultural resources from the aftermath of catastrophic fire events and degradation of historic site conditions. Aerially herbicide spraying would not be an additional adverse physical impact on cultural resources. Long-term minor to moderate benefits to archeological resources associated with controlling invasive plants and restoring native communities would be maximized. The adverse physical impacts of chemical treatments to archeological resources would be negligible and short-term. The beneficial effects of herbicide use would be long-term and minor.
Ethnographic Resources	Short-term negligible to minor adverse impacts would be expected to cultural sites and medicinal or ceremonial plants caused by mechanical control techniques, such as hand pulling or digging. Cultural control techniques (revegetation) would be cleared by an archeologist before work occurs, and known cultural sites would be avoided. The park archeologist would be consulted prior to any herbicide application using a sprayer mounted on a truck or a UTV and cultural resources and sensitive plants would be avoided. Minor to moderate short-term adverse impacts to ethnographic resources could occur from spot treatments with herbicides. Minor to moderate long-term benefits to ethnographic resources associated with controlling invasive plants and restoring native plant communities would be expected.	Cultural sites would receive greater protection as IPM efforts would be expanded. The most appropriate IPM control technique would be selected to protect sensitive cultural resources from invasive plants. The ability to treat substantially more acres of invasive plants would allow for increased protection of cultural sites and native plant communities from the aftermath of catastrophic fire events and degradation of historic site conditions. Aerially spraying would not be an additional adverse physical impact on cultural material. Alternatives to using chemical controls would be considered in cultural sites when practicable. Greater care would be used in avoiding herbicide contact with identified medicinal or ceremonial plants. Herbicides would be excluded from the most ethnographically sensitive sites as identified through investigation and tribal consultation. With a fully integrated invasive plant program, long-term minor to moderate benefits to ethnographic resources associated with controlling invasive plants and restoring native communities would be maximized. The adverse physical impacts of chemical treatments to ethnographic resources would be negligible and short-term. The beneficial effects of herbicide use would be long-term and minor. The adverse impacts to ethnographic values at cultural sites from the use of herbicides would be moderate but short-term.

Impact Topic	Alternative A (No Action)	Alternative B (Preferred)
Park Operations	<p>Because Alternative A would be the continuation of the current IPM program, management practices would not have significant impacts to divisional work plans, training, or budgets (outside the invasive plant management programs within the Division of Research and Resource Management). With Alternative A, existing relations would continue with park neighbors, as well as state and local officials, who have expressed concern about invasive species spreading from each park onto neighboring lands. Other landowners may continue to build relationships with the park and monument as part of ongoing outreach programs. Continuing current management practices could slightly affect other park operations, adversely in terms of invasive plant control support needs. Most effects on park operations would be beneficial in terms of performing a valuable service in vegetation management. The impacts of Alternative A on park operations would therefore be both adverse and beneficial. Adverse impacts would be park and monument-wide, long-term and short-term, and moderate. When combined with other past, present, and foreseeable future actions that would result in impacts to park operations, Alternative A would have adverse, long-term moderate impacts. This is because for the foreseeable future, park operational resources would experience greater challenges.</p>	<p>The availability and access to all possible IPM tools would allow more flexibility and creativity in achieving goals to benefit overall land uses and park operations. A fully integrated IPM approach would improve relations with park neighbors as well as state and local officials who have expressed concern about invasive plants spreading from the park and monument onto neighboring lands. Having a feasible ability to treat large acres of cheatgrass in the future would help reduce fire hazards, benefiting all park operations. The natural resource program would be challenged to meet the higher performance levels expected under the preferred alternative. Expanding cooperative ventures with partnering agencies could help reduce some of this stress. External funding sources can be explored to facilitate control efforts on adjacent public and private lands. The IPMP also prescribes necessary compliance and mitigation measures for other park projects and operations. Fire management, interpretation, GIS staff, maintenance, and administrative support for personnel and procurement may experience minor short-term impacts and negligible long-term impacts. The impacts of IPM management on park operations would therefore be both adverse and beneficial. Adverse impacts would be park and monument-wide, long-term and short-term, and moderate. Also there would be short-term minor impacts to staffing and administrative personnel during aerial treatment application projects, but at this time these would be expected to occur infrequently.</p>
Visitor Experience	<p>In general, all IPM techniques would have a long-term minor to moderate beneficial impact on visitor experience as weedy invasive vegetation is converted to natural vegetation and catastrophic fire potential is reduced. Activities related to mechanical control of invasive plant species (digging, pulling, and use of gasoline-powered mowers and string trimmers) is expected to have a short-term localized minor adverse impact on visitor experience. Invasive plant control work would take place during high visitation seasons but only in localized areas of the park which should impact only a small percentage of park visitors. There would be short-term noise impacts associated with the use of powered equipment, and short-term visual impacts associated with personnel working on invasive plant control at various locations within the park. Revegetation work is expected to cause short-term localized minor adverse impacts to visitor experience. Biological control should have no adverse impact on visitor experience. Herbicidal control is expected to have a short-term localized minor adverse impact on visitor experience. Chemical control activities (use of backpack sprayers, use of a truck or ATV with a boom sprayer) would create short-term noise impacts and visual impacts. Tire marks through vegetation may be visible up to a year.</p>	<p>The environmental consequences of using mechanical, cultural, biological and chemical IPM methods are the same as Alternative A. Depending of the perspective of the visitor, short-term localized minor impact (beneficial or adverse) may occur. To help mitigate impacts to visitor experience, visitors would need to be further educated about the threats posed by invasive plants and about controversial control methods. The impact of aerial application of herbicide would be similar to aerial seeding in Alternative A. No aerial applications of herbicide would take place in close proximity to areas accessible to the public or areas would be closed during application and not reopened until it is entirely safe.</p>

Impact Topic	Alternative A (No Action)	Alternative B (Preferred)
Human Health and Safety	<p>Mowing, digging or using a gasoline-powered string trimmer, chainsaw, or mower on invasive plants is expected to cause a minor elevated risk to human health and safety from potential contact with moving parts, hot surfaces, and sharp edges. Additionally, volunteers or park employees who engage in mechanical control activities face risks that are similar to those encountered when people are involved in strenuous outdoor activities during the summer months. Irritation and allergic reactions can result from contact with plants. Hearing loss is possible with the use of loud machinery without hearing protection. All of these hazards can be minimized through the consistent and proper use of appropriate personal protective equipment and following safety procedures prescribed in Job Hazard Analyses. Volunteers or park employees who engage in revegetation activities face risks that are similar to those mentioned under Mechanical Treatment. Aerial seeding presents an increased risk associated with the use of aircraft. Pilots are responsible for the safe use of their aircrafts. Biological control techniques are expected to cause a minor elevated risk to human health or safety. Driving and hiking to release sites may pose a small hazard. Workers applying herbicides may be exposed to chemicals via dermal, respiratory, and dietary routes (e.g. contact with vegetation at a recently treated site, breathing herbicide spray particles, breathing herbicide vapors at a recently treated site, touching or tasting objects with residues). Barring accidents, it is unlikely workers would receive doses above the “No observed effect” level. Exposure would exceed “acceptable daily intake” only if they fail to use prescribed Personal Protective Equipment (PPE). Human cancer risks from exposure to the herbicides we propose to use are negligible. Given the herbicides and amounts proposed for use in MVNP, the potential for bioaccumulation or biomagnification appears to be negligible. Areas to be treated with herbicide would be identified with informative signs and would be closed to the public during chemical application. Notification signs would remain in place at all treated areas for as long as needed consistent with re-entry restrictions indicated on the herbicide labels.</p>	<p>The environmental consequences and risks to human health and safety from using mechanical, biological, and chemical controls are the same as Alternative A. No aerial applications of herbicide would take place in close proximity to areas accessible to the public or areas would be closed during application and not reopened until it is entirely safe. Treatment areas would be off-limits to park staff during projects. Contractor and staff would use appropriate PPE, safety and mitigation measures and procedures. Helicopter operations for herbicide use or the application of biological organisms would use the same kinds of flight safety protocols as for aerial seeding. With implementation of mitigation measures, which include employee safety measures and adequate notification of the public, there would be no measurable increased cumulative risk to human health and safety with either alternative.</p>

Affected Environment

All NPS lands at MVNP and YHNM are covered in this analysis. Areas of the park and monument affected by invasive plant control are described. Future site-specific proposals following approval of this plan may require further surveys and environmental compliance.

Natural Resources

Soils and Vegetation

SOILS

MVNP. Two major soil groupings are recognized on Mesa Verde. First are soils on the stable mesa tops that developed from windblown deposits. The second group includes steep canyons and hills that are composed of colluvial material fallen from steep slopes and alluvial material washed down from the slopes by intermittent stream flows.

The windblown soils generally have excellent qualities for native vegetation growth and agricultural uses. Soil depth and development varies by location relative to the mesa edges. Near the mesa edges or canyon rims, bare sandstone is commonly exposed. Closer to the rims, the soils often are a mixture of windblown soil and sandstone. These soils have a sandy loam texture with minimal development of soil horizons or layers. Farther back from the mesa edges the windblown soil has accumulated to greater depths, 50 to 100 cm (19 to 39 in). These soils are relatively stable with little influence from the underlying bedrock. Subsoil textures are generally loam to clay loam with the development of subsoil argillic horizons (clay layer).

Winter moisture has leached calcium carbonate downward from the surface over thousands of years; calcium carbonate has accumulated in the lower parts of the soil profile, forming a white powdery deposit known as calcic horizons. Still farther away from the canyon edges, near the middle of the mesa, the windblown soils have developed to a greater depth. Soil accumulation over the sandstone or shale can be as deep as one to two meters (3.3-6.6 feet). These deeper soils show excellent evidence of stability and soil development. Well-developed subsoil argillic horizons along with calcium carbonate deposits in calcic horizons are common. Deep deposits may extend over large areas on level topographies, but depths decline in the adjoining canyons or on steeper, less stable hillsides.

Soils in the steep canyons exhibit the greatest soil variability in the park. In most cases, steep canyons and mesa slopes are capped by a band of hard sandstone, with softer and more erosive shale or inter-bedded materials beneath. Colluvial soils develop below the near vertical cliffs formed by the harder Cliffhouse Sandstone. These soils incorporate sandstone pieces from above mixed with the inter-bedded sandstone and shale layers of the underlying shale in the Menefee Formation. The soils tend to be shallower and have minimal development on the convex positions of the landscape and nearer the tops of the slopes. This is because the exposed steeper slopes have high erosion rates, approaching the point where erosion is equal to deposition and weathering of the bedrock. These steep rocky slopes with little soil development tend to be poorly vegetated. The available water capacity is very

low due to the shallow depth and little water infiltrates into the soil. Consequently the runoff rates are high.

The soils at the lower portion of the slopes accumulate to greater depths as the material erodes from above and is deposited in the fans and toe slopes near the bottom. These soils sometimes exceed 6 m (19 feet) in depth. Deep colluvial soil is made up of soil and geologic material that has fallen from above. Lower slope soils have generally well-developed soil features and horizons. Weakly-to-well developed argillic and calcium carbonate deposits are common. Soil textures tend to be loams to light clay loams but have a great deal of variability, depending on the upslope geologic formations.

Soil moisture varies with location on the landscape. Many areas near the lower parts of the slope benefit from increased moisture due to runoff from areas above. The aspect, that is the orientation direction, north, south, east or west, also plays a major role in determining the development and moisture status of the site. The soils on north facing slopes are more fully developed and have better vegetative cover due to the better moisture status. The pH, organic material, and leaching of carbonates are all tangible evidence of this increase in available moisture on the north facing slopes (Ramsey 2003).

Within pinyon-juniper woodland habitat, Mikim loam and Arabrab-Longburn soils are the most likely to be invaded by invasive vegetation after the soils are disturbed, such as after wildfire but also due to livestock or human activities. In addition, Arabrab-Longburn soils are more likely to support invasive plants even without significant disturbance (Floyd et al. 2006).

YHNM. The soils at YHNM are very similar to those found on the northern slopes of MVNP, mostly composed of weathered and colluvial deposits from Mancos Shale geology. In near-surface environments, Mancos Shale weathers to shale residuum, which resembles soil in its characteristics but retains the physical structure of the shale (Wright 2006). Residuum profiles in the Mancos Shale can range from several feet to tens of feet thick.

VEGETATION

MVNP. The vegetation at MVNP is somewhat distinct within the arid Southwest because of the park's relative abundance of water, with an annual average of about 46 centimeters (18 in) annual precipitation, the result of orographic uplift from surrounding high peaks of the southern Rocky Mountains, long growing season, diverse geological substrate and subsequent soils, and topographic variety (Floyd et al. 2003a).

Vegetation at MVNP recently has been classified and mapped through a multi-agency effort, resulting in the identification and description of 47 plant communities, many of which were aggregated into broader community groups to improve mapping accuracy (Thomas et al, 2009). The dominant vegetation types are mountain (or montane) shrublands and pinyon-juniper woodlands. Pinyon-juniper woodlands occur on most southern mesa tops and upper canyon slopes, while montane shrublands occupy northern mesa tops and slopes. A patchy distribution of pinyon-juniper woodlands and shrublands occur on the eastern and northern edges of the park on Mancos shale slopes. Some upper-elevation canyons and northern escarpment slopes support mixed conifer habitats. Many upper

canyon bottoms support dense shrublands, dominated by Gambel oak (*Quercus gambelii*), giving way to grassy big sagebrush (*Artemisia tridentata*) habitat as canyons widen lower down toward the south.

Fire is an important factor in shaping the distribution of vegetation types across the mesa. Several small lightning-ignited fires occur nearly every summer. Large summertime wildfires occur during periodic droughts, particularly when high winds are present. Where fires occur frequently, vegetation tends to be dominated by deciduous shrubs, capable of regenerating by sprouting after fire. In recent years, large stand-replacing wildfires that occurred in former pinyon-juniper woodlands have typically been planted with native grass seeds, resulting in thousands of acres of mesa-top grassland.

Another important factor shaping vegetative communities is herbivory by wildlife. Populations of native herbivores, such as rabbits, deer, elk, etc., fluctuate over time resulting in changes to the amount of biomass consumed on the landscape. Similarly, the numbers of loose unclaimed livestock roaming the park have varying impact levels on the park's vegetation. The definition of "livestock" used in the IPMP refers to unauthorized hooved stock occurring in the park, whether branded or not." As both cattle and horses are primarily grazers, they prefer habitats with plenty of grass, but they also are limited by the availability of drinkable water. Their overall impact is unevenly spread over the landscape. They prefer grasslands, open canyon bottoms, and montane shrublands, with areas located near surface water sources receiving the heaviest impacts to plants and soil. As horses and cattle select preferred forage species, a further competitive advantage is extended to invasive plants on disturbed soils.

Summaries of important community groups are presented below:

Mountain Shrublands. Community types in the Rocky Mountain Gambel Oak-Mixed Montane Shrubland Group (mountain shrublands) are dominant at MVNP, covering 11,400 ha (29,000 ac), over 50% of the total park. Montane shrublands occur primarily on gently sloping terrain, widely distributed throughout the higher elevation areas in the northern and eastern reaches of MVNP. Soil textures associated with mountain shrublands include coarse to fine sandy loam to sandy clay loam (Moore 2005a). This vegetation type is dominated by a diversity of shrubs. Some of the dominant shrubs include Gambel oak, mountain mahogany (*Cercocarpus montanus*), chokecherry (*Prunus virginiana*), Utah serviceberry (*Amelanchier utahensis*), bitterbrush (*Purshia tridentata*), fendlerbush (*Fendlera rupicola*), gooseberry (*Ribes cereum*), skunkbush (*Rhus trilobata*), and snowberry (*Symphoricarpos oreophilus*). Commonly associated understory forbs and grasses include showy goldeneye (*Heliomeris multiflora*), toadflax penstemon (*Penstemon linarioides*), two lobe larkspur (*Delphinium nuttallianum*), hairy false goldenaster (*Heterotheca villosa*), Indian ricegrass (*Oryzopsis hymenoides*), and needle-and-thread grass (*Hesperostipa comata*).

Fire is the major natural disturbance for this vegetation type. The fire turnover time, approximately 100 years in this community, is shorter than the fire turnover time for the adjacent pinyon-juniper woodlands, which historically has been near 400 years (Floyd et al. 2000). Montane shrublands tend to have high fuel continuity of dense shrubs with leaf litter and abundant grasses and forbs. Many of the dominant shrubs (e.g., Gambel oak, serviceberry, fendlerbush) are vigorous sprouters, thus adapted to

reoccurring fire. Without periodic fire, pinyon pine, Utah juniper, and Douglas-fir (*Pseudotsuga menzeisii*) colonize the old-growth montane shrublands (Floyd-Hanna et al. 1996).

Pinyon-Juniper Woodlands. Several community types make up the Colorado Pinyon-Juniper Woodland Group (pinyon-juniper woodlands) at MVNP. Formerly the dominant cover type in the park, these woodlands have been severely reduced by fires since 1996. Currently, pinyon-juniper woodlands cover approximately 5,500 ha (14,000 ac), approximately 25% of the park. They occur primarily on mesa tops and canyon slopes in the lower elevation areas in the southern and western reaches of MVNP but extensive stands also grow on the lower slopes of the northern and eastern escarpments. Soil textures associated with pinyon-juniper woodlands include clay loam, loose sandy duff, loamy sand, and sandy loam (Moore 2005a). At its upper boundary, this vegetation type grades into montane shrublands. Colorado pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) are the dominate trees, with juniper more important at lower elevation/xeric sites and pinyon pine more important at higher elevation/mesic sites. Often, juniper dominates the basal area of most stands, while pinyon pine is the more abundant of the two species (Floyd et al. 2003a) although recent drought induced pinyon pine mortality significantly changed historic stand structures. Rocky Mountain juniper (*Juniperus scopulorum*) replaces or co-occurs with Utah Juniper at higher elevations, at the bases of the escarpments, and/or in cooler microhabitats (Moore 2005a).

Commonly associated understory shrubs include bitterbrush, yucca (*Yucca baccata*), big sagebrush, dwarf rabbitbrush (*Chrysothamnus depressus*), and mountain mahogany. Common grasses and forbs include toadflax penstemon, rock goldenrod (*Petradoria pumila*), buckwheats (*Eriogonum umbellatum*, *Eriogonum racemosum*), muttongrass (*Poa fendleriana*), and Indian ricegrass.

Invasive plant species tend not to be important in intact pinyon-juniper woodlands in the park. However, where soil and canopy are disturbed, non-native plants may invade. Typical invasive species include the herb Sophia (*Descurainia sophia*), cheatgrass, curve-seed butterwort (*Ceratocephala testiculata*), tumble mustard (*Sisymbrium altissimum*), and musk thistle (*Carduus nutans*).

MVNP includes several old-growth pinyon-juniper stands, estimated to be 300-400 years old or more. Most of these stands are naturally dense and not a direct result of historical fire suppression. Old growth pinyon-juniper woodlands are characterized by old, large trees, 50-100 cm (19-39 in) diameter at breast height (dbh), high tree density and basal area, canopy gaps which allow herbaceous plant diversity, lack of fire scars and charred wood, and well-developed biological soil crusts (Floyd et al. 2003).

Scattered throughout these woodlands are even older trees, including a pinyon estimated at 1,600 years old (MVNP 2002a). A Utah juniper, listed as a "Colorado champion," measures 150 centimeters (59 inches) diameter at breast height (dbh), and is estimated to be 1,350 years old. An even older Utah juniper, estimated at 1,500 years old, is located near Rock Springs Canyon (MVNP 2002a). The extensive presence of very old woodland stands, large old trees, and the lack of live trees with fire scars are clear indications that until recently, fire frequencies at MVNP have been very low and that low severity surface fire regimes, such as occurs in ponderosa pine stands, were absent (Floyd et al. 2003).

Most of the pinyon-juniper woodland communities at MVNP are highly susceptible to post-fire incursion by invasive plants (Floyd et al. 2004, 2006). Every wildfire in the park since 1989 has experienced this phenomenon. On the other hand, intact woodlands are virtually weed-free, even after they sustain significant mortality levels from bark beetle infestations. Studies are underway to determine the environmental factors that retain woodland resistance against weed invasion. However, it has been observed that sites inside MVNP mechanically opened up to reduce hazardous fuel loading have experienced an altered understory including a growth surge among shrubs, tree seedlings, and herbaceous species, including invasive plants such as cheatgrass, musk thistle, and others. The park is struggling with finding ways to reduce the risks and spread potentials of posed by future wildfires in the park because, among other reasons, post-fire conditions remain one of the most challenging in terms of invasive plants.

Grasslands. The grassland cover types include both natural and planted grasslands in MVNP, which in total occupy 2,800 hectares (7,000 acres), 13% of the total park landscape. A majority of these grasslands are a result of aerially seeding native grasses following severe wildfires since 1996 in former pinyon-juniper woodlands. Currently, bunch and sod grasses, forbs, and small shrubs dominate these communities. Pinyon and juniper regeneration is almost completely absent in these areas. Common grasses include muttongrass, needle-and-thread grass, Indian ricegrass, blue grama (*Bouteloua gracilis*), squirreltail (*Elymus elymoides*), western wheatgrass (*Pascopyrum smithii*), and other cool and warm season grasses that resprout following fire. Invasive plant species, including musk thistle, cheatgrass, prickly lettuce (*Lactuca serriola*), and various mustards (e.g. tumble mustard), immediately colonized these severely burned areas and were the dominant vegetation for several years following fires (Floyd et al. 2004b). Natural grasslands also grow in some of the major canyon bottoms including the parts of Prater and Morefield canyons.

Mixed Conifer Forest. The Southern Rocky Mountain Montane Mixed Conifer Forest (mixed conifer forest) is relatively rare in MVNP, now occupying just 250 ha (650 ac). Douglas-fir is the dominant tree within the mixed conifer forest. These stands are patchy and isolated, occurring primarily in two separate habitats within the park: 1) on steep, sloping terrain distributed throughout the montane shrublands in the northern portion of the park, and 2) in deep canyons in the southern portion of the park (MVNP 2002a). Soil textures associated with Douglas-fir stands range from clay loam to loose sandy duff, loamy sand and sandy loam (Moore 2005a). Associated tree species include Gambel oak, chokecherry, serviceberry, Rocky Mountain maple (*Acer glabrum*), and in one stand, the only occurrence of bigtooth maple (*Acer grandidentatum*) in Colorado. Understory plants include blue leaf aster (*Aster glaucoides*), Oregon grape (*Berberis repens*), Wood's rose (*Rosa woodsii*), mountain snowberry (*Symphoricarpos oreophilus*), and boxleaf myrtle (*Paxistima myrsinites*). Approximately 90 percent of Douglas-fir stands have burned in the park since 2000, primarily in the Bircher Fire in 2000. Numerous stands of the remaining Douglas-fir also suffered heavy losses as a result of bark beetle and wood-boring beetle attacks on drought-weakened trees (MVNP 2003a). Rare, old-growth stands of Douglas-fir exist in the deep canyons in the southern portion of the park, such as Wickiup Canyon, Navajo Canyon, and Spruce Canyon. Stand age studies show that some of these southern Douglas-fir stands are between 446-511 years old (Floyd et al. 2004b).

Other communities. Other important plant communities growing in smaller aggregate acreages at MVNP include Mixed Bedrock Canyon and Tablelands, Big Sagebrush Shrublands, Barrens, Riparian Woodlands and Shrublands, Wet Meadows, and scattered, extremely small stands of Ponderosa Pine Woodland.

Invasive vegetation. Vegetation within MVNP and YHNM has been affected by a variety of direct and indirect human actions, including historical grazing by managed livestock (ending in the 1930s), grazing by loose unclaimed cattle and horses, intentional planting of non-native species, infrastructure development and maintenance, fire suppression, past and present invasive plant control efforts, and hazard fuel reduction. Developed areas, including roads, campgrounds, visitor centers, employee housing, utility corridors, wastewater treatment facilities, and other disturbed areas contain the largest concentrations of invasive plants. Species such as cheatgrass, musk thistle, and smooth brome (*Bromus inermis*) have increased significantly in some areas of the park following catastrophic fire events. See Appendix C for a list of the typical invasive plant species actively controlled in recent years.

YHNM. Although only 34 acres, YHNM sustains an island remnant of largely natural vegetation that has been protected for many years from the intense grazing and cultivation that occurs on many neighboring lands. A desert-shrub community, including four-wing saltbush (*Atriplex canescens*), greasewood (*Sarcobatus vermiculatus*), and wolfberry (*Lycium pallidum*) occupies the northern portion of the monument, surrounding the primary archeological site. Isolated pockets of wetland habitat are associated with three perennial springs and from inflow runoff from irrigation on neighboring land. To the south and west of the main archeological site, hill tops and slopes support Utah juniper, big sagebrush, and some pinyon pine, along with other woody and herbaceous plant species.

Cheatgrass constitutes much of the dominant understory surrounding the archeological sites. Neighboring agricultural and ranching activities enhance the spread of invasive plant species such as Russian knapweed, cheatgrass, and musk thistle that occur within and surrounding the monument. The long-term presence of an open irrigation ditch and ponds, roads, livestock grazing, and farming activity has facilitated the spread of invasive species by disturbing the soil and discouraging native species.

Aquatic, Wetland and Riparian Communities

MVNP. Surface water areas are rare and fragile in MVNP and contain the highest flora and fauna biological diversity, but occupy only 91 hectares (224 acres), less than one percent of the entire park. Riparian areas within the park consist of the Mancos River, springs and seeps located along the base of cliff forming sandstone or between sandstone cliffs, and artificial water sources, such as sewage lagoons and wastewater discharge into Little Soda Canyon (artificial irrigation). Soil texture associated with this vegetation type includes silty, sandy clay and gravel bars along the Mancos River (Moore 2005a). Riparian woodlands and wetlands are defined as the transition between the aquatic environment and the upland terrestrial environment where the water table is generally at or near the surface or the land is covered with water (Cowardin et al. 1979). A spring is defined as a location with some form of standing water and a seep is a location with moisture seeping out of a wall or the ground with no standing water (Moore 2005a). The Mancos River is the most predominant riparian feature

within the park, occupying 4 kilometers (2.5 miles) within the eastern part of the park boundary. The riparian area consists of numerous trees and shrubs including Alamosa cottonwood (*Populus deltoides* var. *wislizenii*), coyote willow (*Salix exigua*), buffaloberry (*Shepherdia argentea*), and skunkbush (*Rhus trilobata*). This riparian area has been classified as separate vegetation type, cottonwood / buffaloberry riparian woodlands, from all the other riparian areas within the park. This document combines cottonwood/ buffaloberry riparian woodlands and other riparian vegetation types. Privately owned up until 1995, the riparian area along the Mancos River was grazed for about a century and is increasingly becoming dominated by invasive species in areas burned in 2000 by the Bircher Fire. Invasive species include Russian knapweed, Canada thistle, and cheatgrass. Other herbaceous dominants, many that are disturbance-adapted species, include muhly (*Muhlenbergia asperifolia*), canary reed grass (*Phalaris arundinacea*), smooth brome, hairy golden aster (*Heterotheca villosa*), yellow sweet clover (*Melilotus officinalis*), and milkweed (*Asclepias speciosa*) (Moore 2005a). In addition to this riparian area are numerous canyons that dissect the Mesa Verde geologic formation. These canyons in recent years, due to fire-induced hydrophobic soils on the East Escarpment, have experienced rapid runoff that fills canyon bottoms during even moderate rainstorms. These canyon environments are fragile and sensitive to rapid runoff, affecting floral and faunal diversity. Tamarisk (*Tamarix spp.*), aggressive invasive species prevalent in the Southwest, has been recorded and controlled along the Mancos River, in the Morefield Sewage lagoons, and in Navajo, Spruce, Cliff, Rock, Wickiup, and Soda canyons.

On July 31, 1997, the Water Judge for Colorado Water Division 7 signed a decree that granted Federal reserved water rights for MEVE. The decree granted the United States Federal reserved water rights for springs, the Mancos River, and for other surface and ground water within the park. The purposes for these reserved rights, which are directly related to the purposes for the establishment of MVNP and subsequent boundary adjustments, include the preservation of wildlife and habitats, aquatic and land vegetation, forests, watershed, and Wilderness, among other values. The park has a right to continuous flows in the Mancos River within the park for the following amounts during the designated time periods each year. (Note: cfs – cubic feet per second and 1 cfs equals 448.83 gallons per minute.)

August 1 through January 31	5 cfs
February 1 through February 28	10 cfs
March 1 through March 31	15 cfs
April 1 through April 30	30 cfs
May 1 through May 31	45 cfs
June 1 through June 30	12 cfs
July 1 through July 31	6 cfs

However, the priority date for the instream flow right in the Mancos River is January 1, 1995. This date is junior to most irrigators and other water users in the Mancos River watershed. In recent years the park often has received less than the flows allocated by this water right. This has had a profound impact on the aquatic and riparian biotic resources in the park.

The Mancos Canyon restoration project started in 1998 and consists of an 80 hectare (200 acres) area that historically was plowed, irrigated, and seeded to non-native plants, and grazed by cattle. The NPS acquired the land on October 13, 1978 but grazing continued for another 20 years when the grazing right on this tract expired. Approximately 68 hectares (170 acres) of this restoration project is recovering rapidly with native tree and shrub species; the other remaining areas are recovering more slowly due to washout from burned slopes and the presence of invasive plants such as Russian knapweed and cheatgrass.

Over 100 seeps are scattered throughout the park. Many of these seeps are sensitive to drought and therefore have gone dry in recent years as water tables have dropped.

YHNM. Water resources at YHNM consist of three highly mineralized, perennial springs and the small wetlands supported by their short-distance flows (Wright 2006). It is also important to note that the NPS does not own any of the water rights to the springs in or around the monument. These three sites are in close proximity and may or may not be issuing from the same subterranean source. The middle spring, Aztec Spring, is the largest of the three and is the only dependable natural source of surface flow within the monument. A substantial wetland grows along its southeastward flow including cattails (*Typha*). The south spring's flow may be enhanced from imported water at the stock pond and irrigated field immediately west of the monument. Flow from the north spring, Gate Spring, begins outside of the monument but flows inside the boundary, supporting additional wetland vegetation.

Water Quality

The Mancos River is the only perennial stream in the Mesa Verde area. Throughout most of its middle drainage, it is fringed with numerous irrigation ditches drawing off water to agricultural fields. As a result of the low flows caused by the diversions and return flows coming off the irrigated fields, water chemistry is altered by warmer temperatures and evaporation concentrates dissolved compounds such as salts. Several of the smaller stream reaches also are recharged with ground water derived from irrigation infiltration that returns to the main channel via buried gravels, picking up additional salts, agricultural pesticides, herbicides, and, from shale soils, selenium (Colyer 2003).

The importance of perennial rivers in dry Southwestern landscapes cannot be overstated. These drainages are extremely important habitats for riparian floral and faunal communities. These drainages also serve as corridors for seasonal migration of deer, mountain lions, bears, and others seeking wild fruit and fish, migrating birds that use the cottonwood tree tops for cover and feed on the ground, and a number of other kinds of wildlife that periodically use the river corridors. Past land use practices along the Mancos River have removed cottonwoods and willows from the bottomlands, plowed and grazed the understory and replaced it with agricultural crops and non-native species, removed beavers and their dams, and introduced cattle – actions that greatly reduced the available natural habitat and biodiversity (Colyer 2003).

In Colorado, surface water quality is assessed primarily in conjunction with preparation for the review of water quality standards, as well as for special projects and preparation of the 303(d) List required by the Clean Water Act. Water quality standards for the waters of the San Juan Basin are contained in a regulation titled “Classification and Numeric Standards for the San Juan and Upper Dolores River

Basins, Regulation No. 34” prepared by the Colorado Department of Public Health and Environment, Water Quality Control Commission.

The main stem of the Mancos River, including all wetlands, tributaries, lakes, and reservoirs, from the source of the East, West, and Middle Forks to Highway 160 is classified by the State as waters with the following designates uses: Aquatic Life (cold), Water Supply, Agriculture, and Recreation. Water quality standards are set to protect these designated uses. The canyons that drain MVNP to the south flow into the Mancos River south of Highway 160. The main stem of the Mancos River from highway 160 to the Colorado/New Mexico State line and its tributaries are classified for Aquatic Life (warm), Agriculture, and Recreation. The big differences between the Aquatic Life (cold) and the Aquatic Life (warm) classifications are the dissolved oxygen standard and temperature standard. The State of Colorado also designated flows within the Mancos River watershed within Mesa Verde National Park as “Outstanding Waters,” which requires special protections from pollution sources originating in the park.

Water quality problems in the Mancos River above Highway 160 have been noted for sediment loads from roads and timber harvesting in the past, and these areas currently exceed the copper standard. Some geological features in the headwaters of the East Mancos River contribute substantial natural levels of copper and other metals to the drainage. Below Highway 160, no violations of water quality standards have been noted by the State.

YHNM. There are a few natural springs at YHNM, the largest known as Yucca House Spring, Aztec Spring, or the Main Spring. Although water resources at YHNM are important to the biotic communities of the area, the quality and quantity of these resources may be changing. Inflow of irrigation water from surrounding agricultural fields could be adversely impacting water quality through the influx of pesticides, salts, bacteria, and excess nutrients. The quantity of water may be declining due to drought and water withdrawals from the regional aquifer. Recent changes in irrigation water distribution patterns threaten the persistence of well-established wetland and riparian areas.

Precipitation falling on east of Sleeping Ute Mountain flows down-gradient through an alluvial fan and discharges in some small springs in and around YHNM (Wright 2006). The water from Ismay Spring is drinkable because of contact with alluvium and colluvium, which is not highly mineralized. Water from the alluvial fan mixes with water in the Mancos Shale, and then is mixed with irrigation water to form water that discharges at Yucca House (Aztec) Spring. Evidence supporting the fact that Yucca House Spring is affected by human activities includes flow path diagrams indicating geochemical evolution of ground water, the presence of nitrate in water from the spring, saturation indices of mineral speciation, and ground-water flow path modeling. Water-quality samples from the springs at YHNM had high salinity and low sodium-alkali hazard ratings.

Wildlife

Wildlife in MVNP and YHNM is diverse and abundant reflecting the wide range of Upper Sonoran and Transition Life Zone habitat types that are found in the park and monument. The distribution of species within the park and monument varies by season, elevation, and varieties of habitats present. Because of its very small size and low habitat variability in mostly desert-shrub, the species diversity at

YHNM is much lower, amounting to a subset of that for MVNP, but is not distinguished here separately.

Mammals

There are at least 68 species of mammals that inhabit MVNP. There are six shrews living in MVNP which represent the Insectivore Order. There are 15 species of bats known to occur in MVNP including (*Tadarida brasiliensis*) the Brazilian free-tailed bat. Two additional species, the Yuma myotis (*Myotis yumanensis*) and Allen's big-eared bat (*Idionycteris phyllotis*), are suspected to occur. Bats at Mesa Verde depend on riparian and meadow habitats for foraging and large trees, snags, and rock crevices for roosting. There are three lagomorph (rabbit) species, six species of squirrels, three species of chipmunks, seven species of mice, three species of voles, and other rodent species including muskrats, woodrats, beaver, porcupine, gophers, prairie dogs, and kangaroo rats that inhabit the Mesa Verde and vicinity. Carnivores at Mesa Verde include the coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), black bear (*Ursus americanus*), ringtail (*Bassariscus astutus*), long-tailed weasel (*Mustela frenata*), mink (*Mustela vison*), spotted skunk (*Spilogale gracilis*) and striped skunk, (*Mephitis mephitis*), badger (*Taxidea taxus*), mountain lion (*Felis concolor*), and bobcat (*Felis rufus*). Bighorn sheep (*Ovis canadensis*), mule deer (*Odocoileus hemionus*), and Rocky Mountain elk (*Cervus elaphus*) are also found at MVNP but the bighorn sheep is functionally extirpated.

Birds

There are approximately 50 bird species that commonly occur in the MVNP. This includes several owl species; the great horned (*Bubo virginianus*), Mexican spotted (*Strix occidentalis lucida*), long-eared (*Asio otus*), northern pygmy (*Glaucidium gnoma*), northern saw-whet (*Aegolius acadicus*), western screech (*Megascops (Otus) kennicottii*), and flammulated (*Otus flammeolus*) owls and other raptors including the turkey vulture (*Cathartes aura*), Northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*), golden eagle (*Aquila chrysaetos*), American kestrel (*Falco sparverius*), and others. Results of the Breeding Bird Survey since 1996 show little change in the total number of species. Some individual species show large annual variations in abundance.

A sampling of other breeding species at Mesa Verde include the ash-throated flycatcher (*Myiarchus tyrannulus*), gray flycatcher (*Empidonax wightii*), dusky flycatcher (*E. oberholseri*), olive-sided flycatcher (*Nuttallornis borealis*), western kingbird (*Tyrannus verticalis*), warbling vireo (*Vireo gilvus*), plumbeous vireo (*Vireo solitarius plumbeus*), violet-green swallow (*Tachycineta thalassina*), juniper titmouse (*Baeolophus ridgwayi*), white-breasted nuthatch (*Sitta carolinensis*), black-throated gray warbler (*Dendroica nigrescens*), Virginia's warbler (*Vermivora virginiae*), Bewick's wren (*Thryomanes bewickii*), broad-tailed hummingbird (*Selasphorus platycercus*), western tanager (*Pirango ludoviciana*), mountain bluebird (*Sialia currucoides*), dusky grouse (*Dendragapus obscurus*), American robin (*Turdus migratorius*), black-headed grosbeak (*Pheucticus melanocephalus*), spotted towhee (*Pipilo erythrophthalmus*), green-tailed towhee (*Chlorura chlorura*), house wren (*Troglodytes aedon*), pine siskin (*Spinus pinus*), vesper sparrow (*Pooecetes gramineus*), lark sparrow (*Chondestes grammacus*), Steller's jay (*Cyanocitta stelleri*), Clark's nutcracker, (*Nucifraga columbiana*), Western scrub-jay

(*Aphelocoma coerulescens*), piñon jay (*Gymnorhinus cyanocephalus*), and wild turkey (*Meleagris gallopavo*).

Migratory Birds

Under the auspices of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712), the following avian species of MVNP are listed on the USFWS Birds of Conservation Concern-Bird Conservation Region 16-Southern Rockies/Colorado Plateau (BCC) list: American peregrine falcon (*Falco peregrinus anatum*), black-throated gray warbler (*Dendroica nigrescens*), flammulated owl (*Otus flammeolus*), golden eagle (*Aquila chrysaetos*), gray vireo (*Vireo vicinior*), northern harrier (*Circus cyaneus*), piñon jay (*Gymnorhinus cyanocephalus*), and Virginia's warbler (*Vermivora virginiae*). However, any of the park's native birds are protected under this law.

Reptiles and Amphibians

There are many reptiles suited to the semiarid habitats found in MVNP. The Reptile Class is represented by at least nine lizards, eight snakes, and a skink. There are fewer amphibians that can survive under these conditions. Some of the amphibians that are adapted to the region are in decline, such as the Utah tiger salamander (*Ambystoma tigrinum*) and northern leopard frog (*Rana pipiens*). The Utah tiger salamander is very rare in MVNP and the northern leopard frog is believed to be completely extirpated from the park. Other amphibians include the Rocky Mountain toad (*Bufo woodhousii woodhousii*), red-spotted toad (*Bufo punctatus*), and boreal chorus frog (*Pseudacris maculata*).

Fishes, including Non-native Species

Like many locations in the southwest, native fish populations in MVNP have experienced a marked decline. There is no fish habitat in YHNM. There are six fishes that occur or formerly occurred in the park, limited by the extent of the Mancos River. Of these, the Colorado pikeminnow (*Ptychocheilus lucius*) and the razorback sucker (*Xyrauchen texanus*) are listed as endangered but have long been extirpated from the park. The flannelmouth sucker (*Catostomus rimiculus*) and the bluehead sucker (*Cycleptus elongatus*) still swim in the Mancos River but are rare. The roundtail chub (*Gila robusta*) was briefly extirpated but has been reintroduced through a stocking program run by the state of Colorado's Division of Parks and Wildlife. The speckled dace (*Rhinichthys osculus*) is the only native fish species not in danger of being extirpated. There also is one record of a mottled sculpin (*Cottus bairdii*) in the park. A number of issues have hindered recovery of the native fishery at the park.

Fish population declines are due in large part to climactic conditions, water use outside the park, and competition from non-native fishes. In July of 2000, fire retardant was accidentally dropped in the Mancos River while fighting the Bircher Fire in the Mancos Canyon. As a result, a large number of native fishes were killed along 5 kilometers (3 miles) of the river extending into the Ute Mountain Indian Reservation. Effects to fish below 5 km (3 mi) from the drop site were minimal due to dilution of the retardant. Fishes were observed re-colonizing the kill zone within months of the initial kill (Bircher Fire BAER Wildlife Team, 9 August 2000). The aftermath of the Bircher Fire created additional impacts in the form of heavy siltation and erosion from exposed slopes. Furthermore, in 2002 the Mancos River

was reduced to isolated pools because of severe drought and water diversion by senior water rights holders upstream from the park. At that time, the few surviving roundtail chubs were salvaged for captive breeding.

Starting in 2003, thousands of roundtail chubs were released annually into the Mancos River. A few Bluehead sucker (*Cycleptus elongatus*) and flannel mouth sucker (*Catostomus rimiculus*) trapped from the San Juan River have been transported and released in the Mancos River. Due to these efforts the native fishery has improved since the extreme drought conditions that prevailed in 2002. Aquatic invertebrate populations also were severely impacted by the fire retardant, siltation, and subsequent drought. The fisheries recovery is dependent on aquatic invertebrates for food and the invertebrate numbers and diversity are still much lower than before the Bircher Fire and ongoing drought.

Three species of non-native fishes are known to occur in the park. Rainbow trout (*Oncorhynchus mykiss*) occur at times during spring runoff, but are not considered a serious threat to native fish populations because they are not persistent. The green sunfish (*Lepomis cyanellus*) and the fathead minnow (*Pimephales promelas*) are considered a threat because they can survive the Mancos River environment year around and compete for a diminished food supply of aquatic invertebrates. Green sunfish also are predatory on the young of the native species.

Non-native Wildlife Species

In addition to horses and cattle, and the fishes mentioned above, the chukar partridge (*Alectoris chukar*), ring-necked pheasant (*Phasianus colchicus*), Eurasian collared dove (*Streptopelia decaocto*), brown-headed cowbird (*Molothrus ater*), house sparrow (*Passer domesticus*), European starling (*Sturnus vulgaris*), common raccoon (*Procyon lotor*), and European red fox (*Vulpes vulpes crucigera*) are also non-native vertebrate wildlife species that occur in MVNP. Non-native invertebrate species at MVNP include the honey bee, European paper wasp, northern crayfish, and house centipede.

Introduced Biological Control Insects

Since the later 1990s, MVNP has intermittently released biological control insects on some invasive plant species. None have been released in the last few years. Here is a list of the species used so far.

Invasive Plant Species Biological Control

Canada thistle	<i>Ceutorhynchus litura</i> <i>Larinus planus</i> <i>Urophora cardui</i>
Musk thistle	<i>Trichoceracaulus horridus</i> <i>Rhynocerus conicus</i>
Diffuse knapweed	<i>Cyphocleonus achates</i> <i>Larinus minutus/obtusius</i>
Common mullein	<i>Gymnetron tetrum</i>

To date, only the two weevil species released on musk thistle appear to have had any effect on the target invasive plant and have self-sustaining populations. The others do not appear to have become established.

Habitat

Wildlife populations require an environment that provides the resources and conditions necessary for their continued survival including forage, shelter, and dispersal. These conditions must be met on a year around basis for wildlife populations that do not migrate and seasonally for those species that do migrate. Habitat must be well distributed over a broad geographic area to allow breeding individuals to interact spatially and temporally within and among populations.

Human activity, including pedestrian and vehicle traffic, and fire suppression have impacted wildlife and their habitats at MVNP. While many species, such as mountain lions, foxes, and eagles tend to avoid areas of human activity, there are other species, such as rodents, that tend to aggregate around human activity. The area has experienced intensive human activity in the past starting with the Native American occupation, which included farming and hunting. It is highly unlikely that native peoples suppressed wildfires to any degree. On the contrary, they appear to have managed their landscape with fire (Anderson et al. 2012). However, during that period there were no invasive plant or wildlife species and the Mancos River maintained a natural flow regime. For the park's plants and wildlife today, both of these factors have been changed.

Different species of wildlife respond in different ways to fire-caused habitat changes. The greatest impacts to wildlife and habitat are from high intensity fires that burn and kill entire stands of trees and brush. These infrequent high-intensity fires are common in the type of pinyon-juniper forests that cover much of MVNP (Romme et al. 2003). Wildlife in the area has lived with this type of fire regime for centuries. Since fire suppression began as a park policy nominally in 1906 these types of fires may have been slightly less common due to early control of small fires that could have become large. However, fire exclusion during the first half of the 20th century probably was influenced more by climate and by historic livestock grazing than by the minimal efforts that could be employed in those days.

Current records indicate that two amphibian, 75 bird, 25 mammal, and ten reptile species have been reported at YHNM. Although no threatened or endangered animal species breed in YHNM, bald eagles are seen in winter and peregrine falcons nest in the neighboring cliffs and crags and hunt over the whole valley. The collapsed multi-stored masonry structures in YHNM, largely heaps of rocks, provide important cover and hibernacula for many reptiles, especially snakes.

Land uses of adjacent properties, particularly grazing and irrigated farming, have fragmented natural habitats, changed migratory patterns of wildlife, and reduced the biotic diversity around the monument. Private lands border YHNM on all sides. Further development of these lands could completely isolate the movement of wildlife species from adjacent wild lands. Agricultural use of pesticides may contribute to a low productivity of the invertebrate food base and aquatic biota. In combination, these land uses and management practices may reduce the existing level of biotic diversity at YHNM. Threats to wildlife include diseases such as sylvatic plague, chronic wasting disease, and West Nile virus and lethal predator control by local livestock interests.

Special Status Species

The Endangered Species Act requires the NPS to identify and protect federally listed threatened or endangered species. As required under NEPA guidelines, a biological assessment and consultation with the USFWS was done for this plan. The federal and state special status designations are defined as:

- **Federal Endangered** – An animal or plant species in danger of extinction throughout all or a significant portion of its range.
- **Federal Threatened** – An animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
- **Federal Candidate** – Plants and animals that have been studied and the US Fish and Wildlife Service has concluded that they should be proposed for addition to the Federal endangered and threatened species list.
- **Colorado Endangered** – A species in immediate jeopardy of becoming extinct throughout all or a significant portion of its range.
- **Colorado Threatened** – An animal that is not in immediate jeopardy of extinction but is vulnerable because it exists in small numbers or is so extremely restricted throughout all or a significant portion of its range that it may become endangered.
- **Colorado Species of Special Concern** – A species that may be at risk of becoming threatened or endangered in Colorado.
- **Colorado S1 plant species** – Critically imperiled in Colorado because of extreme rarity (5 or fewer occurrences), or very few remaining individuals, or because of some factor of its biology making it especially vulnerable to extirpation from the state.
- **Colorado S2 plant species** – Imperiled in Colorado because of rarity (6-20 occurrences), or because of other factors demonstrably making it vulnerable to extirpation from the state.

Table 3 names all of the species in Montezuma County, Colorado listed under the Endangered Species Act as of September 26, 2014. Under Section 7 of the Act, the National Park Service will consult with the US Fish and Wildlife Service on these species in a Biological Assessment (BA) concurrently with this EA. Most of these species do not occur in the area affected by the IPMP or would not be affected. A determination only will be provided for species that would or could be affected.

Special Status Plants

A number of species are considered globally or locally rare. Many of these rare and endemic plants within the park are associated with unique soils, creating soil-flora relationships that are still not fully understood. The park has 226 species that have been identified as sensitive by park staff. MVNP tracks populations of plants that are rare within the park, but may be abundant in other areas of their range. Six special status plant species with an S1 ranking that are known to occur in MVNP are listed in Table 5 along with their habitat preferences. The short-stem beardtongue is the only plant in this table that grows at YHNM. Note that currently the Schmoll's milkvetch also is a candidate for the federal list of threatened and endangered species. The main threat to the species is the indirect effect of invasion

by invasive plant species after fire and other disturbances (USFWS 2013b). Also note that the MVNP subspecies of MacDougal's Indian parsley may soon obtain full species status.

Table 3. Threatened, Endangered, and Candidate species within Montezuma County, Colorado

Common Name	Scientific Name	Status
Mancos milk-vetch	<i>Astragalus humillimus</i>	Endangered
Schmoll milk-vetch	<i>Astragalus schmolliae</i>	Candidate
Sleeping Ute milk-vetch	<i>Astragalus tortipes</i>	Candidate
Mesa Verde cactus	<i>Sclerocactus mesae-verdae</i>	Threatened
Humpback chub	<i>Gila cypha</i>	Endangered
Bonytail chub	<i>Gila elegans</i>	Endangered
Colorado pikeminnow	<i>Ptychocheilus lucius</i>	Endangered
Greenback Cutthroat trout	<i>Oncorhynchus clarki stomias</i>	Threatened
Razorback sucker	<i>Xyrauchen texanus</i>	Endangered
Southwestern Willow Flycatcher	<i>Empidonax traillii extimus</i>	Endangered
Gunnison Sage-grouse	<i>Centrocercus minimus</i>	Threatened
Mexican Spotted Owl	<i>Strix occidentalis lucida</i>	Threatened
Yellow-Billed Cuckoo	<i>Coccyzus americanus</i>	Threatened
Canada Lynx	<i>Lynx canadensis</i>	Threatened
New Mexico meadow jumping mouse	<i>Zapus hudsonius luteus</i>	Endangered

Table 4. List of Mesa Verde and Yucca House rare plants of highest conservation priority according to the Colorado Natural Heritage Program

Scientific Name	Common Name	State Rank
<i>Acer grandidentatum</i>	big tooth maple	S1
<i>Aletes macdougalii</i> ssp. <i>breviradiatus</i>	MacDougal's Indian parsley	S1
<i>Astragalus deterior</i>	Cliff Palace milkvetch	S1S2
<i>Astragalus schmolliae</i>	Schmoll's milkvetch	S1
<i>Collomia grandiflora</i>	large-flowered collomia	S1
<i>Epipactis gigantea</i>	giant hellebore	S2S3
<i>Gilia haydenii</i>	San Juan gilia	S2S3
<i>Grindelia arizonica</i>	Arizona gumweed	S2
<i>Hackelia gracilentia</i>	Mesa Verde stickseed	S1
<i>Lepidium crenatum</i>	alkaline pepperweed	S2
<i>Penstemon breviculus</i> (YHNM)	short-stem beardtongue	S2
<i>Townsendia glabella</i>	Gray's Townsend daisy	S2

Table 5. List of critically imperiled rare plants at Mesa Verde and their preferred habitats

Common Name	Preferred Habitat
big tooth maple	Habitat consists of a steep (estimated at 50%), north or northeast-facing slopes at the top of the North Escarpment. Associated species are Douglas-fir, Rocky Mountain maple, chokecherry, Gambel oak, and Utah serviceberry.
MacDougal's Indian parsley	Sandstone slabs and canyon walls, usually growing in crevices (rarely on deeper sandy soil) in pinyon-juniper woodland.
Cliff Palace milkvetch	Sandstone rimrock, shallow sandy soil at mesa edges of the pinyon-juniper woodlands.
Schmoll's milkvetch	Aeolian mesa top soils of pinyon-juniper woodlands of Chapin Mesa and a few on Park Mesa and adjoining canyon edges.
large-flowered collomia	Woodlands and canyons.
Mesa Verde stickseed	Shady canyons and mesa tops in deep loamy or sandy-loam soils associated with pinyon-juniper woodlands or montane shrublands.

Special Status Wildlife

There are eight federally listed threatened or endangered wildlife species that occur or have occurred in the past in MVNP and YHNM. Of these, there is only one that may currently occur here; the Mexican Spotted Owl, which also is listed as Threatened by the State of Colorado. There are two proposed Mexican Spotted Owl Protected Activity Centers in the southern portion of the park but there have been no detections of this species since 2009. NPS policy directs that a species is not considered extirpated from a park until there is demonstrated evidence indicating that it has been absent for over a decade. More intensive surveys are needed to make a final determination.

Special status wildlife species and their current park status are presented in Table 6. The Gunnison sage-grouse would only have occurred at YHNM. Note that the golden eagle was added to this list because of its protected status under the Bald and Golden Eagle Protection Act.

In addition to the federally listed species there are five Colorado State Wildlife Species of Special Concern and one Colorado State Threatened species that do not have a federal designation, thus are not listed in Table 6. Two of the state Special Concern species, the northern leopard frog (*Rana pipiens*) and the sharp-tailed grouse (*Tympanuchus phasianellus*), no longer occur in MVNP. Listed as state species of concern, Colorado roundtail chub (*Gila robusta*) are still extant on the Mancos River within the park and Townsend's big-eared bat (*Corynorhinus townsendii pallescens*) have been detected foraging in the park during summer. The State Threatened species, the southwestern river otter (*Lontra canadensis sonora*), also no longer occurs in the park. These are the species that have the potential to be beneficially impacted by management activities inside the park or monument.

There are five federally listed species in Table 3 that are not represented in Table 6. These are the Humpback chub, Bonytail chub, Greenback cutthroat trout, Yellow-billed Cuckoo, and New Mexico meadow jumping mouse. None of these six species have ever been recorded at MVNP or YHNM and habitat is lacking in the park and monument, thus they would not be affected by the IPMP.

Table 6. Special status wildlife species known from MVNP and YHNM

Scientific Name	Common Name	Federal Rank	Park Status
<i>Centrocercus minimus</i>	Gunnison sage-grouse	Threatened	Extirpated
<i>Empidonax traillii extimus</i>	southwestern willow flycatcher	Endangered	Rare migrant
<i>Falco peregrinus anatum</i>	American peregrine falcon	Delisted	Regular nesting
<i>Aquila chrysaetos</i>	golden eagle	--	Regular nesting
<i>Haliaeetus leucocephalus</i>	bald eagle	Delisted	Forages locally
<i>Strix occidentalis lucida</i>	Mexican spotted owl	Threatened	Declining or Extirpated
<i>Ursus arctos horribilis</i>	grizzly bear	Threatened	Extirpated
<i>Canis lupus</i>	gray wolf	Endangered	Extirpated
<i>Mustela nigripes</i>	Black-footed ferret	Endangered	Extirpated
<i>Lynx canadensis</i>	Canada lynx	Threatened	Rare migrant
<i>Xyrauchen texanus</i>	razorback sucker	Endangered	Extirpated
<i>Ptychocheilus lucius</i>	Colorado pikeminnow	Endangered	Extirpated

Wilderness

On October 20, 1976 Public Law 94-567 officially designated three units comprising 8,500 acres (approximately 16 percent) of MVNP as the Mesa Verde Wilderness (see Map 3). There is no designated Wilderness at YHNM. Two of the units are on the North Rim and down the north escarpment in the northwest and north central parts of the park. The largest of the three units is mostly on the East Rim and down the east escarpment on the east side of the park. Currently there is no general public access allowed in the Mesa Verde Wilderness.

The NPS is required to manage Wilderness in accordance with the Wilderness Act of 1964(16 U.S.C. § 1131), passed by the United States Congress with a nearly unanimous vote to protect natural lands from the threats of “expanding settlement and growing mechanization.” Through the Wilderness Act, a primary responsibility is given to each agency that administers any area designated as wilderness – to “preserve the wilderness character of the area” (Section 4(b)).

In 2006, an interagency monitoring team – including the Department of the Interior Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, U.S. Geological Survey, and the U.S. Forest Service (Department of Agriculture) – developed a formal definition of wilderness character using five qualities of wilderness set forth in the Wilderness Act in an effort to establish a common understanding of wilderness character (Marier 2014). These qualities are used nationwide to monitor the status and trends in wilderness (preservation or degradation) over time by accounting for

stewardship actions, as well as impacts from modernization, visitation, and changes occurring outside of the wilderness itself.

The five qualities apply to all wilderness areas regardless of their size, location, administering federal agency, or other unique place-specific attributes and are based on the legal definition of wilderness in the Act. Each of the five qualities as derived from Section 2(c) of the Wilderness Act is described below.

Natural

Wilderness “... *is protected and managed so as to preserve its natural conditions*”

Wilderness ecological systems are substantially free from the effects of modern civilization when the natural quality is preserved.

Untrammeled

Wilderness is “...*an area where the earth and its community of life are untrammeled by man*”

Wilderness ecological systems are essentially unhindered and free from the actions of modern human control or manipulation when the untrammeled quality is preserved.

Undeveloped

Wilderness is “...*an area of undeveloped Federal land ... without permanent improvements or human habitation*”

Wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern human occupation when the undeveloped quality is preserved.

Solitude or Primitive and Unconfined Recreation

Wilderness “...*has outstanding opportunities for solitude or a primitive and unconfined type of recreation*”

Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation when the quality of solitude or primitive and unconfined recreation is preserved.

Other Features of Value

Wilderness “...*may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value*”

Other tangible features of scientific, educational, scenic, or historical value in wilderness preserve wilderness character when they are preserved.

The Act also states that there shall be no commercial enterprise and no permanent roads within Wilderness, and “except as necessary to meet minimum requirements for the administration of the area for the purpose of the Act” (the purpose defined as preserving Wilderness character and “the public purposes of recreational, scenic, scientific, educational, conservation, and historical use”), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation....” Congress also made a special provision that allows aircraft use “as may be necessary in the control of fire...”

The 2006 NPS Management Policies states, “The National Park Service will take no action that would diminish the Wilderness eligibility of an area possessing Wilderness characteristics until the legislative process of Wilderness designation has been completed. Until that time, management decisions will be made in expectation of eventual Wilderness designation. This policy also applies to potential Wilderness, requiring it to be managed as Wilderness to the extent that existing nonconforming conditions allow.” DO-41 guides NPS efforts in meeting the 1964 Wilderness Act, establishing specific instructions and requirements concerning the management of all NPS Wilderness areas.

For the purposes of this document, “backcountry” shall be considered any area in the park that is not open to the park for visitation (MVNP Backcountry Use and Access Plan, 1996). “Backcountry” is not the same as “Wilderness,” and is not a specific management zone. Rather, it refers to a general condition of land that may occur in zones outside Wilderness. Wilderness and backcountry may require different administrative practices because the Wilderness Act imposes additional conditions and constraints. However, backcountry is considered under the term Wilderness for this assessment.

Cultural Resources

MVNP was established by Congress in 1906 with the stated purpose to “provide specifically for the preservation from injury or spoliation of the ruins and other works and relics of prehistoric or primitive man within said park.” These same resources were the basis for the listing of MVNP on the National Register of Historic Places in 1966. In 1978, the worldwide value of the park’s archeological resources was further recognized when the park was selected as one of the seven original United Nations World Heritage sites. Currently, there are 21 World Heritage sites in the U.S. The NPS serves as their chief steward.

Yucca House is one of the largest archeological sites in southwest Colorado and functioned as an important community center for the Ancestral Pueblo people from A.D. 1100-1300. It is one of several large prehistoric settlements, consisting of 450 to 600 rooms, 81 kivas, two towers, two great kivas, a bi-wall structure, and a spring. On July 17, 1919, Henry Van Kleeck deeded 9.6 acres, including most of YHNM, to the federal government. Due to its significance as an excellent example of a valley pueblo, Woodrow Wilson made Yucca House a National Monument by Presidential Proclamation on December 19, 1919. The proclamation stated that the monument was established “with a view to the preservation of said ruin and preservation is deemed to be in the public interest” (NPS 2012b).

Cultural resources in MVNP and YHNM include prehistoric and historic archeological resources, cultural landscapes, and traditional cultural properties or ethnographic resources (both natural and cultural) that are important to the continuing culture and traditions of park-associated American Indian communities. These resources reflect early settlement, use, and management of the lands by indigenous people; westward expansion of Euro-American people (as well as Asian and other non-European people) and their conflict with American Indian groups; resource extraction such as logging and herding; early tourism; early environmental conservation efforts; development of water resources; and park planning, design, and land management. They are the physical evidence of a human presence spanning at least 5,000 years.

Prehistoric Sites and Structures

The prehistoric sites consist of mounds of fallen rubble and earth from small and large villages, soil and water control devices, work areas, rock alignments of uncertain function, scatters of pottery shards and lithic fragments, camp sites, and cliff dwellings. The cliff dwellings vary from large communities, one of which contains over 100 rooms, to small one-room storage areas. The condition of most of the known prehistoric archeological sites is unknown. Approximately 1,000 sites are known to be in good condition. However, approximately 500 sites, largely on steep talus slopes and in areas burned over by recent wildfires, are vulnerable to severe erosion. Until there is significant vegetation recovery from these fires, sites in these denuded areas could continue to be at risk due to erosion.

Impacts to the prehistoric sites and structures come mostly from natural causes, consisting mainly of wind, water, freeze/thaw cycles, rock falls, and rodents, but abundant evidence has shown that wandering bands of livestock, mainly horses, have done direct physical damage to these resources and indirectly exposed them to erosion through the denuding of surface vegetation and leaving the sites more prone to invasive plants. Although the amount of damage caused from visitation is limited by control of public access, prehistoric sites reflect a different evolutionary history than surrounding areas due to the higher degree and duration of human disturbance. As highly impacted locales they are more susceptible to invasive plants than the general landscape, particularly in recently burned areas. It is not unusual to find a dense proliferation of cheatgrass, thistles, and other invasives growing on the mounded rubble of surface pueblos.

Ethnographic Resources

The NPS defines ethnographic resources in Director's Orders 28 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" (NPS 1998a). A traditional cultural property is an ethnographic resource that is eligible for listing in the National Register of Historic Places. Significantly in the context of this document, Native Americans have expressed aversion for the use of herbicides in archeological sites because these sites have special meaning to them as traditional cultural properties (Letter from the Hopi Tribe in Appendix E). A specific concern expressed during consultation discussions in April of 2014 involved contaminating medicinal plants, such as wild tobacco (*Nicotiana attenuata*) that might be harvested by tribal members. A cultural affiliation study in 1995 stated that "substantial evidence exists from native oral tradition, geographical associations, ethnographic accounts, ethnological comparisons, and linguistic studies to support claims of cultural affiliation/association to the MVNP/YHNM area by the Hopi, the Zuni, the Keresan and Tanoan Pueblos, the Navajo, and Southern Ute." More recently the Northern Ute and Jicarilla Apache have also claimed traditional association with Mesa Verde, increasing the number of culturally affiliated or associated tribal communities to 26. Each of these communities maintains a unique connection with the park's landscape and resources based on traditional knowledge and cultural meaning. According to Director's Order 28 and Executive Order 13007 on sacred sites, the National Park Service must preserve and protect ethnographic resources. Given this guidance, the proposed actions in this plan would prohibit removal or purposeful contamination of plants or other

materials identified as ethnographic resources. Impacts would be systematically avoided and mitigated as needed.

A necessary first step in protecting and preserving ethnographic resources entails the preparation of an Ethnographic Overview. Begun in 2011, an ethnographic study of MVNP by Arizona State University has provided further insights into the range, character and complexity of ethnographic resources throughout MVNP and YHNM. In its simplest form the ethnographic resources of MVNP and YHNM reflect both natural and cultural components. Natural components include the overall landscape and view sheds; prominent geological and physiographic features such as alcoves, outcrops, natural bridges, etc.; fossils, crystals, concretions; seeps, springs, bedrock catchments; individual trees and several common plant species found throughout MVNP and YHNM that were used for food, medicine, and other purposes. While some of these plants are potentially located in areas proposed for management activities, they are both abundant and widely distributed throughout MVNP and YHNM. However, wild tobacco typically only is found growing for the first few years following a wildfire within the burn perimeter. Chemical weed treatments within burned areas would avoid contacting the foliage of wild tobacco or other ethnographically significant plants.

In comparison, cultural components include archeological sites ranging from small caches of artifacts, rock art, cairns, trails, agricultural systems, and funerary locations to large, complex settlements exhibiting standing architecture and public spaces. Importantly, there is little distinction between cultural and natural components when viewed from the perspective of traditional knowledge and cultural meaning. Because of this, great care must be exercised in the application of any invasive plant treatments.

Park Operations

The NPS is bound by internal policies and the individual park units are committed to accomplishing their respective missions. To achieve these goals, each park develops a plan to staff and manage the park's different operations. There are five management divisions at MVNP: Administration, Research and Resource Management, Facilities Management, Interpretation and Visitor Services, and Visitor and Resource Protection which includes Fire Management. YHNM is staffed solely and intermittently by MVNP employees. It is expected that implementation of a comprehensive park-wide resource protection plan like the IPMP would have direct effects on each of the park's five operational divisions.

Fire Management plays a significant role in vegetation management with the execution of hazardous fuel treatments, prescribed burns, and fire suppression. This program operates under the Fire Management Plan of 1993; a new plan is in process. Within Administration the park employs a landscape architect who designs and maintains landscapes around certain park facilities such as the Visitor and Research Center. Along with volunteers, the landscape architect plants and maintains plantings and removes invasives. Residents living in the park similarly are held accountable for the grounds around their quarters under the Housing Management Plan overseen through Administration. The archeological stabilization crew within Research and Resource Management also removes encroaching native and non-native vegetation at archeological sites to protect the cultural resources. Also the MVNP concessionaire, Aramark, manages landscapes in the vicinity of the lodge and

campground. They are bound by the maintenance plan within their contract with the park. Currently, the Maintenance division plays a role in invasive plant abatement in the process of maintaining shoulder-ways along the main park roads, utility corridors, and grounds maintenance in the vicinity of some structures and buildings. Maintenance maintains a road corridor of 50 feet from centerline with the use of mowers and herbicide (applied by the Natural Resource program) and sometimes chainsaws or brush hogs for removal of hazard trees and encroaching shrubs. This generally consists of the areas between the road and the curb, generally four feet from the road but up to 12 feet from the road. Generally, grounds maintenance and trailside clearing is accomplished through mowing and chopping.

The lead operation for managing and conserving vegetation resources in the park is the Natural Resource Branch within Research and Resource Management. Currently, recreational fee collections fund approximately 60% of invasive plant control and restoration activities in the park and monument. The park's base operating budget funds approximately 30% (mainly overhead). Approximately 10% is generally funded by special project funds that vary annually. The program attempts to find partners for special projects, such as the Southwest Exotic Plant Management Team, to supplement its operational capacity.

Visitor Experience

MVNP. Annual visitation to MVNP has been approximately 500,000 visitors for many years. The world renowned cultural resources draw visitors from all over the world to learn about the prehistoric occupation of Mesa Verde by the Ancestral Pueblo people and to see the ancient structures up close. Visitors also enjoy the historic architecture of early 20th Century buildings, the natural scenery, wildlife viewing, photography, scenic driving, walking trails, and camping at MVNP. The ability of visitors to appreciate and enjoy their park experience can be greatly enhanced by the growth of healthy native vegetative communities and the wildlife populations they support. Visitors enjoy the shade from evergreen coniferous trees on hot days, wildflowers throughout the growing season, and the fall colors of the montane shrublands. Conversely, this experience can be seriously degraded by landscapes infested with invasive plants. MVNP has received many comments from visitors urging the park to control invasive plants.

YHNM. A few thousand visitors generally visit YHNM yearly unsupervised by park personnel. Law enforcement rangers perform intermittent patrols and natural resource staff members visit the monument to perform wildlife surveys, boundary fence repairs, native plant restoration work, and weather station maintenance. The monument is not signed on Highway 160 and a single sign, boundary fencing, weather station, and sign-in board are the only indication of the existence of the monument. Visitors roam the site without the aid of trails or exhibits. There are few trees and wildflowers. The desert-scrub vegetation here is not likely to be a premier resource to most visitors, but the presence of invasive plants undermines the natural qualities of the site.

Human Health and Safety

Plants have developed a variety of physical and chemical properties that defend them from animals, including humans, and from other plants. Spines, thorns, and toxins can be harmful to humans but not usually seriously so. Plants also produce pollen which can cause varying degrees of allergic responses

from sensitive people. Both native and non-native species can have these properties so reducing the presence of invasive plants does not eliminate this issue from the park. However, actions related to vegetation management do have variable factors that affect the risk levels for human health and safety.

While there have been no deaths or serious injuries to visitors or park staff resulting from vegetation management activities at MVNP or YHNM, health and safety of everyone is a high priority of the NPS. Persons engaged directly in vegetation management activities bare the greatest risks, mainly from sharp-edged tools, power equipment, vehicle use, and road traffic as well as from environmental factors such as steep or uneven terrain, tripping hazards, tree branches, thorns, spines, animals, insects, etc. Additionally, employees or contractors working with chemicals including herbicides, adjuvants, fertilizer, etc. are at elevated risk from exposure to these elements. To a much lesser extent, secondary contact with vegetation management chemicals is a potential risk to park visitors, residents, and other employees.

Environmental Consequences

This chapter includes a description of the potential environmental impacts that could occur to the resources described above. This chapter contains the methodology for assessment and analyses of all potential impacts to MVNP and YHNM natural resources, cultural resources, land use, and park operations that could occur as a result of implementing the two alternatives under consideration. This section is organized by impact topic and contains the following information for each topic:

Impact Analysis - benefits and risks of implementing each alternative

Cumulative Effects - effects of combined impacts of past, present and reasonable foreseeable future actions regardless of agency for each alternative

Conclusion - summary of intensity and duration of effects for the alternative

The impairment determination, whether this plan's proposed actions would or are likely to impair park resources or values, is made in the proposal's Record of Decision, not the Environmental Assessment.

Methodology for Assessing Impacts

Applicable and available information on known natural, cultural, and human resources were compiled. Both alternatives were evaluated for their effects on resources and values determined during the scoping process. Potential impacts were identified for both of the alternatives based on a review of scientific literature, resource management plans, field investigations, and the best professional judgment of resource specialists. Information on total acres infested by invasive species, future rate of spread projections, past and future treatment acres, and treatment methods were also used to estimate impacts.

Impacts are described in terms of type (beneficial or adverse), context (site-specific, local or regional), duration (short- or long-term), and intensity (none, negligible, minor, moderate, major).

For all impact topics, the following definitions were applied:

Beneficial effects result in a positive change in condition or appearance of the resource or a change that moves toward the desired condition.

Adverse effects result in a change that moves the resource away from a desired condition or detracts from its appearance or condition.

Direct effects are caused by an action and occur at the same time and place as the action.

Indirect effects are caused by the action and occur later in time or farther removed from the place, but is still reasonably foreseeable.

Because intensity may vary by impact topic, the thresholds for intensity are defined for each impact topic in Table 7.

Cumulative Methodology

The Council on Environmental Quality (CEQ) regulations, which implement the National Environmental Policy Act, require assessment of cumulative impacts in the decision making process for federal projects. A “cumulative effect” is 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 action regardless of what agency (federal or non-federal) or person undertakes such other actions” (40 CFR 1508.7). Cumulative impacts can result from individually minor, but collectively significant actions taking place over time.

Cumulative effects were determined by combining the impacts of the proposed alternatives with potential other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or foreseeable future projects within MVNP and YHNM. Reasonably foreseeable future activities are those actions independent of the IPMP that could result in cumulative effects when combined with the effects of the proposed actions.

List of Actions in the Cumulative Scenarios

- YHNM land acquisition proposal (in process)
- MVNP Mancos River Corridor Restoration Plan (1998)
- MVNP Fire Management Plan (2015)
- MVNP wildfires and burned area emergency rehabilitation plans (1996, 2000, 2002, 2003, future)
- MVNP Integrated Pest and Hazardous Wildlife Management Plan (in process)
- MVNP livestock control efforts (ongoing for many years)
- MVNP Visitor Distribution and Transportation Plan (in process)
- Paths to Mesa Verde (in process)
- MVNP road construction and major maintenance projects (ongoing for many years)
- MVNP Concessions Contract (2014)
- Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource Management Plan
- Mancos Valley water use (ongoing)
- MVNP Integrated Pest and Hazardous Wildlife Management Plan
- Residential, agricultural, and commercial developments around MVNP
- MVNP Long Range Interpretive Plan (2014)

The temporal boundaries of the cumulative scenarios span about two decades in the past and about one decade in the future. This covers the time in which MVNP has been most affected by recent wildfire activity and related active control efforts against invasive plants and the expected lifespan of the plan going forward. The geographical boundaries of the cumulative scenarios primarily involve all of MVNP and YHNM plus adjoining and adjacent the public, tribal, and private lands. These most proximate areas to the park and monument have the most direct bearing on the resources retained for analysis in this EA. Because of its mobility, for water resource related impacts, the scope of the scenarios involves most of the Mancos River watershed above the park and the river corridor dropping down all the way to the San Juan River.

Table 7. Thresholds for intensity

Impact Topic	Negligible	Minor	Moderate	Major	Duration of Impact
Soils and Native Vegetation	The change in soils and native vegetation communities would be so small that it would not be of any measurable or perceptible consequence.	The change in soils and native vegetation communities would be small, localized and of little consequence. Response to treatments would be within the range of normal effects. Any adverse effects would be effectively mitigated.	A large area of soils or segment of one or more populations of plant species would exhibit effects that are of consequence, but would be relatively localized. Response to treatments would be within the range of treatment effects. Mitigation could be extensive, but likely effective.	Effects would be severely adverse and possibly permanent to soils and native vegetation communities. Response to treatments would be outside the range of expected treatment effects. Mitigation to offset adverse effects may be required and extensive, and success not assured.	Short-term refers to a period of less than 10 years. Long-term refers to a period longer than 10 years.
Aquatic, Wetland, and Riparian Communities	Any effects to streams and wetlands would be below or at the lower levels of detection. Any detectable effect would be slight. No USACE permit would be necessary.	Effects to streams and wetlands would be detectable, site-specific, relatively small and short-term to individual plants. No USACE permit would be necessary.	Effects to streams or wetlands would be detectable and readily apparent. The effect could be site-specific or park- or monument-wide.	Effects to streams or wetlands would be observable over a relatively large localized or regional area. The character of the stream, spring or wetland would be substantially changed.	Short-term refers to a period of less than 10 years. Long-term refers to a period longer than 10 years.
Water Quality	Neither water quality nor hydrology would be affected, or changes would be either undetectable or if detected, would have effects that would be considered slight.	Changes in water quality or hydrology would be measurable, although the changes would be small and likely localized. No mitigation measure associated with hydrology of water quality would be necessary.	Changes in water quality or hydrology would be measurable but relatively localized. Mitigation measures associated with hydrology and water quality would be necessary and the measures would likely succeed.	Changes in water quality and hydrology would be readily measurable, would have substantial consequences and would be noticed on a regional scale. Mitigations would be necessary and their success would not be guaranteed.	Short-term refers to recovery in less than several days. Long-term refers to recovery requiring longer than several months.

Wildlife	The change in wildlife populations and/or habitats would be so small that it would not be of any measurable to perceptible consequence.	Changes in wildlife populations or habitats would be small, localized and of little consequence. Response to treatments would be within the range of normal effects. Any adverse effects would be effectively mitigated.	Changes in wildlife populations or habitats would be of consequence, but relatively localized. Response to treatments would be within the range of treatment effects. Mitigation could be extensive, but likely effective.	Severely adverse effects and possibly permanent effects to native wildlife populations or habitats. Response to treatments would be outside the range of expected treatment effects. Mitigation to offset adverse effects may be required and extensive, and success not assured.	Short-term refers to a period of less than 10 years. Long-term refers to a period longer than 10 years.
Special Status Species	Listed species would not be affected or the change would be so small as to not be of any measurable or perceptible consequence to the population.	There would be a measurable effect on one or more listed species or their habitats, but the change would be small and relatively localized.	There would be a noticeable effect to a population of a listed species. The effect would be of consequence to populations or habitats.	There would be a noticeable effect with severe consequences or exceptional benefit to populations or habitats of listed species.	Short-term refers to a period of less than 3 years. Long-term refers to a period longer than 3 years.
Wilderness	Physical character would not be affected or the change would be so small as to not be of any measurable or perceptible impact to Wilderness values.	Changes to character of Wilderness values are detectable but small, localized and of little consequence. Any mitigation needed to offset adverse effects would be standard, uncomplicated and effective.	Changes to character of Wilderness values are readily apparent and of consequence. Changes may be evident over a large portion of Wilderness. Mitigation measures to offset adverse effects would probably be necessary and likely successful.	Impacts to Wilderness character are severe over a wide area. Mitigation to offset adverse effects would be needed, but its success is not assured.	Short-term refers to a transitory effect, one that largely disappears over a period of hours or days. The duration of long-term effects is months or years.

<p>Cultural Resources:</p> <ul style="list-style-type: none"> • Archeological Resources • Ethnographic Resources 	<p>Impacts to historic/cultural sites, either beneficial or adverse, are at the lowest levels of detection, barely perceptible and not measurable. For Section 106 purposes the determination of effect would be <i>no adverse effect</i>.</p>	<p>The impact affects a historic/cultural site or feature with little data potential. The context of the affected site(s) would be local. The impact would not affect the contributing elements of an eligible or listed National Register of Historic Places structure. For Section 106 purposes the determination of effect would be <i>no adverse effect</i>.</p>	<p>The impact affects a historic/cultural site or feature with modest data potential or higher. The context of the affected site(s) would be state-wide or higher. For a National Register eligible site, the adverse impact would affect some of the contributing elements of the site but would not diminish the integrity of the resource or jeopardize its National Register eligibility; or the impact would be transitory. For Section 106 purposes the determination of effect would be <i>adverse effect</i>.</p>	<p>The impact affects a historic/cultural site or feature with high data potential. The context of the affected site(s) would be national. For a National Register eligible or listed site, the adverse impact would affect some of the contributing elements of the site by diminishing the integrity to the extent that it is no longer eligible for listing on the National Register eligibility. For Section 106 purposes the determination of effect would be <i>adverse effect</i>.</p>	<p>Short-term refers to a transitory effect, one that largely disappears over a period of days to many months. The duration of long-term effects is essentially permanent.</p>
<p>Park Operations</p> <p>Visitor Experience</p> <p>Human Health and Safety</p>	<p>The action could cause a change in park operations or visitor experience, but the change would be so small that it would not be of any measurable or perceptible effect. Few employees or visitors would be affected.</p>	<p>An action that would affect some employees or visitors and cause a change in their activities, but the change would be small and localized. Mitigation would not be necessary.</p>	<p>An action that would cause a substantial, measurable change in park operations, visitor experience or human health. Mitigation to offset adverse effects would be necessary but effective.</p>	<p>An action that would cause a severe change or exceptional benefit to park operations or visitor experience. Human health may be compromised. The change would have substantial and possibly permanent effects on employees or visitors. Mitigation to offset adverse effects would be needed, although success is not assured.</p>	<p>Short-term refers to a period of up to 5 years. The duration of long-term is essentially permanent.</p>

Compliance with Section 106, National Historic Preservation Act

In accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106 of the NHPA (36 CFR Part 800, *Protection of Historic Properties*), impacts to cultural resources and the cultural landscape will be identified and evaluated by (1) determining the area of potential effect, (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 which are unevaluated, 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 NPS's *Conservation Planning, Environmental Impact Analysis and Decision-making* (DO #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 potential impact, for example, reducing the intensity of an impact from major to moderate or minor. However, any reduction in intensity of impact resulting from a mitigation measure is an estimate of the effectiveness of mitigation under NEPA only. It does not mean that the level of effect as defined by Section 106 is similarly reduced. Although adverse effects under Section 106 may be mitigated, the effect remains adverse.

Under the Advisory Council's regulations, a determination of either *adverse effect* or *no adverse effect* also must be made for affected National Register-eligible cultural resources. 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 resources location, design, setting, materials, workmanship, feeling, or association. Adverse effects also include reasonably foreseeable effects caused by an 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 characteristic of the cultural resource that qualifies it for inclusion in the National Register.

MVNP would conduct compliance with the Colorado State Historic Preservation Office (SHPO) and park NEPA and NHPA compliance team for each control project that is separate from, but developed under the guidance of, this plan. With respect to Section 106, this IPMP is meant to serve only as an analysis for particular resources.

Soils and Native Vegetation

Impacts of Alternative A on Soils and Native Vegetation

Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. Short-term adverse impact to soil and vegetation would be mitigated as infestations of invasives were controlled. Perennial native plants are more effective in preventing erosion than most invasive plants. One study conducted in Wyoming on native prairie bunchgrass and spotted knapweed reported native bunchgrass lost 12.5 pounds of soil per acre in a simulated thunderstorm. Spotted knapweed lost over 125 pounds per acre with the same test. Tap rooted invasives will always increase soil erosion when compared to healthy stands of grass. Long-term beneficial impacts on the soil are expected as invasive plants are controlled and native communities are restored.

Mechanical Treatments

Mechanical removal of invasive plants is expected to have negligible to minor localized adverse impacts on soil and native vegetation. Some soil erosion and loss of native plants may occur at the base of an invasive plant when it is dug, pulled, or chopped from the ground. If a large patch is removed, this could increase soil erosion and have a short-term minor adverse impact on vegetation. Mechanical treatments could potentially smother desirable native vegetation by the accumulation of cut material. Disposing of materials or dispersal of vegetative parts would reduce impacts to native plants in treatment areas. Mechanical control (such as hand-pulling) is very effective for new infestations of invasive plants and when plants are few in number. For example, MVNP personnel have hand-pulled single houndstongue plants from some locations in the park and never had any recurrence in that area. In the long-term, native vegetation is expected to recover when invasive plants are removed (McLendon and Redente 1994). As many species of invasive plant seeds remain viable in the ground for years, it is important to remove and carefully dispose of seed heads.

For invasive plants with rhizomes, such as Canada thistle, Russian knapweed, smooth brome, leafy spurge, field bindweed and yellow toadflax, hand-pulling plants is ineffective and can actually promote the spread of the invasive plant. In addition, recent research on diffuse knapweed indicates that digging a plant from the ground (i.e. disturbing the soil) could actually enhance diffuse knapweed seed germination and cause more knapweed seedlings to germinate than if the plant was sprayed with an herbicide and left in place.

Mowing or using a string trimmer causes short-term minor adverse impacts to soil when the high-speed trimmer rakes the ground and would have a minor adverse impact on native species growing amongst the invasives by cutting them. When mowed, some invasive species, like diffuse knapweed, still flower in a dwarfed state and still can produce seed. Timing of mowing is also critical. For example, mowing before the plant flowers and sets seed can reduce the amount of viable seed, but mowing after a plant sets seed will scatter seed over a wider area. Mechanical treatments can be effective on invasive annual grasses but only in limited areas as it is highly labor intensive. Multiple treatments may be needed in the spring to control species that have more than one "crop." Mowing generally does not kill (and may even spread) some invasive plants that can

sprout from rhizomes. However, mowing in combination with another control technique, such as a chemical treatment, can be very effective and far more efficient.

Cultural Treatments

Cultural control is expected to have minor beneficial long-term effects on soil and native vegetation. Restoring disturbed areas to natural conditions prevents soil erosion and enhances native plant communities. Maintaining native plant communities into a healthy vigorous condition can favor native plants over invasive plants (Redente and McLendon 1994, McLendon 1996).

Restoration: Mulching, seeding, installing erosion control matting or logs, and adding soil inoculum and fertilizers are some examples of restoration techniques. Seed prescriptions for appropriate habitats and a map of seeding zones have been developed. Minor short-term adverse effects may result as competition from seeded native grasses may suppress native pioneer forb species.

Biological Control Treatments

The biological control organisms that have been used at MVNP and YHNM to date are listed in the Affected Environment chapter above, under Wildlife - Introduced Biological Control Insects. None of these releases have been shown to have any direct adverse impact on soil or native vegetation, and would have a minor long-term benefit to soil and native vegetation as invasive plant species are replaced with healthy native plant communities. So far, only the two weevil species released on musk thistle have been shown to be established in the parks. There is a slight risk that organisms released in the park may evolve over time and start feeding on native plants closely related to the invasive species. This could cause a reduction in native plant diversity and a possible increase in soil erosion. Carefully screening biological control candidates, and long-term monitoring of organisms used for biological control, should eliminate these potential risks to soil and native plants. Any biological control intentionally released in the park or monument would be approved by APHIS or the EPA in the case of microorganisms, as well as approval by IPM program specialists at the NPS Intermountain Regional level and Washington Office level. All requests for the use of biological control organisms must be proposed through the NPS Pesticide Proposal System (PUPS) for each calendar year requested. MVNP would strive to ensure that any non-native organism with wide diet breadth is kept out of the park's ecosystem, but this would not ensure such organisms would remain excluded from the park as they could enter from neighboring lands. By controlling invasive plants using IPM, the chance for successful restoration of native plant and soil communities is high.

Herbicide Treatments

See Appendix C for a list of the typical priority target invasive plant species and the herbicides used in recent years in controlling them at MVNP and YHNM. Table 8 below summarizes the behavior of these herbicides in soil and the effects on target and non-target plants. The use of herbicide is expected to have a minor localized short-term adverse impact to native vegetation and soils because it is not possible to totally prevent herbicide contact with the soil and with some native plants. When using herbicide, three soil characteristics are particularly relevant. These characteristics are percent organic matter, available water capacity, and soil permeability. When incorporated into the soil, part

of the herbicide dissolves in the soil moisture and part is adsorbed onto soil particles. The amount of herbicide adsorbed onto soil particles depends on the characteristics of the chemical and on the amount of organic matter and fine material in the soil. Any herbicide that remains in water in the soil is available for uptake by plant roots. However, if the water moves off-site or out of the rooting zone, it takes some of the dissolved herbicide with it. Depending on the distance of travel, the concentration of the herbicide, and type of herbicide used, this herbicide movement can be a problem to susceptible non-target plants (USDA-USFS 1996).

Soil permeability and water-holding capacity determines how much water moves through the soil into groundwater or surface water after a rainfall. If the soil retains a large quantity of water in its upper horizons for later use by plants, the water and dissolved herbicide would have little opportunity to move. In contrast, if a soil is highly permeable and has little water-holding capacity, moisture passes through the soil readily and carries some of the herbicide with it (USDA-USFS 1996). Soil contamination could be a concern in the short-term.

Table 8 presents the behavior of the herbicides proposed for use and their effects on soil and plants. To minimize adverse impacts and maximize benefits to soils and vegetation, the most appropriate treatment or combination of treatments would be used along with the appropriate mitigation measures listed in Chapter 6. Driving UTVs in approved areas when applying herbicides, such as parts of Mancos Canyon, YHNM, and Morefield and Prater canyons, would have a short-term localized minor impact on soils and native plants from trampling. Unintentional off-target spray may damage soil microbiota and desirable vegetation. There is a potential for soil disturbance and compaction caused by chemical application. However, the potential for accidental overspray is low because equipment appropriately scaled and calibrated to the job would be used and in the unlikely event of spills, they would be cleaned up according to the Pesticide Handling Plan. Long-term beneficial affects to the soil and vegetation are expected as invasive plants are controlled and native plants flourish.

Many adjuvants used with/in herbicides include either nitrogen or sulfur-based fertilizers. The exact effect of these fertilizers on native vegetation is unknown, but it is suspected that because many invasive plants are competitive in high resource environments, it would give them a small advantage and thus be detrimental to native vegetation (McLendon and Redente 1992, Redente et al. 1992). Adjuvants may also have a detrimental effect on soil microbiota. The park would supplementally use adjuvants only when the advantage of using them to enhance the herbicide's effectiveness or to reduce wash off potential from rain outweighs the small risk to soil and native vegetation and is environmentally safe to do so.

Table 8. Behavior of Herbicides in Soil and Effects on Target and Non-target Plants

Herbicide (active ingredient)	Behavior of the herbicide in soil and impact to plants
Aminopyralid (ex. Milestone)	Aerobic microbial degradation is the primary route of breakdown of aminopyralid in soil. The rate of degradation in the field resulted in an average half-life of 34.5 days for 8 North American sites. Laboratory experiments yielded an average K_{oc} of 10.8 L/kg, indicating some potential for mobility. However, field experiments showed limited movement in the soil profile. No degradation of metabolites of concern was produced in any studies. Aminopyralid was accepted for evaluation under the EPA's Reduced-Risk Pesticide Program. Avoid injury to non-target plants.
Chlorsulfuron (ex. Telar)	Telar has no effect on soil microorganisms. Half-life in soil is 40 days, but can range up to 4-6 weeks. Recommended for soils with a pH of 7.5 or less. It is used at very low rates and is very active. Microbial breakdown is slow and Telar is moderately mobile at high pH. Leaching is less at pH<6. It has a rapid foliar and root absorption. It is generally active in the soil and usually absorbed from the soil by plants. It will leach in sand, sandy loam, silty clay loam, and silt loam.
Clopyralid (ex. Transline)	The average half-life in soil is one to two months but can range from one week to one year depending on the soil type, temperature, and rates of application. Soil microbes degrade it. Where clopyralid leaches to lower soil depths, it persists longer than it does at the surface because the microbial populations generally decrease with soil depth. Under aerobic soil conditions, the half-life is 71 days. No information is available on impacts to microorganisms. It is weakly absorbed in soil and does not adsorb to soil particles, with a moderate to high leaching potential. Clopyralid is relatively persistent in soil, water, and vegetation. Roots and foliage readily absorb the herbicide. Native grass species are especially tolerant of Transline. It can easily leach into water and is not recommended in loamy sand or sandy soil or where the water table is close to the surface.
Glyphosate (ex. Roundup)	Half-life in soil is as low as 3 days and as long as 141 days. Glyphosate and the surfactant have no known effect on soil microorganisms. Glyphosate is rapidly and tightly adsorbed to soil. Low mobility in soils and low potential for run-off. Is non-selective on plants and can kill all plants it comes in contact with in high enough concentrations. Protection of non-target plants is imperative.
Imazapic (ex. Plateau)	Average half-life in soil is 120 days. Weakly absorbed in high pH soil, but adsorption increases with lower pH and increasing clay content. Primarily degraded by microbes. It has limited mobility, but moderately persistent in soil. It does not volatilize from the soil surface. The use of Imazapic on invasive plants has restored native plant species. Reseeding can occur after the herbicide has been applied. This chemical remains in the top 12-18 inches of the soil. Non-target species such as grasses show some browning/yellowing after application but no death. There will be no long-term impacts to native grasses and forbs.
Imazapyr (ex. Habitat)	Studies on soil micro-organisms show that imazapyr has no adverse effect on a number of soil organisms, growth rates of microbial populations, soil enzymes, nitrogen cycling, sulfur oxidation, mineralization of organic substrates, or normal soil respiration processes (Atas 1983). Dissipation in the environment generally occurs most rapidly under warm, humid conditions and is mainly a result of photolysis in water and microbial degradation in soil and is stable in anaerobic environments. Photodegradation under continuous sunlight resulted in half-lives

Herbicide (active ingredient)	Behavior of the herbicide in soil and impact to plants
	<p>of 2.7 days in pH 5 buffer, 1.9 in distilled water, and 1.3 days in pH9 buffer. Imazapyr is weakly absorbed in soil, depending on the soil pH and presence of organic and soil colloids. Absorption increases as soil pH becomes more acidic and the content of soil colloids increases. Little lateral movement in the soil has been shown and the major route of imazapyr loss from the soil is microbial degradation. Imazapyr is selective on many native forb species, particularly composites and legumes.</p>
<p>metsulfuron methyl (ex. Escort)</p>	<p>The half-life is from 120 to 180 days (in silt loam soil). Insufficient information is available to determine possible impacts to soil microorganisms. Escort is generally active in soil, usually absorbed from the soil by plants. Absorption varies with amount of organic material. Adsorption to clay is low. Broken down to nontoxic and nonherbicidal products by soil microorganisms. Application should be carefully done to protect non-target plants.</p>
<p>Picloram (ex. Tordon)</p>	<p>Average half-life in soil is 90 days, but could be as high as 278 days. This is a highly translocated herbicide, active throughout both foliage and roots and many broadleaf plants. It is persistent and more toxic to some broadleaf plants than 2,4-D, thus precautions must be followed diligently to avoid injury to non-target plants. It is a restricted herbicide because of potential injury to susceptible non-target plants. This herbicide has the highest potential for impacts to non-target species. It is leachable in sandy soil and not recommended for use in this soil type when the water table is less than 20 feet. The maximum depth of detectable residue was 18 to 24 inches. It is mobile in water, and leaching is higher with sandy soil or soil with low organic content. Most grasses are resistant, but most broadleaf plants are impacted.</p>
<p>Triclopyr (ex. Garlon)</p>	<p>Half-life in soil is on average 30 days but ranges from 10 to 46 days depending on soil type, moisture, and temperature. It is slightly toxic to practically nontoxic to soil microorganisms. It is not strongly absorbed in soil, which varies with soil and clay content, but its major degradate TCP is expected to be very mobile. Triclopyr is moderately persistent, with persistence increasing as it reaches deeper soil levels and anaerobic conditions. Leaching potential is medium. It decomposes by UV light and the solubility is miscible. It is a growth regulating herbicide for broadleaf plants. It mimics natural plant hormones. Death usually occurs to the plant within 3-5 weeks. The herbicide penetrates foliage, with a rain free period of 4 hours and is rapidly transported in plants. Spraying is not recommended in loamy sand or sand or where the water table is shallow.</p>

Cumulative Impacts

Vegetation and soils within MVNP have been affected by a variety of actions, including historical grazing, past and present invasive plant control, construction in the park, wildfires and wildfire suppression activities, livestock grazing and trampling with currently at least 100 head of stock in the park, and hazard fuel reduction. The Maintenance Division also mows and mechanically clears vegetation along road shoulders and utility corridors along the main park roads, along trails, and in grounds maintenance in the vicinity of structures, buildings, and other facilities. The effect of 100 years of fire suppression has been limited due to the long natural fire turnover times, about 100 years and 400 years for the major vegetation types within the park. The overall effect of these activities on forest structure, composition, and fuel loading in regards to natural fire regimes has the potential over a long timeframe (hundreds of years) to be direct, long-term, and moderate. The populations of widespread invasive plants such as cheatgrass has a detrimental effect on vegetation and soils as well.

Past, present, and reasonably foreseeable actions include fire management and fuel treatment activities outside the park, many of which would be on adjacent Ute Mountain Ute tribal land, private, and BLM lands. These projects would include reductions in the spread of invasive plants, management of fuels and wildfire in a manner more in line with current federal wildland fire management policies, and protection of riparian resources. These efforts, if successful, would improve habitat conditions for vegetation on MVNP by controlling invasive plants and managing fire as part of the ecosystem.

Other actions that would affect vegetation and soils include:

YHNM land acquisition proposal: Negotiations have been underway with a neighboring landowner that could result in the NPS acquiring 160 acres of mainly shrubland adjoining YHNM. This acquisition would put this land under the protection of NPS stewardship which would likely reduce the threat that the land would be widely developed, thus protecting the existing monument soils and vegetation. The new lands would require considerable treatment against invasive plants.

MVNP Mancos River Corridor Restoration Plan: This plan was approved in 1998 and immediately implemented. Over subsequent years park staffs have used herbicides, biological controls, and cultural methods to restore more natural conditions to Mancos Canyon. This has included exclusion of livestock grazing, some tree planting, elimination of tamarisk and Russian olive trees, seeding native grasses, and spraying stands of Russian knapweed, cheatgrass, and whitetop. The growth of native cottonwood, willow, and other native plants has responded well. Attempts to stabilize head-cutting gullies in the shale alluvium have had mixed results but overall the project's effects have been positive.

MVNP wildfires and burned area emergency rehabilitation plans: Sedimentation from flash flooding after major wildfires has affected multiple drainages in the park. Thousands of acres of old-growth forests and shrublands have been converted to early seral stages of regrowth. A spate of wildfires struck MVNP multiple times since 1972, the beginning of the modern era when erosion and invasive plant issues first became a priority. However, the aerial seeding with invasive rhizomatous

grasses, such as crested and intermediate wheatgrasses, that took place in 1972 is now seen as a mistake as this area has developed into an unnatural grassland landscape with low native species diversity. Starting in 1996, post-fire efforts were better coordinated to reduce soil erosion and to suppress the establishment of invasive species. These efforts have been largely but incompletely successful. However, a native rhizomatous grass, western wheatgrass, was included on mesa tops in what were pinyon-juniper woodlands where they normally would not grow. Data suggests that introduced western wheatgrass has had a negative impact on the growth of native forbs in these post-fire herbaceous landscapes. Studies of these rehabilitation projects have led to improved methods for the future that would reduce the adverse effects to native forb species and natural community succession from aerial seeding with native grasses.

2015 Fire Management Plan: This plan would provide long-term impacts to vegetation by clearing or thinning natural forest stands but also reducing the chance of catastrophic fire. If not properly and consistently mitigated, fuels management activities would have the strong potential to increase the spread of invasive plant species over large areas of the park and monument.

Livestock control efforts: Since their earliest years, the NPS has struggled to exclude cattle, horses, sheep, and other livestock from parklands at MVNP and YHNM. Especially in proximity to water sources, grazing and browsing by livestock damage vegetation, compact and expose soil to erosion, and leave the landscape more vulnerable to the spread of invasive plants. Improved fencing in recent years has eliminated the problem from YHNM but livestock persist in MVNP. Intermittent capture and removal operations kept horse numbers down in past years. The park will be working on a strategy for controlling a considerably larger population. Impacts to soils and vegetation would diminish as livestock numbers decline.

MVNP Visitor Distribution and Transportation Plan: Construction of new trails and overlooks, or the opening of other visitation opportunities would further increase impacts to soils and native vegetation and escalate the risk of increasing the spread of invasive plant species over some areas of the park. Considerable and reliable efforts would be needed to monitor and mitigate against these threats to be consistent with the invasive plant control goals of the IPMP.

Paths to Mesa Verde: For several years there have been discussions about establishing a public recreational trail connecting the towns of Cortez and Mancos that would pass through the northern tip of MVNP. The path of the potential trail is not known but its construction would result in soil impacts, the loss of some native vegetation in the park, and increase the risk of additional vectors bringing in weed seed. This risk would increase further depending on the modes of transportation allowed on the trail: foot, bicycle, horseback, other.

MVNP road construction and major maintenance projects: Over the years MVNP has undergone numerous ground disturbing activities including repaving all its roads, reengineering road cuts in steep parts of the road system, installing new water, sewer and other utility lines, new construction of buildings and other facilities, etc. Each of these activities has resulted in damage to the native soils and the existing vegetation. Most of these actions were accompanied by some site rehabilitation measures which could have included reseeding, planting, fertilizer application,

watering, erosion control, and/or invasive plant control. The extent, intensity, and results of post-construction rehabilitation efforts have been highly variable.

MVNP Concessions Contract: The concessionaire for MVNP has operated under contract which includes stipulations related to maintaining the grounds around their facilities. They have been expected to trim vegetation, control invasive plants, minimize and mitigate ground disturbances, and coordinate with park managers. In 2014, the NPS established a new concessions contract that includes and strengthen stipulations related to protecting soils and controlling invasive plants.

Revision of the San Juan National Forest Plan and the BLM Tres Rios Field Office Resource

Management Plan: Implementation of this plan would have at least a moderate, long-term effect on vegetation from grazing, timber management, oil and gas extraction, fire and invasive plant control efforts, and by leading overall to a more ecosystem-based management approach for local Forest Service and BLM lands.

Other external impacts on soil and vegetation: Reasonably foreseeable actions outside of MVNP would include fire management and fuels treatment activities outside the park, much of which would take place on adjacent Ute Mountain Ute tribal land, private, and other federal lands. Although no projects are currently planned for these areas, future management could include reductions in the spread of invasive plants, management of fuels and fire under current federal wildland fire management policies, and protection of riparian resources. The continued withdrawal of large volumes of water from the Mancos River watershed for irrigation and domestic and commercial uses will continue having a large effect on the riparian and agricultural lands of the Mancos Valley outside the park. Area soil and vegetation is affected by alterations from such matters as timber harvesting, gravel mining, farming and ranching, construction of homes and businesses in rural areas, recreational activities, and others.

Implementation of Alternative A would have a negligible adverse cumulative impact on soils and native vegetation in specific areas of the park and monument primarily due to mechanical control such as hand pulling and digging, and using chemicals. Some impacts could also occur from UTV mounted sprayers in limited areas such as around the Visitor and Research Center, Morefield, Prater and Mancos canyons, and cheatgrass treatment areas at YHNM. These cumulative effects would be ameliorated over time as native vegetation is restored and natural conditions return to previously disturbed sites. It is anticipated that Alternative A would be effective at controlling the small populations of aggressive invasive plants like spotted knapweed, Dalmatian toadflax, perennial pepperweed and leafy spurge. Alternative A cannot address larger treatments for cheatgrass, musk thistle, or tumble mustard through the use of aerial spraying. If some invasive plant species continue to spread within the park and monument, it is anticipated that there would be minor to moderate adverse cumulative impacts due to further soil erosion and loss of native plant biodiversity.

Conclusion for Alternative A

Alternative A would result in the long-term beneficial effects to soil and native vegetation but would have some localized short-term minor impacts to soil and native vegetation. Preventing new infestations of invasive plants and reducing or eliminating current infestations would help restore

the vigor of native vegetation. Healthy native plants benefit the soil by preventing erosion. With the implementation of Alternative A and continuation of the current IPM program, many populations of invasive plants would likely be contained by devoting resources to implement mechanical, biological and existing herbicide and cultural treatments. This program would efficiently target isolated populations of invasive species and contribute to efforts to control large-scale populations such as musk thistle, Canada thistle, and mullein through the continued introduction of biological controls. There would be no associated impacts or beneficial effects from use of animal control agents or aerial application of herbicides.

The use chemical or mechanical control could pose a short-term risk to soil and native vegetation, but native vegetation should return in the long-term. Preventing new infestations of invasive plants and reducing or eliminating current infestations would help restore the vigor of native vegetation. The use of herbicides can pose a short-term risk to native vegetation and soils. Driving a UTV in approved areas such as Mancos Canyon, YHNM, and Morefield Campground when applying herbicides may have a short-term localized minor impact on soils and native plants. The impacts from using chemicals are short-term, while the benefits to natural resources are long-term.

Implementing Alternative A would meet the mandate for which the park was established, which is preservation and protection of natural conditions. This alternative meets the guidelines of the Federal Noxious Weed Act, Executive Order 13112 on Invasive Plants, the Carlson-Foley Act, and the Colorado Undesirable Plant Management Act. Among the most significant deficiency of Alternative A is that it has no means of controlling cheatgrass on a broad scale, which has the greatest potential for permanently altering large areas of the park's landscapes. Alternative A tends to be reactive in nature but also leaves the park at risk from its inability to affectively respond to the aftermath of a large wildfire, which is likely to occur in the foreseeable future.

Impacts of Alternative B on Soils and Native Vegetation

The environmental consequences of using mechanical and biological methods are the same as Alternative A. Aerial application is added to chemical and cultural methods. Long-term benefits to soils and vegetation associated with controlling invasive plants and restoring native communities would be maximized. There would still be some short-term adverse impacts associated with implementation.

Aerial application: Imazapic herbicide, a pre-emergent chemical has been proven to be effective at killing seedlings of annual plants using concentrations that do only negligible harm to perennial vegetation. Some native perennials may experience temporary foliar yellowing the first year, but no long-term impacts are expected. Aerial application of herbicides would be limited to emergency site stabilization efforts in very disturbed areas virtually devoid of native annuals that would otherwise potentially be affected by Imazapic herbicide. These would include pinyon-juniper woodlands and sagebrush communities devastated by high intensity wildfire. Imazapic herbicide remains lethal in the soil to annuals for at least two years, which will give a great advantage to the native perennial grasses seeded in after wildfire. Buffer zones would be established around known populations of uncommon perennial plants with no known level of tolerance to Imazapic herbicide and to small

areas of surface waters associated with springs. These small areas may be treated manually at a different time. Aerial application of approved biological agents also may become available in the future to control invasive plants such as cheatgrass (USFWS 2013a). The second stage of this kind of treatment would be the aerial application of native plant seed, such as native bunchgrasses but not western wheatgrass, to establish competition with invasive plants and to stabilize soils exposed to erosion without posing a risk to the growth of native forbs.

With large-scale aerial applications of Imazapic, short-term adverse impacts on vegetation may increase to a moderate level because of a higher risk from overspray. While interfering with natural post-fire succession results from dropping grass seeds onto the burned landscape, past experience has shown that doing so greatly reduces the presence of invasive plants with minor short-term and long-term adverse effects from added competition on native forbs. This impact can be mitigated by not using western wheatgrass in most post-fire seeding mixes. Therefore, long-term beneficial effects on soil and native vegetation are increased as more acres are treated and restored through aerial application of pre-emergent herbicide and potentially biological control organisms, followed-up by native seeds.

Cumulative Impacts

The baseline cumulative scenario is described above. Alternative B would have a negligible to minor cumulative adverse impact similar to Alternative A. It is anticipated that more acres of invasive plants would be treated with the expansion of the existing program to include biological control agents and aerial spraying and seeding. As IPM techniques are expanded and implemented, native vegetation would be restored, resulting in the amelioration of cumulative impacts. Native plant biodiversity is expected to increase in the long-term.

Conclusion for Alternative B

Alternative B would result in the greatest long-term beneficial effects to soil and native vegetation but would have some localized short-term moderate impacts to soil and native vegetation. Alternative B also provides a proactive approach to addressing difficult environmental conditions after wildfires. Moderate impacts would be mitigated through the implementing mitigation measures listed in Appendix A1 and A2. Alternative B would fully meet the mandate for which the park was established, which is preservation and protection of natural conditions. This alternative meets the guidelines of the Federal Noxious Weed Act, Executive Order 13112 on invasive plants, the Carlson-Foley Act, and the Colorado Undesirable Plant Management Act, and provides for adaptive management including a strategy for controlling cheatgrass.

Aquatic, Wetland and Riparian Communities

Impacts of Alternative A to Aquatic, Wetland and Riparian Communities

Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. Negligible to minor, long-term beneficial impacts on the aquatic, wetland, and riparian resources are expected as invasive plants are controlled and native communities are restored.

Mechanical Treatments

Removing invasive plants by hand and with tools is expected to have short-term adverse negligible to minor impacts to aquatic, wetland and riparian communities. Cutting seed heads and cutting plants at ground level would have no negative effect on adjacent native species. However, some soil erosion and loss of native plants may occur at the base of an invasive plant if dug or pulled from the ground. If a large patch is removed in the vicinity of a wetland this could increase soil erosion and have a short-term moderate impact on riparian communities and water quality, however, mechanical control resulting in major soil disturbance would not be implemented in the vicinity of aquatic resources. Other techniques also would be applied to reduce erosion such as seeding, installation of matting and barriers, or other erosion control methods. Native riparian vegetation is expected to recover when invasive plants are removed over the long-term (Redente and McLendon 1994). The removal of invasive plants would enhance native species. Water quality should remain good or improve in the long-term with the restoration of native vegetation and protection of soils.

Cutting invasive plants with weed trimmers would cause little disturbance to the soil, but also could have a minor impact on native species growing amongst the invasives. Cutting is not an effective means of control for many invasive plants that occur in riparian habitats, but could be effective at preventing some species from flowering and producing seed. Just cutting invasive plants generally does not kill (and may even spread) those species that reproduce by seed and through rhizomes.

Cultural Treatments

Restoration: Restoring disturbed riparian communities to natural conditions by replanting and seeding native plant species would reduce soil erosion, enhance native plant communities, and improve water quality. Thus, cultural control through native plant restoration would result in a minor benefit to aquatic, wetland and riparian communities. Maintaining riparian communities in a healthy vigorous condition favors native plants over invasive plants (Redente and McLendon 1994, McLendon 1996).

Biological Treatments

Biological control agents proposed for use in MVNP and YHNM should have no direct impact on aquatic, wetland or riparian communities. Biological control insects would be carefully chosen to selectively feed on the invasive plants to be controlled. The natural spread of other biological agents released beyond the park, such as the tamarisk beetle (*Diorhabda carinulata*), could result in their establishment in and around the park and monument.

Herbicide Treatments

With the implementation of standard operating procedures and the mitigation measures outlined in Appendix A1 and A2, the use of herbicides near water could result in only negligible to short-term adverse impacts to aquatic, wetland and riparian communities. Leaching, root uptake, and movement in soil and groundwater are the primary hydrologic processes governing herbicide movement. Herbicides have the potential to enter open water through runoff and spills. Herbicide concentrates are potential point sources of pollution that can impact surface and groundwater. When the concentrate is mixed with water and applied to invasive plants, contamination of surface waters because of runoff is unlikely except when heavy rainfall occurs soon after application. Applying herbicides when rainfall is imminent would be prohibited except for the use of Imazapic, a pre-emergent that has little mobility in the soil.

Table 9 presents the behavior of the herbicides proposed for use in MVNP in aquatic, wetland and riparian communities. Herbicides proposed for use near water resources must be approved for use in and around water. Hand application methods, such as using a wick or wand applicator, may be used. Personnel applying herbicides would follow all label directions and precautions. Herbicide drift would be negligible with implementation of mitigation measures including requiring the use of buffer zones. Implementation of mitigation measures associated with the protection of water quality would minimize effects on aquatic, wetland and riparian areas. Furthermore, herbicide would not be used in the vicinity (within 5 feet or less) of low flow springs. The potential impact of herbicides on fishes and other aquatic organisms is a function of two factors: the toxic characteristic of the herbicide and the concentration of the herbicide to which the fishes or other organisms are exposed. Herbicides applied in accordance with label restrictions are expected to have negligible impacts on fishes or aquatic organisms because concentrations are so dilute. Table 9 provides a summary of the risks associated with use of the herbicides identified in this plan/EA. This summary is based on previous risk assessments for herbicide (USDA-USFS 1992).

Table 9. Behavior of Herbicides in Aquatic, Wetland, and Riparian Communities

Herbicide (active ingredient)	Behavior of the Herbicide in Aquatic, Wetland and Riparian Communities
Aminopyralid (ex. Milestone)	Mobilization in the soil is typically limited to 6 -12.” In water the primary route of degradation of aminopyralid is photolysis. The photolysis half-life under standard conditions is 0.6 days indicating rapid degradation in surface water. The material is stable to hydrolysis. Groundwater contamination potential is low because of low use rates, moderate field degradation rates, and limited mobility in the soil.
Chlorsulfuron (ex. Telar)	Telar may be dispensed as a suspension in water with constant agitation. Purified chlorsulfuron, which is the active ingredient, is soluble in water. The potential for leaching is high in permeable soils. However, significant groundwater contamination should not occur because of the low use rates and the dispersion of residues with leaching. No information is available for surface water. For this reason, a buffer zone would be maintained when applying it near surface water, or hand methods such as wick or paste applications could be used to avoid drift.
Clopyralid (ex. Transline)	It is highly soluble in water. Because it is highly soluble, it does not adsorb to soil particles and is not readily decomposed in some soils. It may leach into groundwater. Groundwater may be contaminated if clopyralid is applied to areas where soils are very permeable and the water table is shallow. There is also the potential to contaminate surface waters. Clopyralid is relatively persistent in soil, water, and vegetation. Warm, moist soils treated at low rates will lose clopyralid in a comparatively short period, whereas when applied to cold, dry soils or waterlogged soils, and at higher rates, clopyralid residues may persist for several years.
Glyphosate (ex. Roundup)	The Roundup and Rodeo formulations are two of only a few herbicides approved for controlling invasive plants in delicate aquatic environments. Strongly adsorbed to suspended organic and mineral matter, which makes it unlikely to leach into water. However, glyphosate can move into surface water when soil particles to which it is bound are washed into streams, rivers or lakes. Primarily broken down by microorganisms. Half-life in soil is 30 days.
Imazapic (ex. Plateau)	Imazapic is soluble in water and is hydrolytically stable in aqueous solution. Imazapic in water is, however, rapidly photo degrades by sunlight with a half-life in water of from less than 8 hours to one to two days. Based on the chronic reference dose (RfD) of 0.05 mg/kg b.w./day, set by EPA for the time-limited tolerance and the EPA’s default factors for body weight and drinking water consumption, the Drinking Water Level of Comparison (DWLOC) was 1700 ppb and for children the DWLOC was estimated to be 500 ppb. It has little lateral movement in soil. No residues were found below the 18-24 inch soil layer. Imazapic does not readily move off site and binds moderately to most soil types. Imazapic is not registered for aquatic use.
Imazapyr (ex. Habitat)	Imazapyr has been shown to have little lateral movement in the soil and the chemical typically remains in the top 20” of soil. The major route of imazapyr loss from the soil is microbial degradation. It is not volatile and binds to most soil particles. Minimize spray drift and leave a sufficient untreated buffer area adjacent to surface waters to prevent spray drift from reaching water.

Herbicide (active ingredient)	Behavior of the Herbicide in Aquatic, Wetland and Riparian Communities
metsulfuron methyl (ex. Escort)	Escort dissolves easily in water. It has the potential to contaminate groundwater at very low concentrations. It leaches through silt loam and sandy soils. The half-life is from 120 to 180 days in silt loam soil. Because it is soluble in water, there is a potential for surface waters to be contaminated if it is applied directly to bodies of water or wetlands. Tests show that the half-life for Escort in water, when exposed to artificial sunlight ranged from 1 to 8 days.
Picloram (ex. Tordon)	Picloram is soluble in water, may be mobile, and under certain conditions can contaminate groundwater. Under some conditions, Tordon may also have a high potential for runoff into surface water (primarily via dissolution in runoff water). These include poorly draining or wet soils with readily visible slopes toward adjacent surface waters or stream banks that are unstable and may slip into the stream, sites with a water table within 72 inches (6 feet) of the surface and coarse textured soils, areas inside the annual flood plain, frequently flooded areas, or areas over-laying extremely shallow groundwater. These properties combined with its persistence, means it may pose a risk to groundwater contamination. The buffer zone for use of Tordon within MVNP would be 200 feet from any aquatic, wetland or riparian area because of its potential to contaminate aquatic systems. Tordon will not be used when depth to water is less than 72 inches.
Triclopyr (ex. Garlon)	Leaching potential is medium; half-life in soil is on average 30 days but ranges from 10 to 46 days depending on soil type, moisture, and temperature. Typically, 95% of the chemical remains in the first 6-10" of the soil with about a 5% breakdown. The half-life in river water using natural light sources was 1.7 days. Spraying is not recommended where the water table is shallow. If deemed necessary to treat target species in these areas, a wick or paste applicator may be used. Avoid drift into surface water. Both triclopyr BEE and triclopyr TEA may produce TCP, which is relatively mobile and persistent and has the potential to degrade groundwater. Triclopyr and TCP do not absorb to soil and sediment particles, and may be transported by surface runoff waters. However, Triclopyr is not predicted to persist in surface waters and does not move out of roots.

Cumulative Impacts

Historically, aquatic, wetland and riparian communities in MVNP have been affected by presence of invasive plants, past and present invasive plant control, fire exclusion, firefighting activities, facility construction, land use changes in the surrounding region (particularly in upstream watersheds), and periodic high-severity wildfires. The Maintenance Division also performs herbicide applications and mowing projects in the process of maintaining road and trail shoulders and utility corridors along the main park roads and grounds maintenance in the vicinity of structures and buildings. Recent extensive burns (in 1996, 2000, 2002, 2003, and 2012) may have significantly altered some watershed characteristics and influenced patterns of water movement, sediment yield and erosion in large areas of the park. Population growth is a major concern to water quality in the San Juan Basin. Between 1990 and 2000, the basin's population rose 25 percent to a population of approximately 95,000. Major population centers include Cortez, Durango, Farmington and Pagosa Springs. There is concern that continued fast growth of the area will tax the ability of communities to provide adequate water and water treatment. Agriculture and tourism are the two main components of the region's economy. All of these actions would have an expected direct effect on watershed and soil characteristics.

Other actions potentially affecting watersheds include:

YHNM land acquisition proposal: The 160 acres that may be added to YHNM would represent a very small part of the local Navajo Wash watershed, all of which would be downstream of the current monument. The acquisition and conservation measures that would be employed on the new land would have no direct effect on YHNM's current aquatic, wetland and riparian communities but the added acres would increase the amount of these resources in the park. Navajo Wash runs through the parcel from north to south with a narrow channel. Actions related to IPMP implementation would be expected to improve the watershed within this small area.

MVNP Mancos River Corridor Restoration Plan: Removing tamarisk, Russian olive, and cattle grazing from the Mancos Canyon part of the park has measurably improved aquatic, wetland, and especially the riparian communities there. Continuing efforts against Russian knapweed would continue this improvement.

MVNP wildfires and burned area emergency rehabilitation plans: The Bircher Fire in 2000 had a significant effect on local conditions in the Mancos Canyon part of the park. Two aircraft loads of fire retardant landed in the river causing a comprehensive fish kill for miles. Post-fire debris flows clogged the river with sediment, ash, and plant matter for years, embedding the river cobbles which drastically diminished the aquatic food chain. Aquatic insect diversity and abundance, and the native fishery that depends on this resource, have yet to recover. Aerial seeding of the park's East Escarpment may have had a minor role in ameliorating this condition in more recent years; however, in 2012 the Weber Canyon Fire burned off virtually all of adjacent Menefee Mountain which repeated the conditions after the Bircher Fire for areas immediately downstream of the national park, almost wiping out the fishery of the Mancos River on the adjoining Ute Mountain Ute

Tribal Park. Some ash-laden sediment entered MVNP from the north end, but nothing like post-Bircher Fire conditions.

Sedimentation from flash flooding after the Bircher Fire and other major wildfires also affected several other drainages in the park. Aerial seeding and some local stabilization efforts helped to reduce erosion impacts to some of the small wetlands in the park such as in Prater and Morefield canyons where sand close to a foot deep was found on the surface. Sedimentation like this coupled with dropping water tables due to persistent drought have had detrimental impacts on the condition of the park's small scattered wetlands and water pools.

Fire Management Plan: This plan would result in long-term impacts to the park watershed by reducing the chance of catastrophic fire through alteration of fuels over a large area. Ensuring that fire retardant is kept out of the Mancos River would help prevent a repeat of the Bircher Fire fish kill incident of 2000.

Livestock control efforts: Currently the wetland at Aztec Spring in YHNM is secured from livestock encroachment. For the past few decades, livestock have been effectively kept out of the Mancos Canyon riparian area of MVNP. The park's inability to effectively diminish or control livestock throughout most of the rest of MVNP has contributed to the decline or destruction of scattered smaller wetland and aquatic sites. Prolonged drought conditions have made this problem worse. Impacts to wetland and riparian areas would diminish as livestock numbers decline as a result of new livestock control efforts.

Visitor Distribution and Transportation Plan: Construction of new trails, overlooks, or the opening of other visitation opportunities would further increase impacts to the park's watersheds.

MVNP road construction and major maintenance projects: Due to the generally dry nature of YHNM and MVNP, most of the construction and maintenance projects in the parks have had little or no impact on aquatic, wetland, and riparian resources and communities. The primary exception has been impacts related to the development and operation of the wastewater facilities in MVNP which are located in or above Morefield Canyon, Little Soda Canyon, and Spruce Canyon. The construction of the large Morefield facility took place right in a canyon bottom wetland, which no longer exists. About a mile up canyon from here a half-acre wetland was gradually filled and destroyed over several years by park maintenance operations. The Little Soda Canyon and Spruce Canyon wastewater treatment sites experience the release of large volumes of tertiary-treated sewage which results in largely permanent artificial aquatic communities in what would naturally be only intermittently wetted canyons. These two facilities are expected to receive further upgrades over the next several years, but water releases are expected to continue indefinitely.

Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource

Management Plan: Implementation of this plan would have a substantial, long-term effect on watersheds by leading to a more ecosystem-based management approach in the San Juan National Forest and BLM lands around MVNP.

Reasonably foreseeable actions outside of MVNP would include fire management and fuels treatment activities outside the park, much of which would be placed on adjacent Ute Mountain Ute

tribal land, private, and other federal lands. Although no projects are currently planned for these areas, future management could include reductions in the spread of invasive plants, management of fuels and fire under current federal wildland fire management policies, and protection of riparian resources. The continued withdrawal of large volumes of water from the Mancos River watershed for irrigation and domestic and commercial uses will continue having a large effect on the riparian and aquatic resources of the Mancos River inside the park. Water use immediately west of YHNM also would continue to influence the local hydrologic and wetland conditions in the monument.

Alternative A would result in negligible to minor adverse cumulative impacts to wetland and riparian vegetation in specific areas of the park and monument primarily due to mechanical control such as hand pulling and digging and herbicidal control. No motorized vehicles would be allowed in wetland and riparian communities, except under dry soil conditions. Implementation of mitigating measures such as buffers would reduce the potential for contaminating groundwater and impacting wetland and riparian communities. To minimize cumulative impacts on wetland and riparian communities, chemicals would only be used after other IPM techniques were determined to be ineffective. If herbicides are used, wick or wand applicators would be used to further minimize impacts to wetland or riparian communities.

Conclusion for Alternative A

With the implementation of mitigation measures, Alternative A would result in short-term negligible adverse impacts to aquatic, wetland and riparian communities. The level of impact is dependent on the herbicide selected and distance to surface and groundwater. Most herbicides proposed for use in MVNP would not be used near aquatic, wetland or riparian communities. Carefully selected herbicides would be used in the vicinity of water with a wand or wick applicator and appropriate buffers would be implemented. This alternative would result in a long-term minor to moderate benefit to aquatic, wetland, and riparian communities. The implementation of this alternative would ultimately decrease the use of chemicals.

Impacts of Alternative B to Aquatic, Wetland and Riparian Communities

Because aerial applications of herbicides would not be permitted in close proximity to aquatic, wetland, and riparian communities, the environmental consequences of using mechanical, cultural, and biological IPM methods are the same as Alternative A. Mitigation measures would ensure this evaluation. Long-term benefits associated with controlling invasive plants and restoring native communities would be maximized.

Cumulative Impacts

The baseline cumulative scenario is described above. Because new techniques proposed in Alternative B would not be implemented in the vicinity of water, the cumulative impacts would be the same as Alternative A.

Conclusion for Alternative B

The continued removal of invasive plants that affect wetland and riparian areas (such as Russian olive and tamarisk at MVNP and Canada thistle and Russian knapweed at YHNM) would help

maintain natural surface water flows, prevent visual obstructions along stream banks and spring flows, and preserve habitat. Removal of these species with the most appropriate techniques would help the park and monument achieve the desired aquatic resource conditions, restore natural floodplain values, and preserve natural values of wetlands. With the implementation of mitigation measures, Alternative B would result in short-term negligible adverse impacts to aquatic, wetland, and riparian communities. The level of impact is dependent on the herbicide selected and distance to surface and groundwater. Most herbicides proposed for use in MVNP and YHNM would not be used near aquatic, wetland or riparian communities. Selected herbicides would be used in the vicinity of water with a wand or wick applicator and appropriate buffers would be implemented.

Water Quality

Impacts of Alternative A on Water Quality

Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. Negligible long-term beneficial impacts on the water quality are expected as invasives are controlled and native communities are restored.

Mechanical Treatments

Disturbance from mechanical control may temporarily increase turbidity caused by sediment runoff from areas of soil disturbance or loss of vegetation cover. This is likely to occur only in areas of extensive invasive species infestations, such as Mancos Canyon. Techniques to minimize or mitigate soil disturbance would be implemented (see Standard Mitigation Measures in Appendix A1).

Mechanical controls are expected to have negligible, short-term and site specific adverse impacts from disturbing the soil surface, but also long-term beneficial effects as native vegetative cover improves soil stability and reduces sedimentation into surface waters.

Cultural Treatments

Restoration: Restoration activities such as reseeding and irrigation would have a minor long-term beneficial effect of promoting the reestablishment of native vegetation, which could help reduce erosion and sedimentation.

Chemical Treatments

Chemical controls could lead to reduced water quality through leaching and runoff, depending on soil type, water table characteristics, application technique and distance to water, and type of herbicide(s) used. To minimize potential environmental effects, herbicides would be selected based on these factors. Resource managers considering application of herbicide in areas with high water tables would greatly reduce this risk through the application of standard operating procedures and mitigations listed in Appendix A1 and A2. Alternative types of treatments, herbicides, or herbicide application rates would be considered for areas with high leaching potential. The use of herbicides in the vicinity of springs with very low flow rates would be carefully evaluated. Mechanical treatments would be used if water quality would be compromised. With these mitigation measures,

the potential for surface and ground water contamination would be unlikely. Herbicide application would therefore not likely produce detectable changes in chemical water quality standards that exceed desired water quality conditions. The potential for directly spilling pesticides into surface waters is unlikely. Herbicides would be transferred in controlled settings, contained in spill-proof containers, and handled in accordance with label specifications. In the unlikely event that a spill occurs, resource managers would immediately implement standard operating procedures for containing and remediating spills. The impacts of herbicide use on water resources would therefore be adverse, site-specific, short-term and negligible.

Cumulative Impacts

The past activities in the region that have had the greatest potential impact upon water quality have included development, agriculture, oil and gas activities, air pollution, wildfire, and fire suppression activities. The Maintenance division also uses herbicide applications (performed by the Natural Resource staff) and mechanical mowing in the process of maintaining road and trail shoulders and utility corridors and grounds maintenance in the vicinity of structures and buildings. The present and reasonably foreseeable potential activities that would have an effect upon water quality would include:

YHNM land acquisition proposal: The 160 acres that may be added to YHNM would represent a very small part of the local Navajo Wash watershed, all of which would be downstream of the current monument. The acquisition and conservation measures that would be employed on the new land would have no direct effect on YHNM's current water resources at three surface springs and would have little direct effect on the water quality of Navajo Wash within the acquisition. Actions related to IPMP implementation would be expected to improve the watershed condition within this small area although there is always some risk that a small amount of herbicide could enter the wash resulting from application on the acres adjacent to the stream despite proper mitigation measures.

MVNP Mancos River Corridor Restoration Plan: Removing tamarisk, Russian olive, and cattle grazing from the Mancos Canyon part of the park has measurably improved watershed conditions in the Mancos Canyon area of the park. Continuing efforts against Russian knapweed would continue this improvement. Despite proper mitigation measures, implementation actions could have had a small amount of herbicide enter the river resulting from application on the acres adjacent to the stream.

MVNP wildfires and burned area emergency rehabilitation plans: The Bircher Fire in 2000 had a significant effect on local conditions in the Mancos Canyon part of the park. Two aircraft loads of fire retardant landed in the river causing a comprehensive fish kill for miles. Post-fire debris flows clogged the river with sediment, ash, and plant matter for years, and several harmful chemicals were detected in the river. Aerial seeding of the park's East Escarpment may have had a minor role in ameliorating this condition in more recent years; however, in 2012 the Weber Canyon Fire burned off virtually all of adjacent Menefee Mountain which repeated the conditions after the Bircher Fire for areas immediately downstream of the national park, almost wiping out the fishery of the Mancos River on the adjoining Ute Mountain Ute Tribal Park. Some ash-laden sediment entered MVNP from

the north end, but nothing like post-Bircher Fire conditions. Sedimentation from flash flooding after the Bircher Fire and other major wildfires also affected several other drainages in the park which then entered the Mancos River. Aerial seeding and some local stabilization efforts helped to reduce sedimentation impacts to the river.

Fire Management Plan: This plan would result in long-term impacts to the park watershed by reducing the chance of catastrophic fire through alteration of fuels over a large area. Ensuring that fire retardant is kept out of the Mancos River would help prevent a repeat of the Bircher Fire fish kill incident of 2000.

Livestock control efforts: Currently the wetland at Aztec Spring in YHNM is secured from livestock encroachment. For the past few decades, livestock have been effectively kept out of the Mancos Canyon riparian area of MVNP. The park's inability to effectively diminish or control livestock throughout most of the rest of MVNP has contributed to the decline or destruction of scattered small aquatic sites. Impacts to water quality would diminish as livestock numbers decline as a result of new livestock control efforts.

Visitor Distribution and Transportation Plan: Construction of new trails, overlooks, or the opening of other visitation opportunities would further increase impacts to the park's watersheds.

MVNP road construction and major maintenance projects: Due to the generally dry nature of YHNM and MVNP, most of the construction and maintenance projects in the parks have had little or no impact on surface waters. The primary exception has been impacts related to the development and operation of two wastewater facilities in MVNP that release treated sewage back into the environment, Little Soda Canyon and Spruce Canyon. These two wastewater treatment facilities release large volumes of tertiary-treated sewage which results in largely permanent artificial surface waters in what would naturally be only intermittently wetted canyons. These two facilities are expected to receive further upgrades over the next several years which would reduce the amount of nitrogen pollution in the water releases.

Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource

Management Plan: Implementation of this plan would have a substantial, long-term effect on watersheds and water quality by leading to a more ecosystem-based management approach in the San Juan National Forest and BLM lands around MVNP.

Mancos Valley water use: The continued withdrawal of large volumes of water from the Mancos River watershed for irrigation and domestic and commercial uses will continue having a large effect on the quantity and quality of water flowing in the Mancos River inside the park. Water quality in the Mancos River is affected by many factors including sewage treatment, agricultural and residential chemicals, irrigation return flows, hard rock and gravel mining, livestock grazing, timber production, and others. Similarly, water use immediately west of YHNM also would continue to influence the local hydrologic and water quality conditions in the monument.

Compared to the wide array of water contamination sources already affecting MVNP and YHNM, Alternative A would have only a negligible to minor cumulative impact to water quality due primarily to mitigation measures and appropriate buffers. It is anticipated that troublesome invasive plants

would decrease as the full range of IPM techniques are implemented. As native vegetation is restored and habitat improves, cumulative impacts to water quality would be ameliorated.

Conclusion for Alternative A

The continued removal of invasive plants that affect wetland and riparian areas (such as Russian olive and tamarisk) would help maintain natural surface waters flows, prevent visual obstructions along river and stream banks, and preserve habitat. Removal of these species with the most appropriate techniques would help MVNP achieve the desired condition perpetuated for surface waters and ground waters, natural floodplain values restored, and natural values of wetlands preserved. Any negligible to minor short-term adverse impacts would be outweighed by the long-term benefits of improved water quality and habitat. The impacts of current management practices overall on water quality would, therefore, be beneficial, site-specific, short-term, and negligible to minor.

Impacts of Alternative B on Water Quality

The environmental consequences of using mechanical and biological methods are the same as Alternative A. Aerial applications of herbicide are added to chemical and cultural methods. Long-term benefits to water quality associated with controlling invasive plants and restoring native communities would be magnified.

Aerial application. Concerns associated with herbicide and water quality are identified in Alternative A. Short-term adverse effects would be increased to minor to moderate given the large-scale nature of aerial applications of Imazapic herbicide. In order to reduce the risk of herbicides reaching surface waters by overspray or runoff, specific mitigation measures for aerial spraying have been developed to minimize impacts to water quality to negligible to minor adverse.

Cumulative Impacts

The baseline cumulative scenario is described above. Alternative B would have a negligible to minor cumulative impact to water quality due primarily to mitigation measures and appropriate buffers. It is anticipated that troublesome invasive plants would decrease as the full range of IPM techniques are implemented. As native vegetation is restored and habitat improves, cumulative impacts to water quality would be ameliorated.

Conclusion for Alternative B

The continued removal of invasive plants that affect wetland and riparian areas (such as Russian olive and tamarisk at MVNP and Canada thistle and Russian knapweed at YHNM) would help maintain natural surface water flows, prevent visual obstructions along stream banks and spring flows, and preserve habitat. Removal of these species with the most appropriate techniques would help the park and monument achieve the desired water quality conditions perpetuated for surface and ground waters, natural floodplain values restored, and natural values of wetlands preserved. Any negligible to minor short-term adverse impacts would be outweighed by the long-term benefits of improved water quality and habitat. Overall the impacts of current management practices on

water quality would, therefore, be beneficial, site-specific, short-term and long-term, and negligible to minor.

Because Alternative B proposes to expand the IPM program, additional acres would be restored. Overall beneficial effects to water quality would be greater under this alternative because the full range of tools could affect positive change on a larger scale. With the use of appropriate mitigation measures, any minor short-term adverse impacts would be outweighed by the long-term benefits of improved water quality and associated aquatic resources. The overall effects of integrated plant management techniques under this alternative would be beneficial, park and monument-wide, long-term, and negligible to moderate.

Wildlife

Impacts of Alternative A on Wildlife

Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. A decrease in native habitat means decreased numbers of native wildlife species which depend on native plants for food, cover and nesting. Often, invasive plants are detrimental to wildlife. For example, cheatgrass provides almost no nutritional value for grazing wildlife. In fact, by late spring its stiff seeds are sharp enough to puncture the lining of the mouth, throat tissue, and intestines of various wildlife species. Punctures can cause sores and infection, reducing the feed intake of grazers. Long-term beneficial impacts on wildlife are expected as invasive plants are controlled and native communities are restored.

Mechanical Treatments

Removing invasive plants by using tools (including mowing and the use of string trimmers) would have a negligible adverse impact on wildlife. Some soil erosion and loss of native plants may occur at the base of an invasive plant if it is dug, pulled or chopped from the ground, resulting in a negligible loss of habitat. If a large patch is removed this could increase the potential impact to some wildlife, but this impact is still considered negligible. There may be short-term displacement of wildlife in the vicinity of invasive plant management operations. Mechanical treatment is labor intensive and would often require periodic retreatment for targeted invasive plants. Therefore, the impacts from mechanical treatment can be recurring but still infrequent for any given site.

Cultural Treatments

Restoration: Mulching, seeding, installing erosion control matting or logs, and adding soil inoculum and fertilizers are some examples of restoration techniques designed to restore native vegetation and enhance wildlife habitat. Minor short-term effects may result as competition from seeded native grasses may suppress native pioneer forb species preferred by some animals. The presence of humans in the work area also can temporarily frighten off animals.

Biological Treatments

The biological control organisms proposed for use in MVNP should have no impact on wildlife and the long-term benefit of using biological controls should enhance wildlife habitat. There is a possible long-term risk that some biological control organisms could evolve and have a negative impact on native flora and fauna. Some native insects may be displaced from the use of biological control insects, but there is no documentation to indicate that this will occur. Research would be needed to substantiate this potential impact.

Herbicide Treatments

The NPS would use the least toxic herbicide to manage prioritized invasive plant species. Herbicide use has the potential to create a short-term minor impact to wildlife species. Herbicides have the potential to enter systems. Some can bioaccumulate in wildlife although bioaccumulation should not be a problem given the herbicides and amounts proposed for use in MVNP and YHNM.

Contamination of sensitive wildlife species because of runoff or drift is unlikely except when heavy rainfall occurs soon after application. For this reason, herbicides would not be applied when rainfall is imminent or predicted with the exception of Imazapic in which adequate soil moisture and/or light rain is important for chemical uptake by the soil. Appropriate buffers would be used in the vicinity of water.

Implementation of mitigation measures requiring the use of buffer zones would help protect aquatic organisms and wildlife species that utilize riparian habitat for food and shelter. Applying any chemical near aquatic, wetland or riparian areas would require approval through the Intermountain Region IPM Coordinator. Aquatic-labeled herbicides only would be applied by hand-spraying within 100 feet of aquatic, wetland, or riparian areas. On a limited basis, herbicides also could be applied within 100 feet of aquatic, wetland, or riparian areas with a wick or wand applicator or cut and paste methods or as otherwise indicated on the product label. Furthermore, herbicide would not be permitted in the vicinity of a low flow spring. Implementation of mitigation measures associated with the protection of wildlife would effectively eliminate any negative impact.

Table 10 presents the potential impacts to threatened, endangered or rare wildlife species from the various chemicals proposed for use in MVNP. This information also applies to non-listed wildlife species.

Cumulative Impacts

The past activities in the region that have had the greatest major impact upon wildlife have included development, oil and gas activities, and fire suppression activities. The Maintenance division also performs herbicide applications and mowing projects in the process of maintaining shoulders and utility corridors along the main park roads and ground maintenance in the vicinity of structures and buildings. Previous invasive plant control has resulted in negligible cumulative impacts to wildlife. The present and reasonably foreseeable potential activities that would have an effect upon wildlife would include:

MVNP Mancos River Corridor Restoration Plan: Removing tamarisk, Russian olive, and cattle grazing from the Mancos Canyon part of the park has measurably improved aquatic, wetland, and especially the riparian wildlife habitat there. Continuing efforts against Russian knapweed would continue this improvement in more upland habitat.

MVNP wildfires and burned area emergency rehabilitation plans: The Bircher Fire in 2000 had a significant effect on local conditions in the Mancos Canyon part of the park. Two aircraft loads of fire retardant landed in the river causing a comprehensive fish kill for miles. Post-fire debris flows clogged the river with sediment, ash, and plant matter for years, embedding the river cobbles which drastically diminished the aquatic food chain. Aquatic insect diversity and abundance, and the native fishery that depends on this resource, have yet to recover. Aerial seeding of the park's East Escarpment may have had a minor role in ameliorating this condition in more recent years; however, in 2012 the Weber Canyon Fire burned off virtually all of adjacent Menefee Mountain which repeated the conditions after the Bircher Fire for areas immediately downstream of the national park, almost wiping out the fishery of the Mancos River on the adjoining Ute Mountain Ute Tribal Park. Some ash-laden sediment entered MVNP from the north end, but nothing like post-Bircher Fire conditions.

In the past two decades, many thousands of acres of old-growth forest and shrubland habitat have been converted to early seral vegetation stages in MVNP. This has favored the expansion of wildlife species that prefer edge and open country habitats while tall tree and closed canopy species have declined with some becoming extirpated. Aerial seeding and other controls on invasive plants have improved the quality of these post-wildfire habitats for wildlife in many areas.

Fire Management Plan: This plan would result in long-term impacts to the park landscape by reducing the chance of catastrophic fire through alteration of fuels over a large area. By reducing the size of large wildfires, the plan could help maintain forested wildlife habitat. Habitat alternatives resulting from fuels treatment would have local level impacts on wildlife populations. Ensuring that fire retardant is kept out of the Mancos River would help prevent a repeat of the Bircher Fire fish kill incident of 2000. Performing bird nest surveys before spring season fuels treatments take place would help mitigate impacts to migratory birds. Related to the new fire management plan is a possible proposal to develop a new helicopter base somewhere on Chapin Mesa in MVNP. Returning helicopter operations into MVNP with the expected frequent low level flights over the park could cause a substantial increase in these kinds of stresses to wildlife over current conditions where low overflights occur rarely.

Livestock control efforts: Currently YHNM is secured from livestock encroachment so wildlife is not being impacted directly there. For the most part, livestock have been effectively kept out of the Mancos Canyon riparian area of MVNP over the past few decades. The park's inability to effectively diminish or control livestock throughout most of the rest of MVNP has contributed to many resource impacts including the decline or destruction of scattered smaller wetland and aquatic sites. Aggressive competition from livestock near water has been shown to keep native wildlife from drinking, such as elk and mule deer. Heavy livestock grazing in some areas, including in proximity to reliable water sources, has altered habitat conditions which favor some native animals over those

that prefer better cover. Livestock also have supported small numbers of brown-headed cowbirds, a brood parasite which lay their eggs in the nests of native songbirds which results in the reduction or elimination of their own reproductive effort. Impacts on wildlife would diminish as livestock numbers decline as a result of new livestock control efforts.

Visitor Distribution and Transportation Plan: This plan could minimally impact wildlife directly from an increase in disturbances in wildlife habitat (noise, presence of humans) potentially including areas that currently are not open to visitation. Construction of new trails and overlooks, or the opening of other recreational opportunities would increase impacts to the park's landscape.

MVNP road construction and major maintenance projects: Due to the generally dry nature of YHNM and MVNP, most of the construction and maintenance projects in the park and monument have had little or no impact on aquatic, wetland, and riparian resources and communities. The primary exception has been impacts related to the development and operation of the wastewater facilities in MVNP which are located in or above Morefield Canyon, Little Soda Canyon, and Spruce Canyon. The construction of the large Morefield facility took place right in a canyon bottom wetland, which no longer exists. About a mile up canyon from here, a half-acre wetland was gradually filled and destroyed over several years by park maintenance operations. The Little Soda Canyon and Spruce Canyon wastewater treatment sites experience the release of large volumes of tertiary-treated sewage which results in largely permanent artificial aquatic communities in what would naturally be only intermittently wetted canyons. These two facilities are expected to receive further upgrades over the next several years, but water releases are expected to continue indefinitely.

MVNP Integrated Pest and Hazardous Wildlife Management Plan: Implementation of this plan is expected to have negligible to minor adverse impacts on some wildlife populations, primarily those occupying developed areas or otherwise occurring in the small area of the park frequented by humans. The vast majority of park wildlife populations would not be affected.

Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource

Management Plan: Implementation of this plan would have a substantial, long-term effect on wildlife habitats by leading to a more ecosystem-based management approach in the San Juan National Forest and BLM lands around MVNP. Implementation of this plan would have long-term beneficial and adverse effects on wildlife habitat. Although it will attempt a more ecosystem-based management approach, continued extractive and recreational activities also will continue to adversely affect wildlife.

Other external impacts on wildlife: Reasonably foreseeable actions outside of Mesa Verde would include fire management and fuels treatment activities outside the park, much of which would take place on adjacent Ute Mountain Ute tribal land, private, and other federal lands. Although no projects are currently planned for these areas, future management could include reductions in the spread of invasive plants, management of fuels and fire under current federal wildland fire management policies, and protection of riparian resources. The continued withdrawal of large volumes of water from the Mancos River watershed for irrigation and domestic and commercial uses will continue having a large effect on the riparian and aquatic habitats of the Mancos River

inside the park. Water use immediately west of YHNM also would continue to influence the local hydrologic and wetland habitat conditions in the monument. Area wildlife is affected by habitat alteration from such matters as timber harvesting, gravel mining, farming and ranching, construction of homes and fences in rural areas, vehicular traffic on roads and highways, hunting, and others.

Compared to existing impacts, Alternative A would have a short-term negligible to minor cumulative impact to wildlife due primarily to temporary displacement while invasive plant control activities are being conducted. It is anticipated that troublesome invasive plants would decrease as a range of IPM techniques is implemented resulting in a long-term moderate benefit to wildlife. As native vegetation is restored and habitat improves, cumulative adverse impacts to wildlife would be ameliorated.

Conclusion for Alternative A

Alternative A would result in long-term beneficial effects to wildlife as negative impacts to wildlife habitat from invasive plants decrease. Biological control species may have potential long-term secondary impacts on native species and would be carefully evaluated before selected for use. None of the biological control organisms proposed for release in this Plan/EA are expected to cause adverse effects on native vegetation. Negative impacts from the use of herbicide are also expected to decrease as the number of acres requiring treatment decreases. Extreme caution would be used during herbicide applications and wetlands would be avoided to minimize possible negative impacts to wildlife, including invertebrates and aquatic species.

Impacts of Alternative B on Wildlife

The environmental consequences of using mechanical, cultural, biological and chemical methods are the same as in Alternative A with additional consequences associated with the use of aerial herbicide spraying and seeding. Long-term benefits to wildlife associated with controlling invasive plants and restoring native communities would be magnified.

Aerial application: As stated in Table 9, Imazapic is considered to be nontoxic to mammals, birds, fishes, and aquatic invertebrates. If ingested by mammals, imazapic is rapidly excreted in the urine and feces and does not bioaccumulate in animals. The potential exposure to wildlife following a labeled application of imazapic would not be expected to have any adverse effects. Imazapic is non-toxic to fishes and aquatic vertebrates with a 96 hour LD₅₀ value greater than 100 mg/L (compare with caffeine at 192 mg/L). Mitigation measures would minimize adverse effects to wildlife. Because of the large-scale nature of aerial spraying, adverse effects to the native vegetation of wildlife habitat would be minor to moderate and short-term and be restricted to areas already seriously impacted by invasive annual weeds such as cheatgrass and high intensity wildfire. Aerial seeding would more quickly establish native vegetation useful for wildlife. Stress or displacement of wildlife from the presence of aircraft for aerial spraying and seeding would cause minor to moderate and short-term impacts.

Cumulative Impacts

The baseline cumulative scenario is described above. Alternative B would have similar cumulative impacts as Alternative A. Alternative B would be able to optimize the full range of IPM techniques to treat significantly higher acreages of invasive plants maximizing benefits to wildlife habitat.

Conclusion for Alternative B

Alternative B would have the greater long-term benefits to wildlife. Negative impacts to wildlife habitat from invasive plants would further decrease under this alternative. Some wildlife might be temporarily disturbed in the short-term, but would benefit in the long-term. Wetlands would be avoided when using more aggressive techniques to minimize possible negative impacts to wildlife, including invertebrates and aquatic species.

Special Status Species

Studies demonstrate that invasive plants cause reduced abundance of and/or diversity of birds, reptiles, small mammals and insects (Huenke 1996). Habitat tends to degrade from the invasion of invasive plants, which has a direct impact on endangered, threatened and rare species (Olson 1995). Grass production can drop by as much as 90% with the expansion of invasive plants (Harris and Cranston 1988). This in turn reduces forage and cover for wildlife. Displacement of native plants by invasive plants may be a primary mechanism for global and regional loss of biodiversity (Stholgren 1999). Containing, controlling, and eradicating the priority invasive plants addressed in this IPMP (see Appendix D) would protect endangered, threatened, and rare species within the boundaries of the park and monument.

MVNP will seek concurrence with the U.S. Fish and Wildlife Service (FWS) Ecological Services, Colorado Field Office. On January 4, 2006, MVNP initiated discussions with the FWS. The initial Biological Assessment (BA) indicated implementation of the preferred alternative (Alternative B) is not likely to have an adverse effect the park's federally listed, candidate or rare species. A new BA addressing potential impacts to listed species and offering a similar conclusion will be sent to FWS during the comment period for this plan/EA. Formal consultation will be initiated over the use of aircraft in restoration work over habitat of the Mexican spotted owl.

Impacts of Alternative A on Special Status Species

There are no known federally listed threatened or endangered (T&E) plants within the boundaries of MVNP or YHNM, but twelve Special Status plant species are listed as rare by the CNHP and one other at YHNM (see Table 4 on Page 48). Among these is one candidate for federal listing, Schmoll's milkvetch. Each of these plant species is considered collectively in this impact analysis except in the case of Schmoll's milkvetch which is sometimes discusses individually. There are several species of listed wildlife that could occur, are known to occur, or historically occurred in MVNP and YHNM (see Table 6 on page 49). Most of these animals do not typically occur or no longer occur in MVNP or YHNM. This analysis will concentrate collectively on those species that still occur at MVNP and YHNM (Mexican spotted owl, American peregrine falcon, golden eagle, Colorado roundtail chub,

Townsend's big-eared bat) when appropriate; however, the Mexican spotted owl and roundtail chub are sometimes discussed individually.

Every area prioritized for invasive plant control work would be reviewed before treatments begin and work would be adjusted accordingly to protect these sensitive species. Surveys documenting rare plants have been ongoing for a number of years and all known rare plant locations are being mapped and entered into the park's Geographical Information System (GIS) database. In addition, rare plant locations are being assessed for threats by invasive plants. This information would be made available to crews involved in control efforts. Invasive plant prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. Long-term beneficial impacts on T&E habitat are expected as invasive plants are controlled and native communities are restored.

Mechanical Treatments

Removing invasive plants using tools would have negligible, short-term adverse impacts on federally or state listed threatened, endangered or rare species. Some soil erosion and loss of native plants may occur at the base of an invasive plant if it is dug or chopped from the ground. If a large patch is removed, this could increase the chance that rare plant species could be affected. Flagging would be used to identify known locations of rare plants when invasive plant control work is to be conducted nearby. If invasive plants are intermixed with rare plants, control work would be carefully done by hand pulling or digging. Currently, there are no known patches of invasive plants near known breeding locations of endangered, threatened, or rare wildlife species, with the exception of the Mexican spotted owl. Any work conducted in the vicinity of Mexican spotted owl breeding locations would be subject to existing regulations and mitigation. Gas powered mowers or string trimmers would not be used near endangered, threatened, or rare flora that has not been recently surveyed and flagged for avoidance.

Cultural Treatments

Restoration: The introduction of undesirable species through contaminated equipment, seed mixes, or through the improper selection of species for revegetation could impact sensitive plant species. Restoration activities could damage listed plants or disturb listed wildlife. Mitigation and conservation measures would keep these effects site-specific and of no consequence to T&E species.

Aerial seeding by helicopter would have short-term negligible impacts to threatened and endangered species. Potential impacts to Mexican spotted owl would be the temporary flushing of the birds. Aerial seeding is currently implemented through post-fire restoration operations. Aerial application of seed is proposed both on mesa tops as well as canyons. To mitigate disturbance to this species, applications would be timed outside of the nesting and breeding periods when spotted owls are known to be in the area and aircraft passes over occupied habitat would be held to a minimum. Restoring disturbed plant communities to natural conditions through revegetation efforts would provide a long-term benefit to T&E or rare species. The primary goal of revegetation efforts is to ensure that rare plant communities are protected. Genetic integrity and local genotypes of rare

plants must be preserved. Revegetation efforts near or among rare plants would be limited to the minimum necessary to ensure the preservation of the rare species and would rely heavily on passive (seeding) versus active planting.

Biological Control Treatments

The introduction of biological control agents may have unintentional effects on T&E wildlife by introducing a new food source. The effect may be positive or negative depending on what species utilize the new food source and how closely co-evolved are the various members of the affected ecosystem (e.g., birds, bats, insects, etc.). If generalists respond positively to the new food source, it may increase competition with other species, causing an overall decline in specialist populations. Biological control insects would be carefully chosen to ensure that they only feed on the invasive plants to be controlled. Because biological control agents considered for use have been tested for host specificity, there would be no known direct impacts to non-target T&E plant species. Over time, biological controls would have a long-term beneficial effect on T&E species' communities by reducing pressure and competition with invasive species. Native plant species are expected to benefit from the use of biological controls, which would also have a long-term benefit on threatened, endangered or rare species by enhancing habitat. The net impacts of biological treatments on T&E wildlife would therefore be indirectly beneficial, site-specific to park and monument-wide, long-term and minor.

Herbicide Treatments

As part of a unified IPM program, MVNP and YHNM would use the least toxic, most effective herbicides to control invasive plant populations. Herbicide use has the potential to create a short-term minor impact to endangered, threatened or rare species. If rare plants are found among invasive plants proposed for control by chemical means, further review would be required prior to chemical use. In some cases, herbicides have been used in Colorado among rare plant habitat. For instance, the herbicide Imazapic was researched and found not to have adverse effects on the plant species in the Fabaceae family (BASF Corporation, 2008) (Kaeser and Kirkman, 2010). Imazapic has been applied in MVNP in treatment areas with Schmoll's milkvetch (Fabaceae family). Potential impacts to rare plants would be reviewed by NPS Intermountain Regional wildlife and plant specialists and by the Intermountain Region IPM Specialist. If federally listed or candidate species are involved, the NPS would consult with the U.S. Fish and Wildlife Service (FWS). With the implementation of mitigation measures listed in Appendix A1 and A2, the risk of impacting T&E species and rare plants with chemical control would be reduced to a negligible level.

Herbicides have the potential to infiltrate ecosystems and some can bioaccumulate in wildlife. Contamination of sensitive plant species because of runoff or drift is unlikely except when heavy rainfall occurs soon after application or during high winds. For this reason, herbicides would not be applied under windy conditions or when rainfall is imminent, with the exception of Imazapic, which requires adequate soil moisture and/or a light rain for soil uptake. Long-term persistence of herbicides in the food chain, and subsequent toxic effects, is not expected to occur in MVNP and YHNM. This is primarily due to the chemicals proposed for use, the rates at which they would be

applied, and the quantities proposed to be used. The chemicals proposed for use do not contain organochlorines that can cause egg-shell thinning and other harmful effects to wildlife.

For the concentrations of herbicides proposed for use, the risk to fish and aquatic organisms is low. Herbicides would not be applied to aquatic vegetation or to stream side vegetation in or in the vicinity of roundtail chub habitat except with appropriate mitigations. Implementation of mitigation measures for protection of water quality can effectively minimize or eliminate most impacts to the aquatic environment, which includes habitat for the state designated Special Concern species, roundtail chub. Table 10 includes the impacts of herbicides proposed for use in MVNP to wildlife including special status wildlife species. Through dilution, the amount of herbicide that might reach the San Juan River would be negligible where the Colorado pikeminnow and razorback sucker may occur. Also refer to Table 8 for impacts to vegetation.

Table 10. Impact of Herbicides on Threatened, Endangered, and Rare Species

Herbicide (active ingredient)	Impacts of the Herbicide on Threatened, Endangered and Rare Species
Aminopyralid (ex. Milestone)	Contact with endangered, threatened or rare plants may injure or kill them so must be used with extreme caution around known locations of non-target and/or sensitive plants. Aminopyralid has been shown to be practically non-toxic to birds, fish, honeybees, earthworms and aquatic invertebrates. While slightly toxic to algae and aquatic vascular plants, the expected environmental concentration resulting from invasive plant control applications is orders of magnitude below any level of concern established for these organisms by the EPA. The acute mammalian toxicity is low. The acute oral LD ₅₀ and dermal LD ₅₀ in rats were greater than 5000mg/kg and acute inhalation LD ₅₀ was greater than 5.5 mg/L. It is not carcinogenic, teratogenic, mutagenic, neurotoxic or a reproductive hazard.
Chlorsulfuron (ex. Telar)	Contact with endangered, threatened or rare plants may injure or kill them so must be used with extreme caution around known locations of non-target and/or sensitive plants. It is practically nontoxic to most fishes and aquatic invertebrate animals. It does not bioaccumulate in fishes. It is practically nontoxic to birds and mammals. It is not considered a hazard to threatened, endangered or rare species or other species of animals. Should be used with caution near any known locations of sensitive wildlife. It is not known to be carcinogenic to animals.
Clopyralid (ex. Transline)	Contact with non-target plants may injure them, so clopyralid should be used with caution around known threatened, endangered or rare plants. It has low toxicity to fishes and aquatic invertebrate animals. It does not bioaccumulate in fish tissues. It has low toxicity to birds and mammals and is not toxic to bees. However, clopyralid can cause severe eye damage to mammals including permanent loss of vision. It is not classified as a carcinogen, teratogen, mutagen, or reproductive inhibitor.
Glyphosate (ex. Rodeo)	The Rodeo formulation of Glyphosate is the one of only a few herbicides approved for controlling invasive plants in delicate aquatic environments. Contact with threatened, endangered or rare plants may injure or kill them so non-target plants must be protected. Glyphosate has an intermediate to acute toxicity to freshwater fish and aquatic invertebrates. Glyphosate is practically nontoxic to birds and mammals. It is practically nontoxic to bees but exposure to freshly dried Glyphosate killed over 50% of three other species of beneficial

Herbicide (active ingredient)	Impacts of the Herbicide on Threatened, Endangered and Rare Species
	<p>insects: a parasitic wasp, lacewing, and a ladybug. The surfactant MONO818 included in Roundup may interfere with cutaneous respiration in frogs and gill respiration in tadpoles and is highly toxic to fishes. MVNP will avoid using MONO818 in the vicinity of water resources. Glyphosate and its formulations have not been tested for chronic effects in terrestrial animals, but do show blood and pancreatic effects during subchronic feeding studies with rats and mice. Some studies indicate that glyphosate does not cause genetic damage, but other studies have shown that both glyphosate and glyphosate products are mutagenic. Glyphosate may be a hazard to threatened, endangered, or rare species if applied to areas where they live.</p>
Imazapic (ex. Plateau)	<p>Imazapic is not mutagenic or teratogenic and would not be expected to have any adverse effect on wildlife. Imazapic is considered nontoxic to mammals, aquatic invertebrates and birds, but is of moderate toxicity to fishes. Imazapic is nontoxic to bees. It does not have the potential to “mimic” estrogen, nor can it be considered an endocrine disrupter. It is considered nontoxic to mammals through physical exposure or ingestion. If ingested, Imazapic is rapidly excreted in the urine and feces and does not bioaccumulate in animals. It is also highly unlikely to move through the food chain. However, no specific toxicology studies have been conducted on amphibians, although impacts to these sensitive species should have no adverse effect based on research on other species.</p>
Imazapyr (ex. Habitat)	<p>Imazapyr works by inhibiting a biosynthetic process which occurs in plants, but not animals. Contact with non-target sensitive plants may injure or kill them. It is essentially non-toxic through physical exposure or ingestion to mammals, birds, fishes and aquatic invertebrates. If ingested, imazapyr is rapidly excreted in the urine and feces and does not bioaccumulate. It is not mutagenic or teratogenic and would not be expected to have adverse effects on mammals.</p>
metsulfuron methyl (ex. Escort)	<p>Contact with non-target sensitive plants may injure or kill them. It is practically nontoxic to fishes and aquatic invertebrates. It does not bioaccumulate in fish. It is practically nontoxic to birds and mammals. It is practically nontoxic to bees. It may be a hazard to threatened, endangered or rare plants, and has to be used around known locations of these plants with extreme caution, and buffer zones must be established. It is not considered a hazard to endangered, threatened or rare animals.</p>
Picloram (ex. Tordon)	<p>The preponderance of data shows Picloram to be non-mutagenic in ‘In vitro’ (test tube) tests and in animal test systems. However, one study found that chromosome aberrations increased in frequency in hamster ovary cells exposed to picloram. Some other recent studies show additional evidence of mutagenicity. The herbicide is slightly to moderately toxic to aquatic organisms on an acute basis (LC₅₀/EC₅₀ between 10 and 100 mg/L in most sensitive species). There is evidence that picloram is lethal to fish at a concentration of 1 ppm. Picloram has very low toxicity to soil microorganisms at up to 1,000 ppm. Picloram is almost nontoxic to birds. It is relatively nontoxic to bees. Picloram is low in toxicity to mammals; animals excrete most picloram in the urine, unchanged. Picloram may be a hazard to threatened, endangered or rare plants when used on or near them. Picloram may be a hazard to some invertebrates if it is applied to areas where they live. There are no federally threatened or</p>

Herbicide (active ingredient)	Impacts of the Herbicide on Threatened, Endangered and Rare Species
	endangered invertebrates in the park. It is not expected to be a hazard to other threatened, endangered or rare animals.
Triclopyr (ex. Garlon)	Contact with non-target sensitive plants may injure or kill them. Avoid drift around known locations of sensitive plants by establishing buffer zones. Triclopyr has low toxicity to fishes and is not known to accumulate in fishes. If deemed necessary to treat invasive plants near water, a wick or paste applicator may be used with basal bark or cut stump applications in order to avoid water contamination. Triclopyr rapidly breaks down in water to a less toxic form. It is slightly toxic to nontoxic to invertebrates. It is slightly toxic to mammals, and mammal species that feed on short grasses are the most susceptible to possible acute impact from the use of triclopyr TEA and BEE above 3.0 lb. ae/A. Although the persistence of triclopyr acid/anion on avian food items is unknown, it is possible environmental concentrations would remain high enough for sufficient duration to produce some chronic effect(s) when triclopyr is used at higher amounts. The triclopyr degradate, TCP, is more toxic than the TEA or triclopyr acid and is similar to BEE in acute toxicity to fishes. The EPA is currently requiring additional confirmatory data to better characterize the fate and chronic toxicity to fishes of triclopyr degradate TCP. Mammals excrete most of it unchanged in urine. It has low toxicity to birds and is nontoxic to bees. It has not been tested for chronic effects in terrestrial animals. In an eight-day dietary study on birds, the LC ₅₀ ranged from 2,935 to greater than 5,000 ppm.

Cumulative Impacts

The past activities within the region that have had the greatest potential impact upon T&E and listed species have included development, the degradation of habitat by livestock, oil and gas activities, and fire suppression activities. Present and reasonably foreseeable potential activities that would have an effect upon special status species would include:

YHNM land acquisition proposal: Negotiations have been underway with a neighboring landowner that could result in the NPS acquiring 160 acres of shrubland adjoining YHNM. This acquisition would put this land under the protection of NPS stewardship, which would likely reduce the threat that the land would be widely developed, thus buffering special status plants in the existing monument from outside encroachment. It is possible that some additional special status species may be found in the addition lands.

MVNP Mancos River Corridor Restoration Plan: This plan was approved in 1998 and immediately implemented. Over subsequent years park staffs have used herbicides, biological controls, and cultural methods to restore more natural conditions to Mancos Canyon. This has included exclusion of livestock grazing, some tree planting, elimination of tamarisk and Russian olive trees, seeding native grasses, and spraying stands of Russian knapweed, cheatgrass, and whitetop. The growth of native cottonwood, willow, and other native plants has responded well. Attempts to stabilize head-cutting gullies in the shale alluvium have had mixed results but overall the project's effects have been positive. Habitat for special status wildlife, such as sensitive native fishes and migratory birds,

are in better condition than what would have existed without it. Ongoing efforts against Russian knapweed would continue this improvement in more upland habitat.

MVNP wildfires and burned area emergency rehabilitation plans: Sedimentation from flash flooding after major wildfires has affected multiple drainages in the park. Thousands of acres of old-growth forests and shrublands have been converted to early seral stages of regrowth. A spate of wildfires struck MVNP multiple times since 1972, the beginning of the modern era when erosion and invasive plant issues first became a priority. Post-fire rehabilitation efforts have been coordinated to reduce soil erosion and to suppress the establishment of invasive species using native grasses dropped as seed from helicopters. Additional care would be taken after future fires to ensure the seeded species do not excessively compete with rare plant species and herbicide treatments against invasive species similarly do not put rare plants at risk. These efforts have helped reduce impacts to rare plants from erosion and invasive plants and wildlife in sensitive habitats such as the Mancos River. Nevertheless, impacts to crucial habitat for special status species were caused by these and other conditions such as the accidental fire retardant drop into the Mancos River during the 2000 Bircher Fire. Many thousands of acres of old-growth forest and shrubland habitat have been converted to early seral vegetation stages in MVNP. This has disfavored tall tree and closed canopy species such as the threatened Mexican spotted owl.

2015 Fire Management Plan: This plan would result in long-term impacts to the park landscape by reducing the chance of catastrophic fire through alteration of fuels over a large area. By reducing the size of large wildfires, the plan could help maintain forested wildlife habitat needed by special status species such as the threatened Mexican spotted owl. Habitat alterations resulting from fuels treatment would have local level adverse impacts on habitat quality. This plan's actions would cause long-term impacts to special status plant species during the course of cutting and hauling fuel and burning slash piles. Fuel management activities also could encourage the growth of competitive invasive plants. Tree removal in Mexican spotted owl habitat also could disturb the birds and reduce habitat quality. However, fuel reduction may reduce the chance of catastrophic wildfire which would have much more extensive impact on the owl's limited habitat. Marking and avoiding rare plant locations before fuels treatments would help protect species such as the Schmol's milkvetch. Ensuring that fire retardant is kept out of the Mancos River would help prevent a repeat of the Bircher Fire fish kill incident of 2000.

Related to the new fire management plan is a possible proposal to develop a new helicopter base somewhere on Chapin Mesa in MVNP. Bringing helicopter operations into MVNP with the expected frequent low level flights over the park could cause a substantial increase in stresses on any Mexican spotted owls occupying the adjacent proposed Protected Activity Centers. Strict flight paths that limit the noise intensity and duration disturbing sensitive habitat would be prescribed by park management. Construction of the helibase on Chapin Mesa likely would result in the direct loss of some Schmol's milkvetch plants, a candidate for the federal list of Threatened and Endangered Species.

Livestock control efforts: Since their earliest years, the NPS has struggled to exclude cattle, horses, sheep, and other livestock from parklands at MVNP and YHNM. Especially in proximity to water

sources, grazing and browsing by livestock damage vegetation, compact and expose soil to erosion, and leave the landscape more vulnerable to the spread of invasive plants. Improved fencing in recent years has eliminated the problem from YHNM but loose unclaimed livestock persist in MVNP. Intermittent capture and removal operations kept livestock numbers down in past years. Impacts to sensitive species would diminish as livestock numbers decline as a result of new livestock control efforts.

The park's inability to effectively diminish or control livestock throughout most of MVNP has contributed to many resource impacts including the threat of consumption of rare plants such as the Schmoll's milkvetch. Livestock also have supported small numbers of brown-headed cowbirds, a brood parasite which lay their eggs in the nests of native songbirds which results in the reduction or elimination of their own reproductive effort. If special status migratory songbirds were to nest in the park, such as the southwestern willow flycatcher, their nests could become vulnerable to cowbirds.

MVNP Visitor Distribution and Transportation Plan: By opening access and new activities into areas that currently are not open to public use, this plan could impact special status species directly from an increase in disturbances (noise, presence of humans) in or near habitat important for nesting Mexican spotted owls or trampling of special status plants, such as the Schmoll's milkvetch.

Paths to Mesa Verde: For several years there have been discussions about establishing a public recreational trail connecting the towns of Cortez and Mancos that would pass through the northern tip of Mesa Verde National Park. The path of the potential trail is not known but its construction could lead to habitat loss and further trampling of special status plants such as the alkaline pepperweed.

MVNP road construction and major maintenance projects: Over the years MVNP has undergone numerous ground disturbing activities including repaving all its roads, reengineering road cuts in steep parts of the road system, installing new water, sewer and other utility lines, new construction of buildings and other facilities, etc. Despite implementation of mitigation measures, past actions have resulted in some losses to special status plants such as the Schmoll's milkvetch from excavation and paving. Better planning in future projects could reduce these kinds of impacts but the large number of facilities located in Schmoll's milkvetch habitat will mean that future losses probably cannot be avoided.

MVNP Concessions Contract: The concessionaire for MVNP has operated under contract which includes stipulations related to maintaining the grounds around their facilities. They have been expected to trim vegetation, control invasive plants, minimize and mitigate ground disturbances, and coordinate with park managers. In 2014, the NPS established a new concessions contract that includes and strengthen stipulations related to protecting special status species such as the Schmoll's milkvetch around the Spruce Tree Terrace facility.

Revision of the San Juan National Forest Plan and the BLM Tres Rios Field Office Resource

Management Plan: Implementation of this plan would have various minor to moderate, long-term adverse and beneficial effects on special status species. Although it attempts a more ecosystem-based management approach, continued extractive and recreational activities also will continue to

adversely affect special status species. Both the USFS and the BLM monitor special status species and implement conservation measures to reduce impacts; however, it is likely that adverse impacts will occur.

Other external impacts on special status species: Reasonably foreseeable actions outside of Mesa Verde would include fire management and fuels treatment activities outside the park, much of which would take place on adjacent Ute Mountain Ute tribal land, private, and other federal lands. Although no projects are currently planned for these areas, future management could include reductions in the spread of invasive plants, management of fuels and firefighting under current federal wildland fire management policies, and protection of riparian resources. The continued withdrawal of large volumes of water from the Mancos River watershed for irrigation and domestic and commercial uses will continue having a large effect on fish habitats of the Mancos River inside the park and beyond. Special status species in the area can be affected by habitat alteration from such matters as timber harvesting, gravel mining, farming and ranching, construction in rural areas, vehicular traffic on roads and highways, recreational activities, and others.

Alternative A would have a negligible to minor cumulative impact to endangered, threatened and rare species due primarily to areas being surveyed for these species before control occurs. It is anticipated that troublesome invasive plants would decrease as the full range of IPM techniques are implemented. Appropriate mitigation and conservation measures would minimize identified short-term impacts to these species. As native vegetation is restored and habitat improves, cumulative impacts to endangered, threatened and rare species would be ameliorated.

Conclusion for Alternative A

Alternative A would result in long-term benefits to endangered, threatened and rare species by effectively controlling invasive plants. There would be an increase in the availability of or improvement of habitat for breeding, nesting, and feeding for fauna and a decrease in competition between native flora and invasive plants. Herbicide treatments can present some risks to threatened, endangered and rare species, especially for plants. The herbicides and amounts proposed for use in MVNP and YHNM are expected to pose little risk to animals but could be a risk to rare plants. With the implementation of mitigating measures (refer to Appendix A1 and A2) such as mapping of known locations of rare plants and establishing buffer zones, the risk would be kept to a minimum. Being proactive versus reactive in preventing the spread of invasive plants would be a long-term minor benefit to threatened, endangered or rare species.

Impacts of Alternative B on Endangered, Threatened, and Rare Species

The environmental consequences of using mechanical, cultural, biological and chemical methods are the same as Alternative A with the addition of aerial spraying of herbicides, biological organisms developed in the future, and the possibility of additional aerial seeding after wildfire.

Aerial application: Aerial spraying and seeding is proposed only for an extremely selective herbicide with low toxicity and for native plant species seeds. A Biological Assessment (BA) was prepared for this project to evaluate potential effects of aerial application on federally listed species. The BA evaluated the potential effects of implementing the proposed action on T&E species that are known

to occur or have potential to occur in the treatment area. A number of conservation measures have been developed to mitigate potential impacts to T&E species and are fully described below. These measures are considered part of the proposed action. Although candidate species are not afforded the same protection under the ESA, efforts would be made to avoid or minimize potential impacts to these species as well because NPS policy requires candidates be protected as if they were listed.

Conservation/Minimization Measures

Conservation measures are actions to benefit or promote the recovery of listed species that are included by the Federal agency as an integral part of the proposed action. These actions would be taken by the Federal agency and serve to minimize or compensate for project effects on the species under review. Mitigation efforts that would directly reduce potential adverse impacts to the Mexican spotted owl and its habitat from aerial spraying and seeding actions would include:

- Conducting surveys for the MSO as prescribed through consultation with the designated USFWS biologist. Typically this requires annually conducting at least four call surveys following the standardized methods for MSO by a biologist with certified training in these methods. Additional call surveys would be conducted shortly after a wildfire to determine the presence or absence of MSO in proximity to any needed aerial application of pre-emergent herbicide in late summer or for fall season aerial seeding.
- If surveys have detected MSO in areas near target treatment sites, MVNP will consult with USFWS before proceeding with treatments.
- If USFWS grants permission to proceed with treatments near MSO active roosting or nesting sites, MVNP staff will monitor the status of these owls and their response to treatment. Findings will be reported to USFWS.
- Aerial applications would not be carried out within 100 yards of active roosting or nesting sites from March 15th to August 30th, and helicopter flight paths would avoid detection sites and proposed PAC core areas except where necessary for the application. Flight time over these sensitive areas will be held to a minimum with ferrying flight lines diverted away from them.
- Aerial applications of imazapic, seeds, or biological control agents would be restricted to daylight hours during the late summer or fall (after August 15) when the MSO and their nestlings are less vulnerable to disturbance; when perennial plants are dormant or less fragile; and when other wildlife are done breeding and young are more capable of escaping.
- A natural resource monitor would be available throughout the project to ensure mitigation measures are carried out according to specifications.
- Contractor(s) would be informed of these mitigating measures and any additional stipulations applied to a contract and made responsible for adherence to them.
- Water influence zones are defined as the land next to water bodies where vegetation plays a major role in sustaining long-term integrity of aquatic systems. The water influence zone

varies, but a typical buffer zone would be 100 feet from the top of each stream bank, or a distance equal to the mean height of mature dominant late-seral upland vegetation, whichever is greater. Hand applications would be conducted when feasible in the narrower areas of canyons with water resources. The vast majority of the canyon bottoms are dry, making them suitable for aerial application.

- Buffer zones would be identified using GPS to avoid open water, habitat for rare plants and animals, and desired vegetation. Buffers will be a minimum of 100-feet, and shall be larger where required by applicable law, regulation or policy. The slope of the treatment area will be considered when choosing buffer distances for sensitive resources; 0-5% slope would be at least 100 feet, 5-15%:125 feet, 15-35%:150 feet, 35-55%: 175 feet, 55-75%: 200 feet; herbicide would not be applied on slopes greater than 75% in the vicinity of water or sensitive resources.
- Application methods and equipment would be selected to minimize potential for drift and off-target impacts while meeting invasive exotic plant control objectives. Drift reduction techniques would include low-pressure spray of less than 30 psi, appropriate nozzle size and type, and keeping spray nozzles close to the ground.
- No aerial herbicide applications would be made in moderate (10 mph) or greater or gusty wind conditions.
- MVNP would disseminate information to staff and visitor use rangers on various control projects as to how and why particularly loud techniques, such as helicopters, are necessary to accomplish project goals.
- The helicopter would avoid sensitive times within sensitive areas such as documented roosting areas and active nesting and fledging areas during the breeding to fledging season, February through August.

One of three possible determinations was chosen for each listed species analyzed in the BA. The three possible determinations are:

“No affect” – where no effect is expected;

“May affect, not likely to adversely affect” – where affects are expected to be beneficial, insignificant (immeasurable), or discountable (extremely unlikely); and

“May affect, likely to adversely affect” – where affects are expected to be adverse or detrimental.

For most special status species there would be no effect from implementing Alternative B. Based on a thorough analysis of the potential effects founded on the best available scientific literature and the professional judgment of the biologists and ecologists, the proposed actions under this (preferred) alternative may affect, but are not likely to adversely affect the other special status species which are found or could potentially be found within the park or monument’s boundaries with the exception of the Mexican spotted owl (MSO). Concurrence will be sought from the USFWS on these determinations on federally listed species and formal consultation for “take” and a

biological opinion will be sought regarding the impacts that could occur on MSO from aerial restoration work.

Cumulative Impacts

The baseline cumulative scenario is described above. Alternative B would have a negligible to minor cumulative impact to endangered, threatened and rare species due primarily to areas being surveyed for these species before control occurs. It is anticipated that troublesome invasive plants would decrease as the full range of IPM techniques are implemented. Appropriate mitigation and conservation measures would minimize identified short-term impacts to these species. As native vegetation is restored and habitat improves, cumulative impacts to endangered, threatened and rare species would be ameliorated.

Conclusion for Alternative B

Alternative B would result in the greater long-term benefit to threatened, endangered and rare species as more acres of invasive plants could be treated. Using the full range of IPM techniques available to manage invasive plants gives resource managers the best chance of restoring native plant communities and their ecological function to the benefit of all special status species. Beneficial effects to T&E species habitat would be detectable and readily apparent. Overall beneficial effects to habitat would be greater under this alternative because the tools available have the potential to address the scale of management necessary to affect positive change in preferred habitat. The minor, short-term, adverse impacts would be outweighed by the long-term benefits of habitat restoration. The impacts of integrated plant management techniques on T&E species would therefore be beneficial, park and monument-wide, long-term, and minor to moderate with minor short-term adverse impacts.

Wilderness

Currently, detected populations of targeted invasive species are not at threshold levels for treatment in the park's 8,500 acres of Wilderness. For example, musk thistle may occur in low densities, particularly when occurring on Mancos Shale soils where it does not compete well with native vegetation. Other than aerial seeding, such as what took place on MVNP's East Escarpment Wilderness area after the Bircher Fire to reduce heavy sedimentation into the Mancos River, no previous treatments have been exercised that would directly affect invasive plants in the Wilderness areas of MVNP.

Conducting a Wilderness minimum requirements analysis follows the direction of both law and agency policy and helps land managers make informed decisions. Management of wilderness in the NPS is guided by *NPS Management Policies* (NPS 2006) and *Director's Order/Reference Manual #41: Wilderness Preservation and Management*. DO-41 directs: Potential disruption of wilderness character and resources and applicable safety concerns would be considered before, and given significantly more weight than, economic efficiency and convenience. If a compromise of wilderness resources or character is unavoidable, only those actions that have localized, short term adverse

impacts would be acceptable. Any prohibited use proposed in wilderness for non-emergency activities must be considered and documented with a Wilderness minimum requirement analysis.

The Minimum Requirements Decision Guide, 2014 Revision, or MRDG, developed by the interagency Arthur Carhart National Wilderness Training Center (Wilderness.net), is the tool of choice for performing the Wilderness minimum requirement analysis. The MRDG is designed to assist Wilderness managers in making stewardship decisions. The analysis would be used to address future proposed actions in the Mesa Verde Wilderness consistent with the methods prescribed in the IPMP including 1) post-fire aerial application of pre-emergent herbicide against cheatgrass, if needed, 2) aerial application of biological pesticides or other biological control agents against cheatgrass or other invasive plants, if needed, and 3) post-fire aerial application of native plant seed to control post-fire erosion and compete against invasive plants, if needed.

At this time there are no plans to conduct any invasive plant control work in the Mesa Verde Wilderness, thus there is no actual project for which the minimum requirement analysis can be performed in advance for the IPMP EA. If such a future necessity arises and a proposal is developed, the Wilderness minimum requirement analysis would first include a determination of whether such use is necessary for the administration of the area as Wilderness, and if so, would then determine the minimum method or tool that causes the least amount of impact to the physical resources and experiential qualities of Wilderness, as well as a discussion of the alternatives considered.

The impact analysis for the IPMP's EA is performed here with regard to Wilderness Character, both individually and collectively.

The Five Qualities of Wilderness Character

- Natural Conditions
- Untrammelled by Man
- Undeveloped
- Solitude or Primitive and Unconfined Recreation
- Other Features of Value (ecological, geological, scientific, educational, scenic, historical)

The following is an analysis of impacts on Wilderness in the event that high priority species were detected or threshold levels were reached and control measures were implemented in Wilderness. The analysis related to the Mesa Verde Wilderness' historical values (Other Features of Value) will be discussed park-wide in the Cultural Resources section which immediately follows this section on Wilderness.

Impacts of Alternative A on Wilderness

Prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis. Overall, long-term beneficial impacts on the Wilderness are expected as invasive plants are controlled and native communities are restored.

Mechanical Treatments

In the event invasive plants are detected and targeted for treatment in Wilderness, removal would be completed with the minimum tool necessary. Chainsaws, weed trimmers, and other mechanized equipment would be prohibited. Only manual tools would be permitted. Short-term negligible adverse impacts may occur to the Natural Conditions and Untrammeled by Man Wilderness character qualities resulting from interventions implementing appropriate invasive plant management techniques.

Cultural Treatments

Restoration: Restoring disturbed plant communities to natural conditions by revegetating disturbed sites through aerial or ground level seeding would have a long-term minor benefit on Wilderness but also short-term minor adverse effects, temporarily diminishing the Wilderness Character qualities of Natural Conditions and Untrammeled by Man resulting from IPM interventions. Negligible to minor short-term adverse effects may result as competition from seeded native grasses may suppress native pioneer forb species.

Biological Control Treatments

Biological control insects that target musk thistle are already established in MVNP. Releasing more of these weevils to control thistles after a future wildfire in MVNP could result in long-term benefits to Wilderness by speeding up invasive plant control without setting a new precedent. There is a potential risk that some biological control organisms could evolve over the long-term and have a negative impact on native flora and fauna and consequently on Wilderness. Negligible to minor short and long-term adverse effects to Wilderness Character qualities of Natural Conditions and Untrammeled by Man may result from further encouraging non-native biological agents. As discussed in the soil and vegetation analysis, careful screening of these organisms would minimize this risk and impacts.

Herbicide Treatments

To date there has been no use of herbicides in the MVNP Wilderness areas. This is because the remote and difficult terrain would make ground application with hand and backpack sprayers rather impractical. Nevertheless, such an approach could become a high enough priority to implement if, for instance, a high priority invasive plant species were detected. Use of saddle stock to access some remote sites could supply enough water and personnel to carry out such a project. Specific chemical impacts to natural resources such as wildlife, endangered, threatened or rare species, aquatic resources, air, soil and vegetation are discussed elsewhere in this EA, and would apply to those resources in designated Wilderness areas although the scale would be expected to be much smaller than in the developed parts of the park.

The use of herbicides may temporarily have a minor adverse impact on Natural Conditions and Untrammeled by Man qualities of designated Wilderness. Herbicides have the potential to enter ecosystems. Contamination of sensitive habitat or wildlife in designated Wilderness because of runoff or drift is unlikely except during high winds and when heavy rainfall occurs soon after

application. For this reason, herbicides would not be applied when rainfall is imminent, with the exception of Imazapic, where adequate soil moisture and/or light rain is important for soil uptake, and when moderate or greater winds are blowing.

Implementation of mitigation measures, including the use of buffer zones (please refer to the mitigation measures in Appendix A1 and A2) would help protect aquatic organisms and species that utilize riparian habitat for food within designated Wilderness.

Cumulative Impacts

Ongoing impacts to the character and values of the Mesa Verde Wilderness involve the ongoing development of Montezuma County lands that is in plain view from most of these Wilderness acres. Automobile sounds, aircraft, night lights, and air pollution all reduce the qualities of Natural Conditions, Untrammeled by Man, and sense of Solitude. Past, present and reasonably foreseeable actions include development projects, fire suppression activities and fuel treatment activities inside of MVNP and on adjacent lands. These projects could also increase invasive plant species, which would be an undesirable effect to Wilderness. Relevant actions include:

Fire Management Plan: Hazardous fuel reduction activities under this plan are not expected to take place in the Mesa Verde Wilderness, but those treatments in conjunction with fire suppression activities in the event of a wildfire could reduce the chance of catastrophic wildfire which would have a much more extensive benefit for the condition of the Wilderness areas by reducing the landscape's vulnerability to post-fire impacts such as erosion and invasion by invasive plants. However, suppression activities also would include the short-term use of low-flying aircraft. Establishment of a helicopter base inside MVNP could substantially increase the number of Wilderness area flybys in the park. Strict flight paths that limit the noise intensity and duration disturbing sensitive areas would be prescribed by park management.

MVNP burned area emergency rehabilitation plans: Only the post-wildfire response after the Bircher Fire involved any treatments in the Mesa Verde Wilderness. This involved low flying helicopter seeding over the East Escarpment and other parts of the eastern unit. Such activities could occur again with a future fire in the Wilderness area.

MVNP livestock control efforts: Past and foreseeable future efforts to control livestock in the park would include fence construction along priority segments of the MVNP boundary. However, due to the remote and rugged terrain, helicopter ferrying of equipment, supplies, and possibly workers would be highly desirable because a helicopter would offer the safest and most cost-effective transport method. Such events would be expected to take place in Wilderness areas only on rare occasions so the impacts would be small and temporary. Impacts to natural resources in Wilderness areas would diminish as livestock numbers decline as a result of new livestock control efforts.

Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource

Management Plan: Implementation of this plan would have various negligible to minor to moderate, long-term adverse effects on Wilderness. Although it attempts a more ecosystem-based management approach, continued extractive and energy producing activities near the park could adversely affect Wilderness values at MVNP.

The impacts of the above actions, in combination with the impacts of Alternative A would result in a regional, adverse, minor and long-term cumulative impact to Wilderness.

Residential, agricultural, and commercial developments around MVNP: As human populations increase in extent and density, it is expected that there will be more alteration of the county's landscape by human activities that are within visual and auditory range of the Mesa Verde Wilderness.

Implementing Alternative A would contribute negligible to minor short-term cumulative impacts to Wilderness character values with long-term minor benefits. It is anticipated that troublesome invasive plants would decrease as IPM techniques are implemented. As native vegetation is restored and habitat improves, cumulative impacts to Wilderness would be ameliorated. If invasive plants spread into Wilderness, likely effects would include increased soil erosion, loss of native plant biodiversity and wildlife habitat. Mechanical, cultural and chemical controls would be required, which would create additional cumulative impacts to Wilderness.

Conclusion for Alternative A

Overall, implementing Alternative A would have long-term minor benefits to the Mesa Verde Wilderness. The long-term integrity of Wilderness values would be protected and enhanced. The goal is to aggressively control invasive plants in areas outside designated Wilderness to prevent the spread of invasive plants into designated Wilderness. Currently, the bulk of the 13,000 acres of land infested with invasive plants occurs outside Wilderness, but this could change in the future.

Mechanical and chemical control may impact Wilderness values in the short-term, but would benefit Wilderness values in the long-term. The minimum tool concept would be used for invasive plant management activities that are proposed to occur in Wilderness. No vehicle, such as a tractor, UTV or ATV, would be allowed in designated Wilderness. Backpack sprayers and helicopters may be used to chemically treat invasive plants in designated Wilderness should it become necessary in the future due to a new infestation. However, by being proactive, it is anticipated that invasive plants would not become a serious problem in Wilderness. Helicopter seeding impacts would be adverse, direct, minor, short-term with indirect, minor, long-term beneficial impacts.

Impacts of Alternative B on Wilderness

The environmental consequences of using cultural, biological, and mechanical methods would be the same as Alternative A including aerial seeding.

Aerial application: If cheatgrass becomes a problem in Wilderness, aerial spraying of herbicides and biological control organisms would be considered. Aerial application of herbicide and biological control organisms would have similar adverse impacts to Wilderness character and values as aerial seeding (which would continue to be available as it is under Alternative A) resulting in short-term minor adverse effects, temporarily diminishing the Wilderness Character qualities of Natural Conditions and Untrammelled by Man.

Cumulative Impacts

The baseline cumulative scenario would be the same as Alternative A. Alternative B would have a negligible to minor short-term cumulative impact to Wilderness with a long-term moderate benefit. It is anticipated that troublesome invasive plants would decrease as the full range of IPM techniques are implemented. As native vegetation is restored and habitat improves, cumulative impacts to Wilderness would be ameliorated. If invasive plants spread into Wilderness, likely effects would include increased soil erosion, loss of native plant biodiversity and wildlife habitat. Mechanical, cultural and chemical controls would be required, which would create additional cumulative impacts to Wilderness.

Conclusion for Alternative B

Alternative A and Alternative B would have the same long-term benefits to Wilderness, but benefits for Alternative B would be greater because of the better potential to deal with future invasive plant problems using an expanded array of tools. The long-term integrity of Wilderness values would be protected and enhanced. The goal is to aggressively control invasive plants in areas outside designated Wilderness to prevent the spread of invasive plants into designated Wilderness. Currently, the bulk of the 13,000 acres of land infested with invasive plants occurs outside Wilderness, but this could change in the future.

Mechanical and chemical control may impact Wilderness values in the short-term, but would benefit Wilderness values in the long-term. The minimum tool concept would be used for invasive plant management activities that are proposed to occur in Wilderness. No vehicles, such as a tractor, UTV or ATV, would be allowed in recommended or designated Wilderness. Backpack sprayers and helicopters may be used to chemically treat invasive exotic plants in designated Wilderness should it become necessary in the future due to a new infestation. However, by being proactive, it is anticipated that invasive plants would not become a serious problem in Wilderness. Helicopter impacts from both alternatives would be adverse, direct, minor, short-term with indirect, moderate, long-term beneficial impacts for Alternative B.

Cultural Resources

Invasive plants may have long-term negative impacts on archeological sites due to the alteration of native vegetation landscape contexts, the potential for increased soil erosion, and by elevating the risk of damage to cultural materials from wildfire. In general, removal of invasive plants would contribute to the physical restoration and maintenance of archeological resources and quality of the ethnographic and cultural landscapes in the park and monument. Long-term beneficial impacts on cultural resources are expected with all IPM techniques as invasive plants are controlled and native communities are restored. All treatments around sites listed in the National Register of Historic Places should be planned and implemented in accordance with DO-28 (USDI, 1998).

Impacts of Alternative A on Archeological Resources

Invasive plant prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis.

Mechanical Treatment

Ground disturbing activities, such as digging invasives, clearing vegetation, pulling invasives, or using a string trimmer, could have a short-term minor adverse impact on archeological resources by contacting or displacing them. Ground-disturbing activities, such as plowing/disking or digging could further damage sensitive and fragile archeological sites, particularly unknown sites. These types of activities would be performed in areas suspected or known to contain resources of historic value only after consultation with the staff archeologist, and SHPO if necessary. Mechanical treatments would be deferred if necessary. The adverse impacts of mechanical treatments to archeological resources would therefore be negligible to minor, site-specific, and short-term. In the long-term, the removal of invasive plants would have minor beneficial effects for the protection of prehistoric or historic archeological sites by protecting and enhancing native plant communities that stabilize the soil.

Cultural Treatment

Restoration: Ground disturbing activities related to revegetation work (raking soil, digging in new plant materials, and vehicle (UTV, tractor) and foot traffic could potentially damage previously undiscovered artifacts through direct contact or displacement. However, restoration efforts are generally conducted in highly disturbed and previously surveyed areas. Restoration in areas not surveyed for cultural resources would be carefully inspected by staff archeologists before work is initiated. Therefore, impacts to archeological resources from restoration activities would be long-term, negligible and beneficial.

Biological Control Treatment

There would be no adverse impacts to archeological resources from the implementation of biological control methods. Beneficial effects would be long-term and minor to moderate resulting from the enhancement of native vegetation that tends to stabilize the soil.

Herbicide Treatment

Protection of archeological resources would be included in training programs for the invasive plant seasonal work crews, contractors, or anyone else involved with invasive plant eradication work in MVNP and YHNM. Within archeological sites, invasive plant control techniques using chemical applications only would be employed that would minimize the risk of contacting sensitive historic fabric/materials and minimize the amount, degree, and persistence of the chemicals at the site, especially in the soil.

The potential short and long-term effects of herbicides on prehistoric structures made of various materials, such as wood and stone, are not well understood. No herbicides would be applied directly to prehistoric structures, making effects to these sites incidental and negligible. A one-foot buffer or

physical shielding would be implemented while applying herbicide in the vicinity of archeological resources. In addition, dye would not be used and herbicide would be applied in no wind conditions. Use of these management practices would not alter or diminish the overall character or features of National Register eligible or listed prehistoric structures.

The impact analysis section for Vegetation and Soils thoroughly describes how the IPMP would affect the physical nature of the park environment, both beneficial and adverse, including potentially within the many hundreds of archeological sites in the park and monument. Invasive plant control and the promotion of native plants curtail soil erosion, which is a major concern for protecting the integrity of archeological sites. However, mechanical control techniques are not effective in many circumstances and they can lead to more soil impacts and erosion. In many situations and with many invasive plant species, mechanical control tactics alone can be temporarily successful at best but also can stimulate the growth of some invasive plants. By itself, reseeding with native plants also would be an incomplete tactic under even good conditions and in some areas would be entirely ineffective or contrary to physical site stabilization goals which include limiting impacts from the roots of growing plants and reducing the risk of fuel accumulation.

The IPMP proposes controlling invasive plants throughout MVNP and YHNM including at archeological sites. Not controlling weeds in archeological sites would be contrary to state and federal laws and NPS policy. Only spraying around cultural sites is impractical and would leave the treated areas vulnerable to reinfestation from the many untreated weed seed sources, thus it would be a futile effort. It is clear that judicious use of herbicides is a necessary component of an IPM approach.

For several years, very limited use of herbicides has occurred in a few archeological sites at MVNP and YHNM. Table 8 describes the varying characteristics of the herbicides currently in use. All of these chemicals are transitory to one degree or another as they break down in the environment. Under the circumstances anticipated under the IPMP, none of the chemicals would leave a significant residue beyond two years; most would take far shorter than that. The mitigation measures prescribed for the IPMP would ensure that the amount, degree, and persistence of any herbicides would be kept to a minimum. The vast majority of the applied chemicals would adhere to the vegetation and would not contact the soil and prehistoric fabric. Avoiding applications during and shortly before any rain or during any winds would be a standard best management practice. To avoid spills, handling and mixing herbicides would never take place in archeological sites.

Foot and vehicle traffic (such as a tractor or UTV) during chemical application potentially could damage fragile archeological artifacts on the surface. These types of activities would be performed in areas suspected or known to contain resources of archeological value only after consultation with the staff archeologist, and the Colorado SHPO if necessary. UTVs or tractors would only be used if there was no potential for adverse effect to archeological resources.

The adverse physical impacts of chemical treatments to a limited number of archeological resources would therefore be negligible, site-specific, and short-term. The beneficial effects of herbicide use would be long-term and minor.

Cumulative Impacts

Previous impacts to archeological resources in most areas proposed for invasive plant control are due to visitor use and from earlier anthropogenic disturbances that damaged these sites such as infrastructure construction and maintenance, excavation, fuels management, fire suppression activities and post-wildfire erosion. Use of the park and monument by Native Americans dates back thousands of years. The anthropogenic disturbances varied considerably as to type, intensity, and duration before and after the park and monument were established. Damage to archeological resources from livestock and native wildlife such as deer, elk, rock squirrels and prairie dogs is ongoing. Each day archeological resources are left unprotected from the hoof action and rubbing and scratching of large grazing animals or burrowing by rodents. Other actions that may affect cultural resources include:

YHNM land acquisition proposal: Expanding YHNM to the southeast would reduce the threat of physical harm to archeological sites in the current monument and bring additional archeological sites under the protection of the NPS.

MVNP Fire Management Plan: This plan would result in long-term beneficial affects to archeological resources by reducing the chance of catastrophic fire. Fuels management activities such as mechanical cutting, pile burning, and broadcast prescribed burning could harm some cultural resources so monitoring and mitigation would be required. Firefighting activities also could unintentionally damage cultural sites by cutting lines through sites and by the dousing of sites from the air with harsh chemicals such as fire retardants.

MVNP burned area emergency rehabilitation plans: Erosion control and archeological site stabilization have occurred after the major wildfires of recent decades. As a result, numerous sites were catalogued, evaluated, and saved from damage.

MVNP Integrated Pest and Hazardous Wildlife Management Plan: Visible damage done to archeological resources from various animals would be reduced through implementation of an IPM plan. This would include burrowing rodents, roosting birds and bats, etc.

MVNP livestock control efforts: Construction of boundary fences typically has little or no effect on archeological sites. Known sites would be demarcated before work is done to avoid unnecessary disturbance. Reducing the number of livestock in the park decreases the cumulative impacts from heavy hooved feet and from greater erosion related to grazing impacts of vegetative cover. Impacts to archeological sites would diminish as livestock numbers decline as a result of new livestock control efforts.

MVNP Visitor Distribution and Transportation Plan: The scope and intensity of the possible actions promoted under this plan could have adverse effects on archeological resources. Impacts from visitor access to archeological sites at MVNP and YHNM currently are limited by careful controls and limitations. Even with these measures, impacts to these sites still occur. If visitor access is expanded and/or staff oversight is not assured, it can be expected that there would be more adverse effects on park archeological resources.

MVNP road construction and major maintenance projects: During about the first half of the MVNP's history, many construction and maintenance activities damaged or destroyed hidden archeological resources without much after-the-fact effort to mitigate or document the impacts. Despite the best efforts by modern NPS staffs to locate and avoid impacts to archeological sites, it still happens from time to time but when discovered the damage is mitigated and properly documented.

Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource

Management Plan: Implementation of this plan would affect the management of archeological resources on a regional level. Forest Service and BLM management actions include commercial grazing, timber extraction, oil and gas production, off-highway recreational vehicle use, invasive plant control, and many other activities that could impact archeological resources, but they have monitoring and mitigation measures in place to help conserve these sites.

Residential, agricultural, and commercial developments around MVNP and YHNM: As human populations increase in extent and density, there is more opportunity for archeological resources to be altered by human activities which have a regional impact.

The implementation of Alternative A would add a negligible amount of cumulative adverse impact on archeological resources, primarily due to mechanical controls such as hand pulling and digging. The use of motorized vehicles to apply chemicals would not be approved in archeological sites. Any use of motorized equipment and spot treatment with herbicides would continue to be cleared by a park archeologist to avoid any negative impacts. It is anticipated that troublesome invasive plants would decrease as IPM techniques are implemented. As native vegetation is restored, archeological resource sites would be better protected.

Conclusion for Alternative A

Alternative A would result in short-term negligible to minor adverse impacts to archeological sites caused by mechanical control techniques, such as hand pulling or digging. Cultural control techniques (revegetation) would be cleared by an archeologist before work occurs, and known cultural sites would be avoided. The park archeologist would be consulted prior to any herbicide application using a sprayer mounted on a truck or a UTV and cultural resources would be avoided. Minor to moderate long-term benefits to archeological resources associated with controlling invasive plants and reestablishing native vegetation would be expected.

Impacts of Alternative B on Archeological Resources

The environmental consequences of using mechanical, cultural, and biological IPM methods are the same as Alternative A. Long-term benefits to archeological resources associated with controlling invasive plants and restoring native communities would be maximized.

Herbicide Treatment

Impacts from ground applications of herbicides are explained and justified under Alternative A.

Aerial application:

Imazapic herbicide sprayed at rates of 6 to 10 ounces per acre is not expected to compromise the physical integrity of archeological resources. Imazapic is formulated as an aqueous ammonium salt solution, and as such it does have a mild corrosive activity on mild (malleable) steel. This, however, is for the undiluted product (the concentrate as purchased), and dilution for spraying would significantly reduce the corrosive potential to something approaching that of water. Imazapic is soluble in water, hydrolytically stable, and nonvolatile in aqueous solution. Imazapic in water is, however, rapidly photo-degraded by sunlight with a half-life in water of from less than 8 hours to one to two days. It has little lateral movement in soil. No residues were found below the 18-24 inch soil layer. Imazapic does not readily move off site and binds moderately to most soil types. Imazapic has a neutral pH of 6.4-7. For reference, pure water has a pH of 7 and milk has a pH of 6.5. Imazapic would most likely have similar effects on sandstone as unpolluted rain water.

Aerial application of Imazapic would have opportunities to directly contact large numbers of archeological sites, mainly "surface sites," however this would only take place under rare emergency circumstances after a stand replacing wildfire burned through pinyon-juniper or sagebrush communities in cheatgrass soils. Surface sites are the cultural sites that are not located in ledge or alcove settings. They make up the majority the archeological record in MVNP and all of the YHNM sites. Although largely buried under soil and, in a post-fire environment, a layer of ash and sometimes a coating of pink fire retardant as well, the affected surface sites would be exposed to wind and water erosion and direct sunlight. Exposed stone materials would exfoliate from being cooked by the fire. Within a year the sites would be colonized by invasive plants unless emergency treatments are activated before winter. In combating cheatgrass, Imazapic applied by helicopter currently offers the best option. This chemical is relatively benign and would break down within two years. In combination with aerial seeding, the desired site and landscape conditions are best achieved using this two phase method.

There are promising studies underway that could offer a treatment method that replaces the aerial application of Imazapic as a best management practice. If the aerial application of native fungi or bacteria proves to be safe and cost effective, using Imazapic against cheatgrass would become limited to careful ground applications outside of cultural sites or eliminated altogether.

Cumulative Impacts

The baseline cumulative scenario is described above. New techniques proposed in Alternative B do not substantially increase impacts when compared to the cumulative impact of Alternative A. It is anticipated that more acres of invasive plants could be treated with an expanded program that includes aerial applications of herbicides, but that would take place if the park experiences a wildfire in cheatgrass-susceptible areas. As the capacity of the IPM program expands, cultural resources would have the maximum protection from catastrophic fire and erosion. Aerial applications of herbicide would not significantly impact archeological resources. Standing structures would be avoided and dyes would not be used.

Conclusion of Alternative B

Archeological resources would receive greater protection under Alternative B when compared to Alternative A as IPM efforts would be expanded. The most appropriate IPM control technique can be selected to protect sensitive archeological resources from invasive plants. The ability to treat substantially more acres of invasive plants would allow for increased protection of archeological resources from the aftermath of catastrophic wildfire events and degradation of historic site conditions. As Imazapic herbicide would have a similar effect on sandstone as rain water, aerially spraying would not be an additional adverse physical impact on archeological resources. With a fully integrated program, long-term minor to moderate benefits to archeological resources associated with controlling invasive plants and restoring native communities would be maximized.

The adverse physical impacts of chemical treatments to archeological resources would therefore be negligible and short-term. The beneficial effects of herbicide use would be long-term and minor.

§106 Summary

After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR §800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of the preferred alternative would have *no adverse effect* on the archeological resources of Mesa Verde National Park and Yucca House National Monument.

Impacts of Alternative A on Ethnographic Resources

Invasive plant prevention techniques are designed to not adversely affect resources of any kind and so are not included in this analysis.

Mechanical Treatment

Ground disturbing activities, such as digging invasives, clearing vegetation, pulling invasives, or using a string trimmer, could have a short-term minor adverse impact on ethnographic resources such as medicinal plants should they be damaged in the process. Similarly, ground-disturbing activities, such as plowing/disking or digging and pulling could damage sensitive and fragile archeological sites, including known and unknown sites. These types of activities would be performed in areas suspected or known to contain resources of historic value only after consultation with the staff archeologist, and SHPO if necessary. Mechanical treatments would be deferred if the application is needed. The adverse impacts of mechanical treatments to ethnographic resources would therefore be negligible to minor, site-specific, and short-term. In the long-term, the removal of invasive plants would have minor beneficial effects for the protection of prehistoric or historic sites by protecting and enhancing plant communities that better support native species and that stabilize the soil.

Cultural Treatment

Restoration: Ground disturbing activities related to revegetation work (raking soil, digging in new plant materials, and vehicle (UTV, tractor) and foot traffic could potentially damage previously undiscovered artifacts. However, restoration efforts are generally conducted in highly disturbed and previously surveyed areas. Restoration in areas not surveyed for cultural resources would be

carefully inspected by staff archeologists before work is initiated. Therefore, impacts to ethnographic resources from restoration activities would be long-term negligible and beneficial.

Biological Control Treatment

There would be no adverse impacts to ethnographic resources from the implementation of biological control methods. Beneficial effects would be long-term and minor to moderate.

Herbicide Treatment

Identification and protection of ethnographic resources would be included in training programs for the invasive plant seasonal work crews, contractors, or anyone else involved with invasive plant eradication work in MVNP and YHNM. Decisions on whether or not to use herbicides in ethnographically sensitive areas would include an evaluation into the feasibility of initially using or only using non-chemical methods. Within archeological sites, invasive plant control techniques using chemical applications only would be employed that would minimize the risk of contacting sensitive historic fabric/materials and minimize the amount, degree, and persistence of the chemicals at the site, especially in the soil. A one-foot buffer or physical shielding would be implemented while applying herbicide in the vicinity of cultural resources. In addition, dye would not be used and herbicide would be applied in no wind conditions. Identifying and avoiding chemical contact with ethnographically significant plant species, such as wild tobacco, would alleviate concerns over affecting anyone who might harvest the plants for traditional tribal purposes.

Use of chemicals in controlling pest organisms is controversial to many people. Native Americans have expressed an aversion for the use of herbicides in archeological sites because these sites have special meaning to them as traditional cultural properties. However, achieving the goal of the IPMP is dependent upon implementing an effective and comprehensive IPM approach throughout the park. Having natural invasives-free settings is the most desirable future condition for these sites, however, in implementing IPM tactics in sensitive settings, the option of using chemical-free tactics initially may be preferred and so use of herbicides could be deferred to a future time or indefinitely.

The impact analysis section for Vegetation and Soils thoroughly describes how the IPMP would affect the physical nature of the park environment, both beneficial and adverse, including potentially within the many hundreds of archeological sites in the park and monument. Invasive plant control and the promotion of native plants curtail soil erosion, which is a major concern for protecting the integrity of cultural sites. However, mechanical control techniques are not effective in many circumstances and they can lead to more soil impacts and erosion. In many situations and with many invasive plant species, mechanical control tactics alone can be temporarily successful at best but also can stimulate the growth of some invasive plants. By itself, reseeding with native plants also would be an incomplete tactic under even good conditions and in some areas would be entirely ineffective or contrary to physical site stabilization goals which include limiting impacts from the roots of growing plants and reducing the risk of fuel accumulation.

The IPMP proposes controlling invasive plants throughout MVNP and YHNM including at archeological sites. Not controlling weeds in archeological sites would be contrary to state and

federal laws and NPS policy. Only spraying around cultural sites is impractical and would leave the treated areas vulnerable to reinfestation from the many untreated weed seed sources, thus it would be a futile effort. It is clear that judicious use of herbicides is a necessary component of an IPM approach.

For several years, very limited use of herbicides has occurred in a few archeological sites at MVNP and YHNM. Table 8 describes the varying characteristics of the herbicides currently in use. All of these chemicals are transitory to one degree or another as they break down in the environment. Under the circumstances anticipated under the IPMP, none of the chemicals would leave a significant residue beyond two years; most would take far shorter than that. The mitigation measures prescribed for the IPMP would ensure that the amount, degree, and persistence of any herbicides would be kept to a minimum. The vast majority of the applied chemicals would adhere to the vegetation and would not contact the soil. Avoiding applications during and shortly before any rain or during any winds would be a standard best management practice. To avoid spills, handling and mixing herbicides would never take place in cultural sites.

Foot and vehicle traffic (such as a tractor or UTV) during chemical application potentially could damage fragile archeological artifacts on the surface. These types of activities would be performed in areas suspected or known to contain resources of archeological value only after consultation with the staff archeologist, and the Colorado SHPO if necessary. UTVs or tractors would only be used if there was no potential for adverse effect to ethnographic resources.

The adverse physical impacts from chemical treatment contact to a limited number of ethnographic resources would therefore be negligible, site-specific, and short-term. The beneficial effects of herbicide use would be long-term and minor from removing invasive species and better stabilizing the soil. The adverse impacts to ethnographic values at cultural sites from the use of herbicides would not exceed moderate but also would be only short-term.

Cumulative Impacts

Previous impacts to ethnographic resources in most areas proposed for invasive plant control are due to visitor use and from earlier anthropogenic disturbances that damaged cultural resources such as infrastructure construction and maintenance, excavation of cultural resources, fuel management, fire suppression activities and post-wildfire erosion. Use of the park and monument by Native Americans dates back thousands of years. The anthropogenic disturbances varied considerably as to type, intensity, and duration before and after the park was established. Damage to cultural sites from livestock and native wildlife such as deer, elk, and prairie dogs is ongoing. Each day cultural sites are left unprotected from the hoof action and rubbing and scratching of large grazing animals.

Other actions that may affect ethnographic resources include:

YHNM land acquisition proposal: Expanding YHNM to the southeast would reduce the threat of physical harm to ethnographically sensitive sites in the current monument and bring additional sites under the protection of the NPS.

MVNP Fire Management Plan: This plan would result in long-term beneficial affects to ethnographic resources by reducing the chance of catastrophic fire. Fuels management activities such as mechanical cutting, pile burning, and broadcast prescribed burning could harm some ethnographic resources so monitoring and mitigation would be required. Firefighting activities also could unintentionally damage ethnographically sensitive sites by cutting lines through sites and by the dousing of sites from the air with fire retardants.

MVNP burned area emergency rehabilitation plans: Erosion control and cultural site stabilization have occurred after the major wildfires of recent decades. As a result, numerous sites were catalogued, evaluated, and saved from damage.

MVNP Integrated Pest and Hazardous Wildlife Management Plan: Visible damage done to cultural sites from various animals would be reduced through implementation of an IPM plan. This would include burrowing rodents, roosting birds and bats, etc.

MVNP livestock control efforts: Construction of boundary fences typically has little or no effect on cultural sites. Known sites would be demarcated before work is done to avoid unnecessary disturbance. Reducing the number of livestock in the park decreases the cumulative impacts from heavy hooved feet and from greater erosion related to grazing impacts of vegetative cover and native species that may have ethnographic significance. Impacts to cultural sites and ethnographic resources areas would diminish as livestock numbers decline as a result of new livestock control efforts.

MVNP Visitor Distribution and Transportation Plan: The scope and intensity of the possible actions promoted under this plan could have adverse effects on cultural sites and ethnographic resources. Impacts from visitor access to archeological sites at MVNP YHNM currently are limited by careful controls and limitations. Even with these measures, impacts to these sites still occur. If visitor access is expanded and/or staff oversight is not assured, it can be expected that there would be more adverse effects on park cultural sites and plants with special ethnographic values.

MVNP road construction and major maintenance projects: During about the first half of the MVNP's history, many construction and maintenance activities damaged or destroyed hidden cultural sites and ethnographically significant plants without much after-the-fact effort to mitigate or document the impacts. Despite the best efforts by modern NPS staffs to locate and avoid impacts to cultural sites, it still happens from time to time but when discovered the damage is mitigated and properly documented.

Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource

Management Plan: Implementation of this plan would affect the management of sites on a regional level. Forest Service and BLM management actions include commercial grazing, timber extraction, oil and gas production, off-highway recreational vehicle use, invasive plant control, and many other activities that could impact ethnographic resources, but they have monitoring and mitigation measures in place to help conserve sites.

Residential, agricultural, and commercial developments around MVNP and YHNM: As human populations increase in extent and density, there is more opportunity for cultural sites and native vegetation to be altered by human activities, which have a regional impact.

The implementation of Alternative A would add a negligible amount of cumulative adverse impact on ethnographic resources. The use of motorized vehicles to apply chemicals would not be approved in archeological sites. Any use of motorized equipment and spot treatment with herbicides would continue to be cleared by a park archeologist to avoid any negative impacts to physical features. It is anticipated that troublesome invasive plants would decrease as IPM techniques are implemented. As native vegetation is restored, ethnographic resources would be better protected.

Conclusion for Alternative A

Alternative A would result in short-term negligible to minor adverse impacts to cultural sites and medicinal or ceremonial plants caused by mechanical control techniques, such as hand pulling or digging. Cultural control techniques (revegetation) would be cleared by an archeologist before work occurs, and known cultural sites would be avoided. The park archeologist would be consulted prior to any herbicide application using a sprayer mounted on a truck or a UTV and cultural resources and sensitive plants would be avoided. Even so, minor to moderate short-term adverse impacts to ethnographic resources could occur from spot treatments with herbicides. Minor to moderate long-term benefits to ethnographic resources associated with controlling invasive plants and restoring native plant communities would be expected.

Impacts of Alternative B on Ethnographic Resources

The environmental consequences of using mechanical, cultural, and biological IPM methods are the same as Alternative A. Long-term benefits to ethnographic resources associated with controlling invasive plants and restoring native plant communities would be maximized.

Herbicide Treatment

On February 3, 2014 MVNP received a letter from the Hopi Cultural Preservation Office in which they acknowledged the serious threat that invasive plants impose on the park's natural and cultural resources and values. Although they expressed support for the park developing and implementing the IPMP, they also indicated that use of chemical controls on invasive plants inside cultural sites was not supported. Because many of the invasive plant species impacting the park, including within cultural sites, to date cannot be effectively controlled without chemical methods, this expressed concern over the use of herbicides contradicts the concern over the adverse effects the invasive plants already are having on these same places and the legal mandate under which the park must work to remove invasive plants generally.

Every action taken within the park elicits some level of ethnographic concern among the affiliated tribal communities whether the actions are related to visitor access, infrastructure development, forest management, or any other matter. The degree of concern for each issue is highly variable among the tribes including with respect to the use of herbicides. Cultural sites within the park also vary with respect to their sensitivity to disturbances by park management actions. Furthermore,

there are certain native plant species and plant collecting areas which have special cultural significance and avoiding the contamination of these resources and sites needs special attention. As a component of ongoing consultation, MVNP would work with tribal representatives to more precisely determine where on the landscape these concerns would further restrict the use of herbicides or the method of using herbicides to control invasive plants. Where the removal of vegetation is judged to be necessary and where feasible to achieve invasive plant control objectives, careful mechanical removal would be tried first or perhaps exclusively.

Currently the park would target for vegetation control the cultural sites commonly visited by the public and sites that are highly disturbed and thus significantly infested with invasive plants. As a park-wide standard, use of herbicide would always follow the method of least risk to non-target resources and values. However, the vast majority of cultural sites in MVNP would not be targeted in the foreseeable future either due to the sheer number of them, their inaccessibility, or because they are not yet impacted by invasive plants. However, under the IPMP's action alternative, many more sites could be at risk to infestation by invasive plants and by erosion after future wildfires. Aerial application of Imazapic, in addition to native plant seeds and biological control agents, could be needed to ward off infestation by invasive plants such as cheatgrass and thistles. However, where certain cultural sites of highest sensitivity and concern are identified on the landscape, the herbicide application pattern would be altered to avoid affecting these locations.

MVNP would be obligated to obtain the site-specific information needed to accurately identify and prioritize cultural sites and ethnographically significant plant species for protective consideration under invasive plant treatment tactics. Park managers would obtain this information through consultation with designated tribal representatives and qualified specialists, querying the MVNP and YHNM archeological and cultural resources databases, and from factual publications. Because of the sensitive nature of this information, the results of this investigation would be kept in strict confidence with park officials and not be explicitly included as part of the IPMP. As a result, the decision tree process of the IPMP (Appendix A3) also would undergo a separate pre-screening process related to protecting ethnographic values linked to cultural sites and plants. Use of herbicides would not be extended to any additional cultural sites until this information is obtained and organized.

Impacts from ground applications of herbicides are explained and justified under Alternative A.

Aerial application:

The physical impacts from aerial application of Imazapic herbicide sprayed at rates of 6 to 10 ounces per acre are the same as described under Archeological Resources above.

In combination with aerial seeding, the desired site and landscape conditions are best achieved using this two phase method. With aerial application, identifying and avoiding chemical contact with ethnographically significant plant species would not be possible; however, the aerial spraying would take place in the late summer or early fall following the fire on a landscape largely devoid of vegetation. Plants such as wild tobacco would not be growing in the burn until the growing season

after the spraying took place, thus the Imazapic would not come in contact with the foliage of the ethnographically sensitive plants.

There are promising studies underway that could offer a treatment method that replaces the aerial application of Imazapic as a best management practice. If the aerial application of native fungi or bacteria proves to be safe and cost effective, using Imazapic against cheatgrass would become limited to careful ground applications outside of cultural sites or eliminated altogether.

Cumulative Impacts

The baseline cumulative scenario is described above. New techniques proposed in Alternative B do not substantially increase impacts when compared to the cumulative impact of Alternative A. It is anticipated that more acres of invasive plants could be treated with an expanded program that includes aerial applications of herbicides, but that would take place if the park experiences a wildfire in cheatgrass-susceptible areas. As the capacity of the IPM program expands, ethnographic resources would have the maximum protection from catastrophic fire, erosion, and invasive plants. Aerial applications of herbicide would not significantly affect physically any cultural sites. Standing structures would be avoided and dyes would not be used.

Conclusion of Alternative B

Cultural sites would receive greater protection under Alternative B when compared to Alternative A as IPM efforts would be expanded. The most appropriate IPM control technique can be selected to protect sensitive cultural resources from invasive plants. The ability to treat substantially more acres of invasive plants would allow for increased protection of cultural sites and native plant communities from the aftermath of catastrophic fire events and degradation of historic site conditions. As Imazapic herbicide would have a similar effect on sandstone as rain water, aerially spraying would not be an additional adverse physical impact on cultural material. With a fully integrated program, long-term minor to moderate benefits to ethnographic resources associated with controlling invasive plants and restoring native communities would be maximized.

Alternatives to herbicide use would be considered in cultural sites when practicable. Greater care would be used in avoiding herbicide contact with identified medicinal or ceremonial plants. Alternatives to herbicide use would be selected for the most ethnographically sensitive resources and sites identified through tribal consultation and scholarly investigation. The adverse physical impacts of chemical treatment contact with ethnographic resources would be inadvertent and therefore be negligible and short-term. The beneficial effects of herbicide use would be long-term and minor as native vegetation is restored and invasive species decline. The adverse impacts generally to ethnographic values on a park-wide level from the use of herbicides would not exceed moderate but also would be only short-term.

§106 Summary

After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR §800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of

the preferred alternative would have *no adverse effect* on the ethnographic resource values of Mesa Verde National Park and Yucca House National Monument.

Park Operations

Impacts of Alternative A on Park Operations

Because Alternative A would be the continuation of the current IPM program, management practices would not have significant impacts to divisional work plans, training, or budgets (outside the invasive plant management programs within the Division of Research and Resource Management). The Natural Resource Branch has been and would continue to develop partnerships with other park divisions and various agencies and organizations to enhance the reach and effectiveness of the invasive plant control operations.

Efforts in invasive plant management in MVNP and YHNM have been fairly stable in recent years as biological controls and seeding of burned areas have reduced the time and effort needed to diminish musk thistle populations. This would allow for more effort to be invested in controlling other kinds of invasive plants. If treatments continue to succeed and no new major disturbances occur, the invasive plant program may consist more and more of monitoring and detection with less time treating invasives. Efforts to control invasive plants would again need to ramp up if more infrastructure developments and wildfires occur or new invasive species flourish. If a control program is not continued, it is very likely that many of the gains made since the program started in 1999 would be overwhelmed in due course.

With Alternative A, existing relations and partnerships would continue to be improved with park neighbors, as well as other federal, state and local officials, who have expressed concern about invasive species spreading from MVNP and YHNM onto neighboring lands. Other landowners may continue to build relationships with the park and monument as part of ongoing outreach programs. Managerial overhead costs for developing formal agreements would increase under both alternatives. The park and monument would not be able to take full advantage of certain NPS program resources, particularly the Southwest Exotic Plant Management Team (EPMT), without updating its environmental compliance under this plan/EA. Continuing current management practices could slightly affect other park operations, adversely in terms of invasive plant control support needs. Construction projects, maintenance operations, and fire operations always would need to incorporate Best Management Practices, which cost money and time up front for prevention and mitigation, but would save money and park resources in the long run. Most effects on park operations would be beneficial in terms of performing a valuable service in vegetation management. In addition, under both alternatives, natural resource staff along with other divisions would increase public awareness.

The impacts of Alternative A on park operations would therefore be both adverse and beneficial because of the costs and effort involved in continued implementation of the program and the

advantages of having a park less affected by invasive plants. Adverse impacts would be park and monument-wide, long-term and short-term, and moderate.

Cumulative Impacts

Other park plans that would affect park operations and staffing include:

YHNM Land Acquisition Proposal: The acquisition of the land parcel southeast of YHNM would increase the NPS responsibilities in an area that currently receives only a small amount of attention. The boundaries would require a cadastral survey followed by new fencing to exclude livestock. Inventories of cultural and natural resources and condition assessments would be needed followed by plans to stabilize or rehabilitate the landscape, including implementation of invasive plant control and revegetation. Options to develop a visitor access strategy for YHNM are not predicated on the acquisition of this parcel but it could help facilitate it. If so, it could require a more regular staff presence at the monument. This is a substantial list of actions that likely would need to be phased in over several years to identify the staffing and funding to carry it out.

MVNP Mancos River Corridor Restoration: Natural Resource program staffs have spent many years controlling invasive plants, fencing out livestock, planting trees, controlling erosion, and implementing other conservation efforts in Mancos Canyon.

MVNP Fire Management Plan: MVNP supports a substantial and diverse fire and fuels management operation that requires quite an annual investment in time, funds, personnel, and equipment. Hazardous fuels treatment and maintenance under this plan would result in long-term impacts to the park's natural and cultural resources that would require continuous monitoring and mitigation by the natural and cultural resource programs.

MVNP Burned Area Emergency Rehabilitation Plans: Each of the wildfires at MVNP in the past few decades has required park staff to postpone planned and routine park operations for several weeks in order to implement emergency restorative operations. This included repairing roadways, utilities, and other infrastructure as well as stabilizing archeological sites and controlling invasive plants. The operations are highly intense over the short-term, but occur intermittently. Future wildfires in the park are likely which would repeat these conditions and impacts to park operations.

MVNP Integrated Pest and Hazardous Wildlife Management Plan: Proper implementation of this plan would require additional obligations on park staff and funding to ensure safe working, living, and visiting conditions in the areas of the park frequented by humans. Fully implemented, an animal IPM operation would require considerable investments in time, funds, materials, and personnel directed by an IPM specialist. The single greatest effort would need to be concentrated on keeping mice out of the large number of historic and other buildings but responsibilities and commitments would need to go much further.

MVNP livestock control efforts: Substantial annual efforts go into repairing existing boundary fences and reinforcing segments of fence that receive high levels of pressure from loose unclaimed horses and cattle. Together with monitoring and removing stray livestock, this problem takes up a

substantial part of the park's wildlife management program. Impacts to park operations would increase further as a result of new livestock control efforts.

Mesa Verde Visitor Distribution and Transportation Plan: Implementation of this plan could create additional park staff commitments to create and support new access-related facilities and access changes while ensuring park visitors are well informed and protected within a larger landscape setting than currently exists. Resource monitoring, protection, and restoration efforts by park staff also would need to increase along with the resource impacts expected from expanded visitor opportunities.

Paths to Mesa Verde: Accommodating a through trail across the northern tip of the park likely would require additional infrastructure construction, maintenance, and impacts to park resources. If the trail supports bicycles and/or riding stock, additional accommodations likely would be requested to allow stopping at the Visitor and Resource Center. As with the Visitor Distribution and Transportation Plan, existing park operations would need to absorb these new responsibilities and mitigate the resource impacts.

MVNP road construction and major maintenance projects: Not a year goes by when MVNP is not engaged in a major construction or maintenance project. Most of these projects are funded outside of the normal park operating budget, however the park's staff must devote large amounts of time in planning, compliance, contract and contractor management, and resource inventories, monitoring, and mitigation. Future project development should be designed so that many of these park costs can be recovered by adding them into overall project costs.

When combined with other past, present, and foreseeable future actions that would result in impacts to park operations, Alternative A would have adverse, long-term moderate impacts. This is because for the foreseeable future, park operational resources would experience greater challenges. Unless judiciously regulated, these new burdens could overwhelm the park's capability to meet its core mission and basic functions.

Conclusion for Alternative A

Alternative A alone would not have more than minor additional impacts to current park obligations, mainly for the natural resource program, but also for the benefit of other park programs. On-going invasive plant management activities have always involved other divisions in small ways whether the task is prevention, education, or implementation. Alternative A would not change the job descriptions or duties.

Impacts of Alternative B on Park Operations

Most of the considerations described in Alternative A are the same or similar to Alternative B. With full compliance for additional IPM invasive plant control techniques, it is expected that implementation of Alternative B would result in the most effective, safe, and efficient management of invasive species in the park and monument. The availability and access to all possible management tools would allow more flexibility and creativity in achieving goals to benefit overall land uses and park operations.

By better controlling invasive plants, a fully integrated IPM approach would improve relations with park neighbors, federal partner agencies, as well as state and local officials who have expressed concern about invasive plants spreading from the park and monument onto neighboring lands. Having a feasible ability to treat large acres of cheatgrass in the future would help reduce fire hazards, benefiting all park operations. The natural resource program would be challenged to meet the higher performance levels expected under the preferred alternative, but all park operations would have a role to play in the overall effort to cooperatively address this park-wide issue. The IPMP prescribes necessary compliance and mitigation measures for other park projects and operations. Special projects would be implemented as funding is made available through grants or other sources. The natural resource program would encourage the expertise and contributions of other divisions to leverage nonrecurring project funding. Expanding cooperative ventures with partnering agencies also could help reduce some of the stress on park operations from the greater level of effort prescribed by the IPMP. External funding sources can be explored to facilitate control efforts on adjacent public and private lands. Park staff would provide additional educational outreach to visitors on such proposed aggressive and innovative techniques. Fire management, interpretation, GIS staff, maintenance, and administrative support for personnel, procurement, and partnering may experience minor short-term and long-term impacts from higher workloads. The impacts of IPM management on park operations would therefore be both adverse and beneficial. Adverse impacts from higher workloads would be park and monument-wide, long-term and short-term, and moderate. Also there would be short-term minor impacts to park staffing and administrative personnel workloads during aerial treatment application projects, but at this time these would be expected to occur infrequently, mainly after a wildfire.

Cumulative Impacts

The baseline cumulative scenario is described above. Cumulative impacts for Alternative B would be the same as Alternative A.

Conclusion for Alternative B

Alternative B would have similar impacts as Alternative A, but with additional short-term minor impacts to staffing and administrative personnel during aerial application projects. However, these impacts are extremely short in duration and have long-term benefits. In the long-term, park and monument operations would benefit more under Alternative B overall as a more comprehensive management strategy reduces invasive plant introductions and spread, thereby improving assets such as habitats, roadsides, and fuel conditions.

Visitor Experience

Impacts of Alternative A on the Visitor Experience

Prevention techniques are designed to not adversely affect visitor experience so are not included in this analysis. In general, all IPM techniques would have a long-term minor to moderate beneficial

impact on visitor experience as weedy invasive vegetation is converted to natural vegetation and catastrophic fire potential is reduced.

Mechanical Treatment

Activities related to mechanical control of invasive plant species (digging, pulling, and use of gasoline-powered mowers and string trimmers) is expected to have a short-term localized minor adverse impact on visitor experience caused by the sights and sounds of these activities. Invasive plant management activities would occur primarily during the summer months when invasive plants are actively growing and park visitation is at its highest. Invasive plant control work would take place only in localized areas of the park and should impact only a small percentage of park visitors. There would be short-term noise impacts associated with the use of powered equipment, and short-term visual impacts associated with personnel working on invasive plant control at various locations within the park.

Cultural Treatment

Restoration: Revegetation work is expected to cause short-term localized minor adverse impacts to visitor experience. Impacts are primarily related to the short-term visual intrusion of personnel and equipment at various restoration areas within the park. Until replanted vegetation fills in the disturbed area, a significant amount of bare ground or mulch often is visible, which can be a visual intrusion in an otherwise natural landscape. Aerial applications of seed may diminish visitor experience as a result of noise and visual distractions generated by aircraft flights. This impact would be short-term and minor.

Biological Control Treatment

Biological control should have no adverse impact on visitor experience.

Herbicide Treatment

Herbicidal control is expected to have a short-term localized minor adverse impact on visitor experience. Chemical control activities (use of backpack sprayers, use of a truck, tractor, trailer, or UTV with a boom sprayer) would create short-term noise impacts and visual impacts. Tire marks through vegetation may be visible up to a year. Chemical control work would take place only in localized areas of the park and monument and would impact only a small percentage of park visitors.

Visitor turnover in any given area is rapid in most areas and only a day or less in some areas such as the campground. Therefore the duration of this impact typically is very brief. Areas open to public access that are to be treated with herbicide would be identified with informative signs and would be closed to the public during and shortly after chemical application. Notification signs would remain in place at all treated areas for as long as the chemicals used at the site are considered a risk to public health and safety as per product label instructions. Usually this lasts only as long as it takes the spray to dry but can take up to several days in rare circumstances.

Cumulative Impacts

The effects of past and present actions on visitor experience in MVNP are long-term and range from negligible to moderate. Primary large scale harm to visual resources in MVNP comes from pollution from energy extraction and production, from commercial, industrial, and other development of lands near the park, and the lack of vegetation from past fires. Other actions that could impact visual resources are fire and fuels management actions proposed in the MVNP Fire Management Plan. Implementation of the Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource Management Plan could impact the regional recreational experience through vegetation management activities including prescribed fire, timber management, recreational activity zoning, and with further development of energy extraction activities. Additional past actions that affect recreation would include the development of visitor use facilities in and around the park such as the construction of the Visitor and Research Center. These facilities have provided support to visitors in beneficial and long-term ways. Proposed or on-going projects in MVNP that would affect recreation/visitor experience include:

YHNM land acquisition proposal: How this might affect visitor experiences would depend on how the addition of lands to YHNM might be used by the NPS or accessed by the public. Potential use could include parking and trailhead, information signage, or a visitor contact station.

MVNP Fire Management Plan: Thinning forests, cutting fuel breaks, pile burning cut slash, and using string trimmers on herbaceous growth detract from the appearance of the park's natural landscapes. In the short-term, the use of gasoline engines creates a considerable amount of loud noise and pile burning produces the strong odor of smoke. Once completed, the maintenance cutting and trimming is less intrusive. With the implementation of proper mitigation measures, the new condition of the treated areas would recover enough in the long-term without excessive growth of invasive plants so that the treatment areas blend in acceptably. The benefit to the visiting public comes from the long-term protection of high-risk structures and sites from wildfire.

MVNP burned area emergency rehabilitation plans: Implementing emergency stabilization and rehabilitation work can result in temporary closures of park facilities and destinations while the work is underway. This is mainly done to protect visitors and to facilitate the work. Some activities would require power tools, which impact the local soundscape. The fresh look of construction or stabilization work is not appealing but offers a good educational experience for visitors.

MVNP Integrated Pest and Hazardous Wildlife Management Plan: A fully implemented animal IPM plan would be largely invisible to the visiting public and provide them with a safer park experience. Some activities would necessarily occur in public view when urgent control work cannot wait such as confiscating food from an unattended campsite or rangers hazing a troublesome black bear from the campground. Animal traps and deterrents also would be detected by some alert visitors.

MVNP Visitor Distribution and Transportation Plan: The implementation of this plan could result in an increase in options for visitors in choosing how to visit the park as well as seasonal limitations on access options. Some options could increase or decrease visitor densities or overall usage levels at some destinations.

Paths to Mesa Verde: The implementation of this proposal could offer a new recreational trail, mainly for local residents.

MVNP road construction and major maintenance projects: Implementation of most infrastructure projects at MVNP results in access delays, site closures, or other inconvenience to visitors because the park is not operating routinely during these events. Usually these inconveniences are short-term but have an acute effect on visitors, especially if there is noise and dust involved. The benefit is for future visitation when the park's facilities operate better or more reliably.

MVNP Concessions Contract: One of the goals of the park's concessions operation will be to ensure visitors that wish to take advantage of the park's lodge, campground, gift shops, eating facilities, and certain bus tours all have an optimal experience with these services for a fair price.

Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource

Management Plan: The local BLM and US Forest Service offer millions of acres of exceptional outdoor recreational opportunities for the visiting public. Many of these activities are not appropriate in MVNP or YHNM. Although some activities overlap, all of these visitor experiences between these areas complement each other. Because the BLM and Forest Service are multiple use agencies, these plans also call for extractive and other activities that are detrimental to the visiting public, both within these areas and at MVNP. Activities such as mining, logging, grazing, oil and gas production, and others are balanced with the visitor use goals of these public lands. Also, there can be conflicts between recreational users such as between horseback riders and dirt bike riders or between big game hunters and hikers.

MVNP Long Range Interpretive Plan: The implementation of this plan would result in the improved dissemination of information about the park's resources, features, and facilities to park visitors.

These impacts of other projects in the region, in combination with the impacts of this alternative, would result in long-term and moderate cumulative impacts to park visitor experiences, both beneficial and adverse.

Conclusion for Alternative A

With Alternative A, mechanical, cultural, biological, and chemical treatment methods are expected to result in short-term localized minor adverse impacts on visitor experience. These impacts are primarily related to noise and the visual intrusion of equipment and personnel and possibly the perceived risk of contact with artificial chemicals used in controlling invasive plants. These impacts would be mitigated through measures provided in Appendix A1 and A2. Through the judicious use of an IPM program, invasive plant species can be effectively managed while disruption of the visitor experience is minimized. Over the long-term there would be a moderate benefit to visitor experience as invasive plants decline and natural landscapes are restored.

Impacts of Alternative B on the Visitor Experience

The environmental consequences of using mechanical, cultural, biological and chemical IPM methods are the same as Alternative A. Depending of the perspective of each visitor, short-term localized minor impacts (beneficial or adverse) may occur. Visitors would need to be educated about

controversial methods to help mitigate impacts to visitor experience. The impact of aerial application of herbicide would be similar to aerial seeding in Alternative A. No aerial applications of herbicide would take place in close proximity to areas accessible to the public or areas would be closed during application and not reopened until it is entirely safe.

Cumulative Impacts

The baseline cumulative scenario is described under Alternative A. These impacts of other projects in the region, in combination with the impacts of this alternative, would result in long-term and moderate cumulative impacts, both beneficial and adverse.

Conclusion for Alternative B

In differentiating it with Alternative A, Alternative B allows the park to expand IPM techniques for increased control of invasive plants. The use of aerial spraying would have short-term localized minor to moderate adverse impacts for park visitors caused by the sights and sounds of these activities and possible site access restrictions. With an expanded IPM program, invasive plant species can be more effectively managed and disruption of the visitor experience can be minimized. Over the long-term there would be a moderate benefit to visitor experience as invasive plants decline and natural landscapes are restored.

Human Health and Safety

Impacts of Alternative A on Human Health and Safety

Job hazard analyses (JHA) have been prepared that analyze hazards associated with all aspects of invasive plant management techniques. The JHAs are designed to minimize hazards of daily activities to park staff and the public.

Mechanical Treatment

Mowing, digging or using a gasoline-powered string trimmer, chainsaw, or mower on invasive plants is expected to cause a minor elevated risk to human health and safety from potential contact with moving parts, hot surfaces, and sharp edges. Additionally, volunteers or park employees who engage in mechanical control activities face risks that are similar to those encountered when people are involved in strenuous outdoor activities during the summer months. Risks include sunburn, lightning strikes, biting or stinging insects, dehydration, fatigue, heat exhaustion, or heat stroke. Falls or other accidents are also possible. Other potential hazards related to manual operations include eye irritation or damage from flying debris and bodily injuries from hand tools such as Pulaskis, shovels, or hoes. Thistles have sharp spines that can penetrate the skin. Some of the knapweeds, poison ivy, and leafy spurge produce irritants that may cause sneezing, blisters, inflammation, and dermatitis. Hearing loss is possible with the use of loud machinery without hearing protection. All of these hazards can be minimized through the consistent and proper use of appropriate personal protective equipment.

Cultural Treatment

Revegetation work within the park and monument is expected to cause a minor elevated risk to human health and safety. Volunteers or park employees who engage in revegetation activities face risks that are similar to those mentioned under Mechanical Treatment.

Aerial seeding presents an increased risk associated with the use of aircraft. The park's helitack crew, well trained in the hazards of loading helicopters and associated dangers of working at a helibase, would be used to carry out tasks associated with a helicopter. Aircraft pilots would be chosen based on their experience with applications of these materials in similar terrain. Pilots are responsible for the safe use of their aircrafts.

Biological Control Treatment

Biological control techniques are expected to cause a minor elevated risk to human health or safety. Driving and hiking to release sites may pose a small hazard.

Herbicide Treatment

Evaluations of potential human health effects due to herbicide exposure are based on results of toxicity tests in laboratory animals or studies conducted on human health from chemical exposures.

The Human Toxicity Potential (HTP) is an indicator of the danger posed by a chemical's release into the air or surface water. It was developed to compare emission in life-cycle assessment (LCA) and public emissions inventories such as the U.S. Toxic Release Inventory (TRI). HTP contains two elements:

1. The toxicity of the chemical. This is represented by the unit risk factor (for carcinogens) or the safe dose (RFD) for non-carcinogenic effects.

The potential dose. This is represented by the intake of the chemical by an individual living in a certain model environment (Hertwich et al. 2001, Hertwich et al. 2000). Table 11 summarizes the potential effects on human health of the eleven herbicides proposed for use in MVNP. Also see herbicide risk assessment summaries in Appendix B. All of the herbicides, except for aminopyralid, imazapic, and imazapyr were evaluated using the following sources:

- Risk Assessment for Herbicide Use (USDA-USFS, 1992)
- The Nature Conservancy 2001 Weed Control Methods Handbook
- Numerous web sites (please see Literature Cited).

The 1992 USDA-USFS Risk Assessment quantified general systemic and reproductive human health risks for a given herbicide by dividing the dose found to produce no ill effects in laboratory animal studies by the exposure a person might get from applying herbicides or from being near an application site. Human cancer risk was calculated for those herbicides that caused tumor growth in laboratory animal studies by multiplying a person's estimated lifetime dose of the herbicide by a cancer probability value (cancer potency) calculated from the animal tumor data. The risk assessment included a qualitative analysis of the risk of heritable mutation and synergistic effects.

Those risks, summarized below, are based on conservative, worst-case assumptions, including comparing short-term exposure to long-term safety levels. There can be an indirect effect on human health from herbicide use through improper application, mixing, or contamination of a drinking water source.

Table 11. Impact of Herbicides on Human Health

Herbicide (active ingredient)	Impacts of the Herbicide on Human Health Effects
Aminopyralid (ex. Milestone)	Groundwater contamination potential is low given the low use rates combined with moderate soil half-life. Aminopyralid is practically non-toxic in the environment, not carcinogenic or mutagenic, and did not cause birth defects, neurological problems or any adverse reproductive or endocrine effects in laboratory testing.
Chlorsulfuron (ex. Telar)	No reports of poisoning in humans were found. There are no reported cases of long-term health effects in humans. The exposure levels a person could receive from Telar resulting from routine operations are below levels shown to cause harmful effects in laboratory studies. Telar may cause irritation to the skin, eyes, nose and throat. It is not known to be carcinogenic to animals.
Clopyralid (ex. Transline)	It is not classified as a carcinogen, teratogen, mutagen, or reproductive inhibitor. No reports of acute poisoning in humans have been found. Clopyralid can cause severe eye damage including permanent loss of vision, so eye protection is mandatory for applicators. Expected exposure levels are below the lowest level that should cause harmful effects. Prolonged exposure may irritate the skin. Repeated exposures in high amounts may cause liver and kidney damage. No hazardous contaminants have been identified in Transline.
Glyphosate (ex. Roundup)	Roundup and Rodeo are not considered carcinogenic to humans and are often portrayed as toxicologically benign. However, two new studies indicate that glyphosate is a hormone-disrupter and is associated with birth defects in humans. Other studies conducted on rats and mice indicate higher levels of toxicity. A Swedish study of hairy cell leukemia (HCE), a form of non-Hodgkin's lymphoma, found that people who were occupationally exposed to glyphosate herbicides had a threefold higher risk of HCE. Roundup and Rodeo cause genetic damage in laboratory animals and in human blood cells. Long-term glyphosate exposure has been linked to reproductive problems in humans. Most reported incidents of impacts to humans have involved skin or eye irritation while mixing and loading. Swallowing Roundup or Rodeo causes mouth and throat irritation, pain in the abdomen, vomiting, low blood pressure, reduced urine output, and in some cases, death. These effects have only occurred when the <u>concentrate</u> was accidentally or intentionally swallowed. The amount swallowed averaged about ½ cup. The exposure levels a person could receive from Roundup or Rodeo in MVNP as a result of application operations would be well below levels shown to cause harmful effects in laboratory studies.
Imazapic (ex. Plateau)	Imazapic is not mutagenic, carcinogenic or teratogenic and would not be expected to have any adverse effect on humans. Imazapic is considered to have low toxicity to mammals. It does not have the potential to “mimic” estrogen, nor

Herbicide (active ingredient)	Impacts of the Herbicide on Human Health Effects
	can it be considered an endocrine disrupter. It is considered nontoxic to mammals through physical exposure or ingestion. If ingested, Imazapic is rapidly excreted in the urine and feces and does not bioaccumulate. There are no human health effects of the inert ingredients in Imazapic.
Imazapyr (ex. Habitat)	Habitat is not mutagenic, carcinogenic or teratogenic and would not be expected to have any adverse effect on humans. Acute toxicology results show that there are no human health effects of the inert ingredients in Imazapyr. If ingested, Habitat is rapidly excreted in the urine and feces and does not bioaccumulate.
metsulfuron methyl (ex. Escort)	No reports of chronic or acute poisoning in humans have been found. Expected exposure levels are below the lowest level that would cause harmful effects. Exposure to Escort may cause skin and eye irritation. No hazardous contaminants have been identified in Escort. It is practically nontoxic to birds and mammals and is not considered a carcinogen, mutagen, teratogen or reproductive inhibitor.
Picloram (ex. Tordon)	The preponderance of data shows picloram to be non-mutagenic in 'In vitro' (test tube) tests and in animal test systems. More recent studies that followed the EPA decision to allow re-registration of picloram show some evidence of mutagenicity. The potential for causing tumors (oncogenicity) has not been determined but more studies are ongoing. EPA has found that there is some added cancer risk for applicators, based on the contamination of picloram with Hexachlorobenzene (HCB) and the structural similarity to di-(2-ethylhexyl)-phthalate or DEHP. In contrast to picloram, HCB is absorbed by the body and does bioaccumulate. A few cases of eye and skin irritation have been reported in workers. There are no reported cases of long-term health effects in humans. The exposure levels a person could receive from these sources, resulting from routine operations, are below levels shown to cause harmful effects in laboratory studies. No serious health effects in humans have been verified. Picloram, when commercially produced, is contaminated with trace amounts of hexachlorobenzene (HCB). Although HCB may cause cancer in humans, the EPA considers the risk from the small amount of HCB present in picloram to be small. Picloram is not fat soluble, does not accumulate in the human body, is not modified by metabolism to more harmful compounds, and is excreted unchanged from the human body within 24 to 48 hours. EPA has established a 12 hour restricted reentry interval for applicators using picloram, and this restriction would also apply to other park staff and visitors.
Triclopyr (ex. Garlon)	It is not known to be carcinogenic to animals. There have been no reported effects of acute toxicity. The exposure levels a person could receive from routine operations are below levels shown to cause harmful effects in laboratory studies. Surfactants and emulsifiers used with Redeem are generally low in toxicity. Triclopyr is classified as a Group D chemical (not classifiable as to human carcinogenicity). The most common breakdown product of triclopyr in mammals is 3,5,6-trichloro-2-pyridinol (TCP). The most significant health hazard identified for TCP is that it may be hazardous to children.

Chemical Effects on Employees and Contractors

Workers applying herbicides may be exposed to chemicals via dermal, respiratory, and dietary routes (e.g. contact with vegetation at a recently treated site, breathing herbicide spray particles, breathing herbicide vapors at a recently treated site, touching or tasting objects with residues).

Toxicology: Routine or typical exposures are those likely to occur in the vast majority of applications. Routine or typical exposures are based on average conditions such as average application rate, average number of acres treated, average buffer distances, and average doses seen in field-based exposure guides (USDA 1992). Barring accidents, it is unlikely workers would receive doses above the “No observed effect” level. Exposure would exceed “acceptable daily intake” only if they fail to use prescribed Personal Protective Equipment (PPE).

During routine operations, workers may be dermally exposed to an herbicide if the herbicide concentrate, mixture, or drifting spray droplets contact their skin; or if the workers contact sprayed vegetation or other surfaces. For some kinds of herbicides, respiratory exposure may result from inhaling air-borne spray droplets if workers fail to wear protective masks or respirators. Field studies of workers have demonstrated that inhalation exposure represents only a small part of the total exposure. Dermal exposure can be up to 50 times greater than inhalation exposure.

Research shows that PPE such as long-sleeved shirts, coveralls, rubber gloves, and hats can substantially reduce dermal exposure. Inhalation of herbicides can be reduced by using protective breathing devices when necessary. PPE recommended for use on the label would be required.

Cancer and Mutation: Human cancer risks from exposure to the herbicides we propose to use are negligible. However, there is scientific uncertainty over cancer risks. Assuming application for 30 days each year for 30 years, the lifetime risk to workers range from 0.5 to 50 cancer occurrences in a population of one million applicators. Few if any applicators at MVNP would make a life-long career of herbicide application except contractors.

Bioaccumulation: Given the herbicides and amounts proposed for use in MVNP, the potential for bioaccumulation or biomagnification appears to be negligible. The number of acres proposed to be treated also is low compared to many agricultural operations, which would reduce exposure risk. Humans and animals high in the food chain (eagle, coyote, mountain lion) are not expected to receive concentrated doses of these chemicals by feeding on contaminated plants or animals. The herbicides are water-soluble, generally not lipid soluble, and are excreted rapidly (USDA-USFS 1996).

Areas to be treated with herbicide would be identified with informative signs and would be closed to the public during chemical application. Notification signs would remain in place at all treated areas for as long as needed.

Impacts of Alternative B on Human Health and Safety

The environmental consequences and risks to human health and safety from using mechanical, biological, and chemical controls are the same as Alternative B. No aerial applications of herbicide would take place in close proximity to areas accessible to the public or areas would be closed during application and not reopened until it is entirely safe. Treatment areas would be off-limits to park

staff during projects. Contractors and staff would use appropriate PPE and mitigation measures stipulated in Appendix A1 and A2. Helicopter operations for herbicide use or the application of biological organisms would use the same kinds of flight safety protocols as for aerial seeding.

Cumulative Impacts

With implementation of the mitigation measures in Appendix A1 and A2 that include employee safety measures and adequate notification of the public, there would be no measurable increased cumulative risk to human health and safety with either alternative. Proposed or on-going projects in and around MVNP that would affect human health and safety include:

MVNP Fire Management Plan: Suppression of wildfires is among the most inherently dangerous activities on public lands. Dangers from flame, smoke inhalation, heat exhaustion, rough terrain, firefighting tools, equipment, vehicles, aircraft, chemicals, wildlife, and other factors must be carefully controlled with planning, training, and by following strict procedures. Managing hazardous fuels lacks the acute urgency of wildfire suppression, but uses or experiences many of the same factors and environmental conditions. Under most circumstances, the public is shielded from most impacts from wildfire, wildfire suppression, and hazardous fuels management. During emergencies, the public, and park staff not involved with the wildfire, are evacuated from the park. Smoke during wildfires is the most uncontrollable public health risk, both from inhalation and in the obstruction of visibility for drivers. During pile burning and prescribed burns, signs are posted to warn the public about smoke hazards.

MVNP burned area emergency rehabilitation: Depending on the scope of the damage after wildfire, park staff and the public can be exposed to a wide variety of hazardous situations. Burned landscapes have many conditions that require elevated preparedness including dead trees that are ready to fall, uneven ground concealed by ash, dirt and ash particles in the wind that can cause eye, throat, and lung irritation, and more. Driving in recently burned landscapes may involve missing road signs and guardrails, reduced visibility from blowing dust and ash, and debris flows washed off of burned hills by rainfall. Post-fire emergency response also can involve repairing utility lines including electrical cables and demolishing destroyed structures. Helicopter operations often are needed to assess conditions from the air, transport supplies and workers to remote locations, or to apply erosion control measures such as reseeded.

MVNP Integrated Pest and Hazardous Wildlife Management Plan: Controlling risks to public health and park resources from pest and hazardous wildlife has its own set of risks to park staff carrying out the work and to some extent the public and other park staff. For example, controlling mice in buildings requires safety precautions against exposure to Hantavirus. Controlling prairie dogs around park facilities may involve fumigants. Hazing or capturing black bears in the campground often involves working at night in dense vegetation or setting live traps in the open and handling anesthetizing drugs and fire arms. Capturing and relocating rattlesnakes from public areas exposes staff to snakebites. This new wildlife IPM plan would be designed to improve public health and safety while minimizing risks inherent to implementing the operations.

MVNP livestock control efforts: Park staff and partners engaged in activities to exclude or remove livestock often work long days in remote areas in a variety of weather conditions. Just accessing and walking in these areas poses its own set of safety risks. Construction and repair of boundary fences also is hazardous due to the heavy and unwieldy supplies and equipment involved including power tools, spools of barbed wire, and heavy posts. Use of stock horses, helicopters, and utility vehicles also require special precautions. In the cases where livestock must be captured and transported out of the park, special skills are needed to safely handle large untamed animals. Impacts to human health and safety would diminish as livestock numbers decline as a result of new livestock control efforts.

MVNP Visitor Distribution and Transportation Plan: Because the scope of this future proposed plan is not yet known, it is difficult to predict what level of added risk to human health and safety may come from it. Increasing access to some backcountry areas would likely mean more people would become lost, injured, exhausted, or harmed by wildlife than currently occurs at MVNP, thus requiring more search and rescue or emergency medical operations for park staff. Construction and maintenance of new infrastructure to support expanded public access also has safety risks for the workers that must construct and maintain the facilities. Increasing the scale and magnitude of public activities is likely to lead to more incidents, which then risks the park staff that must respond. However, public transportation could lead to fewer traffic accidents on the park's roads during the peak visitor season.

Paths to Mesa Verde: Opening a public through-trail across the northern part of the park could result in more safety incidents in an area, which would expect none under current conditions except for around the Visitor and Research Center. The degree of the elevated public and staff risks cannot be estimated until a proposal is made.

MVNP road construction and major maintenance projects: MVNP annually is involved in several facilities construction projects and maintenance operations that range from small and routine involving only park staff to large and complex involving staff and contractors. Activities can involve heavy machinery, power tools, heights, tight dark locations, loud noises, falling objects, uncertain footing, exposure to wildlife, disease vectors, dangerous chemicals, and sewage, working in close proximity to moving traffic, and more. The primary risks of these activities are borne by park staff and contractors, which closely follow prescribed health and safety procedures. Additional precautions are implemented to minimize risk exposure to the visiting public. This includes ensuring that drinking water supplies are healthful and public areas are kept under sanitary conditions.

MVNP Concessions Contract: The private company that is awarded the concessions contract at MVNP has special responsibilities related to the health and safety of their own staff and the customers they serve at the campground, lodge, restaurants, bus and tram tours, and gift shops. These include many of the same kinds of maintenance, construction, pest management, and recreational activities named above for park operations. The concessions company has a further responsibility to ensure the foods they prepare are safe to consume.

Revision of the San Juan National Forest Plan and BLM Tres Rios Field Office Resource

Management Plan: The scope and scale of health and safety issues related to the millions of acres of public lands managed by the US Forest Service and BLM in southwest Colorado is too great to describe here in any detail. Many of the same kinds of operations at Mesa Verde occur on these lands such as fire and fuels management, paved roads, trails, and infrastructure construction and maintenance, wildlife and livestock management and invasive plant control, public hiking and camping, etc. Often the size and complexity of these operations on these lands greatly exceeds those at MVNP but additionally their multiple use management goals add another level to their health and safety issues. These management aspects include off highway vehicles, backcountry camping, mountain bikes, water sports, timber extraction, grazing, mining, oil and gas production, dirt roads, major pipelines and electric transmission lines, etc.

Conclusion for Alternative A and B

The invasive plant control techniques that would be employed for Alternative A are expected to cause negligible elevated health and safety risks to park visitors, staff, and nearby residents when compared to all the other issues involved in park management. Park employees and volunteers would be exposed to risks inherent with strenuous outdoor activities during the summer months, and the hazards associated with the use of hand tools, gasoline powered equipment, and chemicals. In addition, visitors, nearby residents, and other park employees and volunteers would be exposed to the small risks associated with the use of herbicides such as skin contact. With the implementation of the mitigation measures found in Appendix A1 and A2, the potential impact of herbicide use on human health is expected to be negligible. Alternative B poses essentially the same risks associated with Alternative A along with some additional intermittent use of aircraft.

Consultation and Coordination

Previous 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 proposal while minimizing the impacts. MVNP conducted both internal scoping with appropriate National Park Service staff and external scoping and consultation with the public and interested/affected groups and agencies.

Current Public Scoping

A press release to notify the public of the scoping period for the IPMP was distributed to local and regional news outlets. A similar invitation letter also was sent simultaneously to over 130 agencies, culturally affiliated tribes, elected officials, and park neighbors. The external scoping process was initiated on January 14, 2014 and closed on February 14, 2014. During this 30-day public scoping period the NPS received a total of nine comment letters. Three were submitted electronically through the PEPC web-centered public database, three were received by US Mail, and three by e-mail. By contacting over 140 people, organizations, and agencies, park management invited the public and any other interested parties or groups to offer suggestions and issues of concern. Feedback from all scoping periods was incorporated into development of this plan/EA.

- The following is a summary of comments and recommendations received during the public scoping period from individuals and agencies. One tribal comment is discussed under Tribal Scoping and Consultation. The recommendations were incorporated into the applicable sections of the IPMP. Adopt best management practices as applied to an integrated form of invasive species management including the use of biological, mechanical, cultural and chemical methods.
- Consider the need of aerial applications of herbicide and biological controls “based on our ever changing technology.”
- Cooperatively survey, map, treat, and monitor invasive species populations with adjacent landowners, agencies, and tribes. Enter into partnership agreements as necessary.
- Share the mapping data on invasive plants from MVNP and YHNM with federal, tribal, state, and local government partners.
- Adopt the Colorado Department of Agriculture's noxious weed list and prioritize invasive plant management efforts in MVNP and YHNM on these species. This would include reporting and treating any List A species found on park and monument lands with the objective of total eradication; report and treat any List B species subject to eradication in Montezuma County with the objective of total elimination; and work to contain and suppress populations of other List B populations.
- Become a member of the Colorado Department of Agriculture's statewide Early Detection and Rapid Response framework, thus providing early detection and treatment of invasive species new to the state or of newly-found populations of Colorado List A species.

- Ensure the Colorado State Historic Preservation Office is consulted in a timely and systematic manner to facilitate the communication of suggestions for improving the plan's protections for cultural resources.
- Consider the contents of the Montezuma County Weed Management Plan.
- Private landowners around the MVNP are struggling with Russian knapweed and several other invasive plant species. A cooperative approach is needed to address the problem.
- There are various tactics available for reducing the spread of invasive plants and for restoring native vegetation.
- There is a need for improving public awareness about the threats of invasive plants. Private landowners would benefit from an outreach educational program to help them better manage invasive plants on their lands.
- MVNP should alter the stand density of their pinyon-juniper woodlands to deter stand replacing wildfires in order to avoid the post-fire environmental conditions that are so favorable for the growth and spread of invasive plants.

The IPMP may receive further modifications based on remarks received while the EA is open for public comment. Once this is completed, it is anticipated that this plan would be formally adopted.

Endangered Species Act Consultation

Endangered Species Act (ESA) Section 7 Consultation with the US Fish and Wildlife Service (USFWS) was initiated with a letter dated February 15, 2006. The 2006 IPMP EA also was sent to the USFWS along with a separate Biological Assessment (BA) for evaluation. The USFWS commented on the plan and requested clarifications and minor modifications, which plan preparers completed. Although, the 2006 plan was never formally adopted, it provided the framework for controlling invasive plants at the park and monument over the following years. Consultation was reinstituted on January 14, 2014 with a new letter notifying USFWS of the new planning effort for the IPMP and development of a new BA. Since then the USFWS has been waiting for the 2015 IPMP EA and BA to be completed.

Other Agency Consultation

In addition to the National Environmental Policy Act (NEPA) and Endangered Species Act (ESA), the undertakings described in this document are subject to §106 of the National Historic Preservation Act (NHPA), as amended in 1992 (16 USC §470 *et seq.*) and, thus, serve as an Assessment of Effect. This EA will be submitted to the Colorado State Historic Preservation Office (SHPO) for review and comment to fulfill MVNP and YHNM obligations under §106 (36 CFR §800.8[c], *Use of the NEPA process for section 106 purposes*).

The Colorado SHPO was notified in January of 2014 that the IPMP was in production. SHPO responded by requesting that they be consulted in a timely and systematic manner to facilitate the communication of suggestions for improving the plan's protections for cultural resources. In January of 2015, a letter was sent to SHPO and also the Advisory Council on Historic Preservation

notifying them that the IPMP would be used to address compliance under §106 of the NHPA. The IPMP will be made available to SHPO for their review and comment during the formal 30-day period.

Tribal Scoping and Consultation

The scoping letter dated February 15, 2006 was mailed to representatives from tribes culturally affiliated with MVNP and YHNM. Three letters were received back from tribal representatives in 2006, the Pueblo of Laguna, Ysleta Del Sur Pueblo of Texas, and the Southern Ute Tribe. These representatives did not have any concerns at that time but requested consultation in the event that archeological discoveries are made in the process of invasive plant management activities.

The NPS annually conducts government to government consultation with tribes culturally affiliated with MVNP and YHNM. Below is a list of Native American tribes contacted. Topics of consultation vary but most often relate to how NPS actions at the two units may affect cultural resources and values of significance to the tribes. Historically, issues related to YHNM have not often been a priority and the topic of invasive plant control has not been discussed much either. However, as a result of recent scoping and consultation, it is expected that consultation regarding this issue for both parks will become a regular topic of discussion.

The tribal scoping letter for the current version of the IPMP was sent to affiliated tribal representatives in January of 2014. In so doing, park management invited the tribes to offer suggestions and issues of concern. The park received a response letter from the Supervisory Anthropologist for the Navajo Nation dated January 30, 2014 and one dated February 3, 2014 from the Director of the Hopi Cultural Preservation Office. Both expressed interest in the IPMP and requested to remain informed. On April 10, 2014 park management also engaged in in-person consultation with culturally affiliated tribes in which the topic of invasive plant management was included and verbal comments were received.

In summary, the letter from the Hopi Tribe stated that they recognize that invasive plants are one of many threats to ancestral sites so their control is important. Although they do not support the use of herbicides in cultural sites, particularly in areas they administer, they do not oppose their careful use in the park and monument. This was clarified through personal communication at the tribal consultation meeting in which it was explained that the tribe was concerned that herbicides could contaminate plants used for traditional medicines and otherwise harm the integrity of sacred spaces, but that retaining the land's native ecology also was important.

Previous Internal Scoping

Internal scoping was conducted between 2002 and 2005 by the MVNP interdisciplinary management team. The management team defined the purpose and need, discussed potential actions to address the need, determined what likely issues and impact topics would be, and identified the relationship, if any, of the proposed action to other planning efforts at the park and monument.

During the 30-day public comment period for the Plan/EA in 2006, The Fire Ecologist for Zion National Park sent a memorandum in response to the scoping letter in support of the preferred

alternative. He stated that the goals and proposed actions were appropriate for the plan. Given adequate sustainable funding, Alternative B, the preferred alternative, with an adaptive management approach, would be most effective in treating infestations and achieving the long-term goals of the plan. He also mentioned the importance of utilizing the NPS Exotic Plant Management Teams to enhance the park's staff crew.

The Natural Resource Conservation Branch within MVNP's Division of Research and Resources Management developed this plan/EA with substantial input from the NPS Biological Resources Management Division, the Intermountain Region Support Office, and the Intermountain Regional Integrated Pest Management Coordinator. Rocky Mountain National Park and Dinosaur National Monument's (Spencer 2005) invasive plant management plans were used as models and examples for developing this document.

Recent Internal Scoping

On April 16, 2014 the park's principal program managers participated in a full day of internal scoping of the IPMP. Several issues were brought forward or reconsidered. Park managers requested that:

- The list of actions be expanded that describes cumulative impacts,
- The use of herbicides be expanded to include controlling native plant species growing in pest or nuisance circumstances,
- Develop an invasive plant control impact mitigation checklist for archeological sites,
- Explain that lands inside the park managed under contract by the concessions company must include the company's responsibilities towards controlling invasive plants,
- Ensure that contractors working in the parks will be held responsible for invasive plant infestations caused by their actions,
- Improve informational/educational outreach to park and concessions staffs about identifying and controlling the spread of invasive plants,
- Include a decision making pathway among the appendices for determining future issues (a good example was found from Canyonlands and Arches National Parks),
- Better explain how the park would evaluate environmental impacts for proposed future use of biological controls and how that would be shared with the public for their consideration and feedback,
- Separate for impact analysis the Cultural Resources section of the EA into three separate categories: archeology and ethnographic resources, and cultural landscapes, and determine an effect for each,
- Remove the Impairment analysis from the EA because this information is now reserved for records of decision.

- Ensure that “cross-operational” roles are defined, including the concessionaire, and the resulting plan is inclusive.
- Ensure that interagency collaboration is identified.
- Expand the list of potentially available mitigation measures.

Subsequent to internal scoping, a series of draft IPMP texts were produced by the MVNP Natural Resource Manager over the following several months with feedback obtained from park management influencing each iteration. Additional reviews were performed by subject matter specialists at the NPS Intermountain Regional Office. Many of the comments obtained during text reviews also provided insight into affected resources, impacts, and mitigations used in the final IPMP EA.

Plan Preparers

George San Miguel, MNVP Natural Resources Manager, chief editor, final document writer, and NEPA and ESA Section 7 compliance coordinator

Bryan Wender, MVNP Vegetation Program Manager, responsible for initially compiling the 2015 version of the plan including environmental consequences, mitigation, consultation/coordination, references and appendices

Scott Travis, MVNP Chief of Research and Resources Management 2008-14, reviewer and NHPA Section 106 compliance coordinator

Plan Reviewers

Marybeth Garmoe, MVNP Vegetation Ecologist

Cliff Spencer, MVNP Superintendent

Bill Nelligan, MVNP Deputy Superintendent

Allan Loy, MVNP Project Manager

Cheryl Eckhardt, NPS IMR Environmental Protection Specialist / Regional §106 Coordinator

Mike Wrigley, NPS IMR Wildlife Biologist / Endangered Species Coordinator

Myron Chase, NPS IMR Integrated Pest Management and Invasive Species Coordinator

List of Agencies and Organizations Contacted

The following agencies, universities or organizations were contacted for information; or assisted in identifying important issues, developing alternatives, or analyzing impacts; or that were invited to review and comment upon the management plan, environmental assessment, assessment of effect,

and biological assessment. In addition, elected officials from the State of Colorado, Montezuma County, and the cities and towns of Cortez, Durango, Dolores, and Mancos also were contacted. Native American tribal members consulted are listed in the following section.

Colorado Department of Agriculture
Colorado Department of Transportation
Colorado Department of Natural Resources
Colorado Parks and Wildlife
Colorado State Land Board
Colorado State Historic Preservation Office (EA/AE will be sent upon completion)
U.S. Fish and Wildlife Service (EA/BA will be sent upon completion)
US Forest Service
US EPA Region 8
Natural Resource Conservation Service
Bureau of Indian Affairs
Bureau of Land Management
Fort Lewis College, Colorado
Prescott College, Arizona
Montezuma County Extension
Montezuma County Planning Department
Montezuma County Weed Program
North American Invasive Species Management Association
Colorado Weed Management Association
Mesa Verde Foundation

List of Native American Tribes Contacted

The 26 tribes and pueblos culturally affiliated with MVNP and YHNM were invited to participate in the issues and alternatives scoping process and to review and comment in this Plan/EA.

Hopi Tribe of Arizona
Kewa Pueblo, New Mexico (previously listed as the Pueblo of Santo Domingo)
Ohkay Owingeh, New Mexico (previously listed as the Pueblo of San Juan)
Pueblo of Acoma, New Mexico
Pueblo of Cochiti, New Mexico
Pueblo of Isleta, New Mexico
Pueblo of Jemez, New Mexico
Pueblo of Laguna, New Mexico
Pueblo of Nambe, New Mexico
Pueblo of Picuris, New Mexico
Pueblo of Pojoaque, New Mexico
Pueblo of San Felipe, New Mexico
Pueblo of San Ildefonso, New Mexico
Pueblo of Sandia, New Mexico
Pueblo of Santa Ana, New Mexico
Pueblo of Santa Clara, New Mexico
Pueblo of Taos, New Mexico
Pueblo of Tesuque, New Mexico

Pueblo of Zia, New Mexico
Ysleta Del Sur Pueblo of Texas
Zuni Tribe of the Zuni Reservation, New Mexico
Jicarilla Apache Nation, New Mexico
Southern Ute Indian Tribe of the Southern Ute Reservation, Colorado
Ute Indian Tribe of the Uintah & Ouray Reservation, Utah
Ute Mountain Tribe of the Ute Mountain Reservation, Colorado, New Mexico & Utah
Navajo Nation, Arizona, New Mexico & Utah

Colorado Congressional Delegation Contacted

Senator Mark Udall

Senator Cory Gardner

Senator Michael Bennet

Representative Scott Tipton

References

- Anderson, R. S., Diana Anderson, Erin Herring, Taylor Joyal. 2012. Environments of Mesa Verde National Park (MEVE) during the Holocene and Anthropocene: an interdisciplinary study of vegetation, fire, humans and climate. Mesa Verde National Park. Unpublished final report on file with the Mesa Verde National Park Natural Resource Office.
- BASF Corporation. 2008. Plateau® herbicide label. Available online: <http://www.cdms.net/LabelsMsds/LMDefault.aspx?pd=3778&t=>
- Carlson-Foley Act (P.L. 90-583).
- Center for Invasive Plant Management. 2003. Invasive Plant Prevention Guidelines. www.weedcenter.org.
- Chase, M. February 20, 2014. Personal communication on acetic acid herbicides. Intermountain Region IPM Coordinator, NPS, Denver, Colorado.
- Chinery, D and L. Weston. 2008. Evaluation of acetic acid based herbicides for use in broad-spectrum turf grass and weed control. Cornell Cooperative Extension
- Clean Water Act. 33 USC 1251-1376 (1982). 1972.
- Colorado Undesirable Plant Management Act (Title 35, Article 5.5 CRS).
- Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. *Classification of Wetlands and Deep Water Habitats of the United States*. Technical Report FWS/OBS/79/31. U.S. Fish and Wildlife Service, Official Bulletin Service.
- Colyer, Marilyn. 2003. *Water Resources in Mesa Verde Country*. In: *Ancient Piñon-Juniper Woodlands: A Natural History of Mesa Verde Country*. Edited by M. Lisa Floyd. University of Colorado Press, 5589 Arapahoe Avenue, Suite 206C, Boulder, Colorado 80303.
- Director's Order (DO) 55*: Interpreting the National Park Service Organic Act, NPS 2000.
- Director's Order (DO) 77*: Natural Resource Management, NPS 1988.
- Director's Order (DO) 28*: Cultural Resource Management Guidelines, NPS 1998a.
- Director's Order (DO) 12* and Handbook: Conservation Planning, Environmental Impact Analysis, and Decision Making. [Washington, D.C.], 2001.
- Endangered Species Act (ESA) (16 U.S.C. 1531 et seq.)
- Executive Order 11990 - "Protection of Wetlands." 42 USC 4321 (1982). May 24, 1977.
- Executive Order 13112 – "Invasive Species." 42 USC February 3, 1999.
- Floyd-Hanna, L., A. Spencer, A.W., and W. H. Romme. 1996. Biotic Communities of the Semiarid Foothills and Valleys. Pp. 143-158 In: Blair, R (editor). *The Western San Juan Mountains: Their Geology, Ecology and Human History*. University of Press Colorado, Boulder, Colorado.

- Floyd, L. M., W. H. Romme, and D. D. Hanna . 2000. *Fire History and Vegetation Pattern in Mesa Verde National Park*, Colorado, USA. *Ecological Applications* 10: 1666-1680.
- Floyd, L. M. and M. Colyer. 2003. Beneath the Trees: Shrubs, Herbs, and Some Surprising Rarities. Pp. 31-60 In: Floyd, L. M. (editor). *Ancient Piñon-Juniper Woodlands: A Natural History of Mesa Verde Country*. University Press of Colorado, Boulder, Colorado.
- Floyd, L. M., 2003. Gnarly Old Trees: Canopy Characteristics of Old-Growth Piñon-Juniper Woodlands. Pp. 11-29 In: Floyd, L. M. (editor). *Ancient Piñon-Juniper Woodlands: A Natural History of Mesa Verde Country*. University Press of Colorado, Boulder, Colorado.
- Floyd, L. M., W. H. Romme, and D. D. Hanna, 2003. Post-Fire Succession following Wildfires in Mesa Verde National Park Community Level Multiple Pathways of Native and Invasive Species. Draft: unpublished document on file with Mesa Verde National Park Natural Resources.
- Floyd, L. M., Hanna, D., Romme, W.H., and T. Crews. 2004. Non-Native Invasions Following Fire in Southwestern Colorado: Long-term Effectiveness of Mitigation Treatments and Future Predictions. Unpublished report on file with Mesa Verde National Park Natural Resource Office.
- Floyd-Hanna, L., D. Hanna, and W. H. Romme. 2006. Predicting and Mitigating Weed Invasions to Restore Natural Post-Fire Succession in Mesa Verde National Park, Colorado, USA. *International Journal of Wildland Fire* 15, 247-259.
- Harris, P. and R. Cranston. 1988. An Economic Evaluation of control methods for diffuse and Spotted Knapweed in Western Canada. *Canadian Journal of Plant Science* 59: 375-382.
- Hertwich E.G., Mateles S.F., Pease W.S., Mckee T.E. 2001. Human toxicity potentials for life cycle assessment and toxic release inventory risk screening. *Environ. Toxicol. Chem.* 20(4):928-939.
- Hertwich E.G., Mckone T.E., Pease W.S. 2000. A systematic uncertainty analysis of an evaluative fate and exposure model. *Risk Anal.* 20(4):437-452.
- Kaesler, Melanie J. and L. Katherine Kirkman. 2010. The effects of pre- and post-emergent herbicides on non-target native plant species of the longleaf pine ecosystem. *Journal of the Torrey Botanical Society*, Vol. 137, No. 4.
- Marier, Joelle. 2014. *Wilderness Building Blocks, Mesa Verde Wilderness*. National Park Service.
- Migratory Bird Treaty Act of 1918 (MBTA), codified at 16 U.S.C. §§ 703–712
- MVNP. 2002a. *Mesa Verde National Park 2002 Annual Report*. Unpublished document on file with Mesa Verde National Park Natural Resource Office, 2002a.
- MVNP. 2003a. *Annual Report*. Unpublished document on file with Mesa Verde National Park Natural Resource Office, 2003a.
- MVNP. 1996. Backcountry Use and Access Plan.
- MVNP. May 1979. Mesa Verde National Park General Management Plan.
- MVNP. 1998. Natural Resource Management Plan.

MVNP. 2000. Yucca House National Monument Strategic Plan.

Montezuma County. 1994. Montezuma County Comprehensive Weed Management Plan.

Moore, Lynn M. 2005a. Post-fire Monitoring of Ponderosa Pine (*Pinus ponderosa* P & C Lawson) in Mesa Verde National Park, Colorado. 18 April. 2005a. Windom Floristics. Durango, Colorado.

Moore, Lynn M. 2005b. Inventory and Monitoring of Select Species of Special Concern: Mesa Verde National Park, Final Report. 18 November 2005. Windom Floristics. Casper, Wyoming.

McLendon, T. 1996. Factors Controlling the Distribution of Canada Thistle *Cirsium arvense* in Montane Ecosystems: Rocky Mountain National Park, Colorado. NPS Contract #1268-1-9002.

National Environmental Policy Act (NEPA) of 1970, 42 U.S.C. 4321 et seq.

Olson, R.A. 1995. *Impacts of Noxious Weeds on Wildlife*. Symposium on non-native invasive plants: A biological disaster, September 19, 1995.

Ramsey, D. 2003. *Soils of Mesa Verde Country*. In: *Ancient Piñon-Juniper Woodlands: A Natural History of Mesa Verde Country*. Edited by M. Lisa Floyd. University of Colorado Press, 5589 Arapahoe Avenue, Suite 206C, Boulder, CO 80303.

Romme, William H., Floyd-Hanna L., Hanna D. 2003. Ancient Piñon-Juniper Forests of Mesa Verde and the West: A Cautionary Note for Forest Restoration Programs. USDA Forest Service Proceedings RMRS-P-29.

Southeast Utah Group. Exotic Plant Management Plan Environmental Assessment. National Park Service.

Spencer, Emily. October 2005. Dinosaur National Monument Invasive Plant Management Plan and Environmental Assessment, National Park Service.

Thomas, K. A., M. L. McTeague, L. Ogden, M. L. Floyd, K. Schulz, B. Friesen, T. Fancher, R. Waltermire, and A. Cully. 2009. Vegetation classification and distribution mapping report: Mesa Verde National Park. Natural Resource Report NPS/SCPN/NRR—2009/112. National Park Service, Fort Collins, Colorado.

U.S. Department of the Interior, Bureau of Land Management. 1991. *Vegetation Treatment on BLM Lands in Thirteen Western States*. EIS, Washington D.C.

U.S. Department of the Interior. 1985. Guide for pesticide use in the national park system. Biological Resources Division, Washington, D.C.

U.S. Department of the Interior, National Park Service. *Management Policies, The Guide to Managing the National Park System*. Washington, D.C. 2006.

U.S. Department of the Interior, National Park Service. 1994. NPS-77 *Natural Resources Management Guidelines*.

U.S. Department of the Interior, National Park Service. 1916. *Organic Act*. 16 U.S.C. 1 et seq. Wilderness Act of 1964, 16 USC. 1131 et seq.

U.S. Fish and Wildlife Service (USFWS). 2013a. A New Biological Management Option against Cheatgrass Raises Hope of Western Land Managers. News Release of April 1, 2013.

U.S. Fish and Wildlife Service (USFWS). 2013b. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form: Schmoll milk-vetch.

Wender, B. February 18, 2014. Personal communication on acetic acid herbicides. District Botanist, BLM, Grants Pass, Oregon.

Wilderness.net. Minimum Requirements Decision Guide, 2014.
<http://www.wilderness.net/index.cfm?fuse=MRDG>

Wright, W. G. March 2006. Hydrology and Geochemistry of Yucca House National Monument and Surrounding Area, Southwestern Colorado. Hydrological Studies Report 2006-1. Southwest Hydro-Logic.

Appendix A1: Invasive Plant Management Plan for Mesa Verde National Park and Yucca House National Monument – Typical Treatment Methods and Sites, Standard Operating Procedures, and Mitigation Measures

Introduction

This Invasive Plant Management Plan is needed to guide park managers in dealing with invasive plant issues that continue to increase in complexity and scope at Mesa Verde National Park (MVNP) and Yucca House National Monument (YHNM). Often the terms “invasive plant,” “exotic plant,” “non-native,” “noxious” and “weed” often are used interchangeably in common speech. For consistency, throughout most of this document the term “invasive plant” will be used in referring to plant species that are not native to the southwestern United States and that have the potential to invade and adversely affect natural communities. In the absence of a comprehensive approach to managing invasive plants, they may negatively affect natural resources, cultural resources, and visitors’ experiences. This plan provides park managers with a comprehensive park-wide strategy to prevent the establishment and to control the spread of invasive plant species. The plan offers up-to-date, long-term, and consistent guidance in preventing, containing, suppressing, eradicating, and monitoring invasive plant populations at MVNP and YHNM.

The primary objectives of the Invasive Plant Management Plan are to:

1. Identify and control priority infestations of invasive plants by eradicating them, reducing their size and density, or containing their spread following a strategy that incorporates an ecological rationale, cultural resource protection goals, and visitor enjoyment goals.
2. Identify best management practices to help detect and prevent the entry, establishment, and spread of new invasive plant species and infestations into the park and monument.
3. Use comprehensive decision-making tools and annual work plans to prioritize and select optimal integrated pest management techniques and treatment options.
4. Identify a process through which new herbicides, bio-controls, and other tools can be evaluated and added to the MVNP toolbox in the future for managing invasive plants.
5. Implement a monitoring and evaluation process that assesses the short- and long-term success, efficacy, and cost treatments; thereby encouraging adaptive management.

MVNP managers intend to be proactive versus reactive by detecting and stopping invasive plants before they become a serious threat to the park’s and monument’s natural and cultural resources. Invasive plants may alter natural plant communities by displacing native species, at times converting communities that are rich in native species into ones that have fewer species. Changes may also occur to soils and hydrology at an infested site. Similarly, ecological processes, such as the frequency or severity of wildfire, may be altered because of invasive plant infestations. In turn,

changes in plant communities may have subsequent effects on wildlife, including rare, threatened, or endangered species.

Invasive plants may alter the integrity and authenticity of historic or cultural landscapes – a major attribute for park and monument visitors. A severe example would be the potential effects on surface and subsurface archeological sites and artifacts that results from more frequent or severe wildfires and soil erosion that might follow some invasive plant infestations.

Visitor enjoyment of park and monument resources also would be diminished if invasive plants are not effectively controlled. . For example, the campground at MVNP currently is infested by houndstongue, an invasive plant that contains toxic alkaloids and produces large quantities of seeds, each covered with hooked barbs that readily attach to clothing, hair, and fur. An encounter with houndstongue seeds can be inconvenient and cause discomfort as they are difficult to remove from clothing and particularly from pet fur.

Invasive plants near park and monument boundaries threaten to infest neighboring lands and communities. Conversely, where neighboring landowners are not effectively controlling invasive plants, these invasive species can spread into the park and monument. A comprehensive invasive plant management plan would help park managers to work closely with local citizens, organizations, communities, local governments, the state, and adjacent federal and tribal landowners to achieve common goals of managing invasive plants.

Strategy

The foundation of this plan is an Integrated Pest Management (IPM) approach to invasive plant control. NPS Management Policies (NPS 2006) instructs each park to implement IPM, which is described as “a decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage by cost-effective means while posing the least possible risk to people, resources, and the environment.”

IPM includes these steps:

1. Identify invasive plant species.
2. Establish action thresholds for new and established invasive plant species and infestations.
3. Identify invasive species management priorities.
4. Evaluate and select treatment techniques appropriate to the species and the site.
5. Confirm that compliance and required approvals have been obtained for proposed actions.
6. Implement selected treatments.
7. Monitor the site to evaluate the efficacy of treatments.
8. Prescribe revised treatment actions as needed.

This approach begins with identifying invasive plant species and infestations, then assessing their potential ecological, economic, operational, and human impacts. Action thresholds would be identified for each species and/or infestation. Invasive plant species and infestations may be prioritized for treatment based on potential impacts (often weighing impacts of treatment vs. impacts of failure to treat), action thresholds, probability of success, and operational considerations.

These factors help to determine treatment objectives, such as whether an invasive plant infestation should be suppressed, contained, eradicated, or potentially not managed. Benchmarks for success would be clearly identified on a case by case basis using the above factors. Subsequently, treatment methods would be selected, often including more than one cultural, mechanical, chemical, or biological treatment. After being implemented, infestations and the efficacy of treatments would be monitored and thoroughly evaluated. As needed, new treatments would be prescribed, with potential changes in technique, equipment, frequency, timing, and other prescription variables.

The Invasive Plant Management Plan is a more comprehensive and adaptive than the previous approach by including these broad components:

1. An invasive plant prevention program that strengthens early detection surveys; reduces the opportunities for new infestations to establish following park operations that cause ground disturbance (e.g., construction, utility upgrades, fuels management projects); enforces compliance for weed-free equipment, gravel, seed, mulch, and other materials brought into the park or monument; and improves the understanding among park staff and visitors of the issues relating to invasive species.
2. A decision-making framework for prioritizing invasive plant infestations for management and determining the appropriate treatment methods (see Appendix A3).
3. Use of additional herbicides, biological control agents, and equipment could be approved following a thorough review process.
4. A monitoring and evaluation process that assesses the short- and long-term success, efficacy, and cost of treatments; thereby encouraging adaptive management.

Prevention and Early Detection

- MVNP Natural Resource staff would have primary responsibility for conducting regular early-detection surveys for potential new invasive plant species in probable habitats, with a focus on road corridors and sewage treatment facilities, the MVNP entrance, the MVNP campground, and other disturbed areas. However, all park operations would contribute to this effort, including the concessionaire, along with other park partners.
- MVNP would join the efforts of the Colorado Department of Agriculture's statewide Early Detection and Rapid Response framework, thus providing early detection and treatment of invasive species new to the state or of newly-found populations of Colorado A-listed species.
- Prevention programs would target participation from MVNP employees, concessionaires, researchers, and contractors.
- An education program for park staff and partners working in the park would solicit their assistance in reporting high priority invasive plants and becoming familiar with best management practices to prevent their entry or spread.

- To prevent the establishment of invasive plant populations, park projects would minimize disturbance of soil and native vegetation to the extent possible.
- When major soil disturbance and vegetation removal cannot be avoided, native species would be reseeded or replanted in the disturbed area under the guidance of Natural Resource staff.
- Any materials used in the park or monument for construction, maintenance, restoration, or landscaping (e.g., sand, gravel, fill, mulch, and wood chips) would be inspected to ensure they are weed-free before entering the park or monument, to the extent practical. When possible, source areas outside the park, such as gravel pits and gravel piles, also would be inspected before they are approved for delivering their products into the park.
- Materials to be moved between locations within the park would be evaluated by park staff to the extent practicable to minimize the spread of viable invasive plant seeds and roots.
- All construction equipment owned by the government, concessions, utilities, and contractors would be required by contract or operation plans to be clean prior to entering the park.
- Park contracts must include a long-term commitment on the part of the contractors and their subcontractors to take responsibility for invasive plant infestations they cause and get them removed.
- Any equipment that operates off-road in a project area known to contain invasive plants would be pressure-washed prior to entering an area that is essentially weed-free.
- Only certified weed-free livestock feed would be permitted in MVNP, with no hay of any kind permitted in the backcountry. Authorized livestock belonging to NPS, partners, or others would be brushed free of seed or debris that could harbor weed seed before entering the park and would use only certified weed-free feed. Weed-free quarantine periods are to last at least five days to be consistent with the Montezuma County Weed Management Plan.
- MVNP staff would increase efforts to inform park visitors about invasive plants and the park's strategy for managing these species. Some ideas for improving and expanding awareness include:
 - Visitor Centers: Expand information available on invasive plants at visitor centers (site bulletins, postings on bulletin boards, and/or through personal communication by rangers).
 - Interpretive Programs: Interpretive rangers leading guided tours may be given information and encouraged to discuss invasive plant management issues and treatments in MVNP.
 - Environmental Outreach Programs: MVNP can integrate invasive plant management issues into current environmental education curricula.

- Park Newspaper/Press Releases: Use the park newspaper or press releases as a venue for informational articles and updates about invasive species and their management in MVNP.
- Signs: Select treatments in high-use areas may be posted with conspicuous signs detailing the purpose of the project.

Treatment

MVNP Natural Resource staff would use a decision-making framework (see Appendix A3) for annually prioritizing invasive plant infestations for management and determining the appropriate treatment methods. Annual treatment priorities and recommended methods would be documented in an annual Invasive Plant Management Work Plan. When possible, the Colorado Department of Agriculture's noxious weed list would be used in setting priorities for invasive plant management efforts in MVNP and YHNM. This would include reporting and treating any List A species found on park and monument lands with the objective of total eradication; report and treat any List B species subject to eradication in Montezuma County with the objective of total elimination; and working to contain and suppress populations of other List B populations. Treatment methods would be site specific, species specific, optimally timed, designed to be practical, and designed to minimize risks to natural resources, cultural resources, and human health and safety. Treatment methods may be manual, mechanical, cultural, chemical, biological, or some combination of these.

The basic elements of this framework are described below:

- *Based on identified action levels and thresholds:* The action level is the size or density of an invasive plant occurrence at which some level of management must be applied in order to prevent that population from reaching a determined threshold level. The threshold level is defined as the size of the invasive plant occurrence that causes unacceptable damage sufficient to warrant management of the problem. (see Appendix A3) If it is determined that eradication is not feasible, the objective would be to suppress the occurrence below the threshold level, or conduct limited eradication or containment in sensitive areas of the park and monument. In some cases, the action level is reached when only one plant is located and eradication is possible.
- *Little or no risk to native vegetation, wetlands, wildlife, soils, or other natural resources:* MVNP would evaluate treatment options and ensure all environmental compliance standards are met. MVNP would review any new relevant scientific literature and references to ensure that the control technique selected utilizes the best technique available. Standard operating procedures and mitigation measures would be used to eliminate the risks herbicides could pose in the vicinity of water. Furthermore, herbicides would not be used within five feet of springs or seeps during low flow periods. In addition, some species may require more than one application of herbicide. To improve the efficacy of an herbicide, other IPM techniques, such as mowing, may be used before the chemical is applied.

- *Little to no risks to humans:* IPM techniques have the potential to harm humans if hazards are not mitigated. Injuries can occur with the use of weed whackers, chainsaws, hand tools, and prescribed fire. There is a potential for harm to visitors and other staff in areas where invasive plant management is occurring in high visitor or staff use areas. The Mesa Verde Hazard Communication Plan addresses the use of hazardous chemicals and materials within the park and monument. This document includes protocols for maintaining MSDS sheets, Job Hazard Analyses (JHA), container labeling, and training of employees and guidelines for respiratory safety. This plan also addresses pesticide handling including storage, disposal, personal protection equipment and an herbicide spill plan. JHA's were developed for the management program. The purpose of the analyses is to define the technique and tools required for each IPM activity and thoroughly examine all steps of the activity and identify and mitigate potential hazards of each step. Other activities include posting notice of herbicide applications in visitor use areas.
- *Little or no risk to cultural resource:* In consultation with cultural resource management specialists MVNP would identify a control technique that poses negligible or no impact to known cultural resources. Ground disturbing activities, such as digging plants, using a UTV or prescribing fire, may not be appropriate for invasive plant removal where cultural resources are present.
- *Cost effective to implement:* Cost is not the driving factor in selecting appropriate IPM techniques, but is considered in the context of size, location, integrity of resources threatened, and the management goal (eradication, suppression, containment) for a particular treatment area. Having a full range of appropriate IPM techniques in an invasive plant management tool box allows the choice of the treatment that is most cost effective to implement. Choices of techniques and management strategy have both long-term and short-term cost implications. Often spending more money initially would allow lower costs in the future if infestations are prevented or controlled.

Other key elements of the approach to treating invasive plants under this plan include:

- Treatment methods would be site specific, species specific, optimally timed, designed to be practical, and designed to minimize risks to natural resources, cultural resources, and human health and safety (see Appendix C for a recent list of invasive species targeted and the chemicals used).
- Treatment methods may be manual, mechanical, cultural, chemical, biological, or some combination of these.
- **Manual/Mechanical Treatments** would be used primarily for small invasive plant infestations whose biology makes it a practical and effective method, or where the environment is not suitable for other methods, such as in some wetlands or sensitive ethnographic locations.

- Manual treatments could include pulling, digging, and cutting by hand or using hand tools.
- Mechanical treatments could include mowing, trimming, harrowing, and tilling using motorized equipment such as tractors, UTVs, mowers, and tillers.
- **Cultural Treatments** could include reseeding, replanting, fertilizing, mulching, irrigating, top soil conservation, shading, and the use of fire and competition from native plants.
 - Native plant communities would be facilitated, planted, or otherwise encouraged on disturbed areas, natural or manmade, in order to minimize infestation by invasive plants and their associated impacts.
 - Manmade activities that disturb soil and remove vegetation, including pipelines, utility trenches, temporary access corridors, temporary staging areas, and all construction sites would be reseeded or replanted and mulched at the optimal timing, in coordination with MVNP Natural Resource staff. This would be a standard requirement of all project scopes of work.
 - When practical, for excavation projects, top soil would be conserved and stockpiled for reuse in order to preserve native seeds, soil organisms, and soil structure integrity.
- **Chemical Treatments** involve the use of herbicides to eradicate, contain, suppress, or prevent aggressive, high-priority invasive plant species.
 - Chemical treatments include the application of approved herbicides, carriers, surfactants, dyes, and other adjuvants.
 - Chemical treatments may be applied by sponges; wicks; hand spray bottles; backpack sprayers; hydraulic spot and boom sprayers mounted to trailers, trucks, and UTVs; and boom sprayers on fix-winged aircraft and helicopters.
 - The park would use the most selective, environmentally compatible herbicide that would cause the minimum amount of impacts to natural communities, water, wildlife, cultural resources, and ethnographic values.
 - Currently approved herbicides and surfactants used in MVNP and YHNM are listed in Appendix C of the Invasive Vegetation Management Plan/EA.
 - New herbicides, not listed on Appendix C of the Invasive Plant Management Plan/EA, would be rigorously evaluated to determine their efficacy in treating target species and potential risks to natural resources, cultural resources, and human health and safety. In order to gain approval, new herbicides must meet the following criteria:
 - Peer-reviewed published literature demonstrates a quantifiable measure of success under field conditions on the targeted species in similar habitats.

- The new herbicide offers increased efficacy or increased selectivity compared to currently approved herbicides, with equivalent or lower risks to natural resources, cultural resources, or human health and safety.
 - The threat to the park from the targeted invasive plant species outweighs risks from using the new herbicide.
 - If environmental impacts from a new chemical exceed those in the analysis of this IPMP, new NEPA analysis would be required starting with a new round of public scoping.
 - When significant unknowns exist regarding the effects of an herbicide on native plant species of concern, the herbicide would not be used in the habitat of that species until trial applications have demonstrated the herbicide to be safe to that species or that mitigations have been demonstrated to be effective in protecting that species from herbicide damage.
 - The new herbicide is cost-effective.
- Risk assessment summaries of all currently approved herbicides are provided in Appendix B of this EA, and full discussions can be found at <http://www.fs.fed.us/foresthealth/pesticide/risk/shtml>.
- All herbicides would require annual approval by IPM Coordinators at MVNP and the NPS Intermountain Regional Office or National Office.
- Applicators would adhere to product label requirements, which have been developed to ensure human safety and to minimize environmental impacts.
- Applicators would use Job Hazard Analyses, Green-Amber-Red (GAR) safety analyses, and Operational Leadership principles to develop and implement project-specific safety practices and mitigations for chemical applications.
- **Biological Treatments** involve the use of living organisms (bio-control agents) to reduce the health, vigor, or reproductive ability of target invasive plants.
 - Bio-control agents may include native or non-native insects, mites, nematodes, fungi, microbes, and other pathogens.
 - Bio-control agents are often most useful in combination with other treatments.
 - Bio-control treatments only would be used for large or widespread invasive plant infestations for which eradication, containment, or suppression using other techniques is not possible or would not be effective.
 - Introducing a non-native bio-control may have unintended consequences, such as attacks on non-target species, host shifting, unintended food web interactions, and effects on the habitat of a native species of concern.

- Bio-control treatments would require annual approval by IPM Coordinators at MVNP and the NPS Intermountain Regional Office or National Office.
- Neither the park nor monument would be used as research release sites of bio-controls that have not yet received a release permit from the USDA, Animal and Plant Health and Inspection Service (APHIS) or EPA. NPS approval also would be required at the Intermountain Regional and National IPM offices.
- New bio-controls would be rigorously evaluated to determine their efficacy in treating target species and potential risks to natural resources, cultural resources, and human health and safety. New bio-control releases in MVNP or YHNM may occur only if all of these conditions are met:
 - Peer-reviewed published literature demonstrates a quantifiable measure of agent success under field conditions on the targeted invasive plant species in similar habitats.
 - Host specificity has been demonstrated under field conditions to the targeted species in similar habitats.
 - Research indicates that the introduced biological control would not harm other native organisms, including populations of species similar to it.
 - Other treatment options have proven ineffective or impractical, or demonstrate unacceptable potential impacts.
 - The threat to the park of continued spread of the targeted invasive plants outweighs the risk of introducing a non-native bio-control species into the park.
 - If environmental impacts from a new biological control are unknown or if they exceed those in the analysis of this IPMP, new NEPA analysis would be required consistent with environmental compliance pathways prescribed in DO-12 and a new round of internal and public scoping would be initiated.
 - If external and internal reviews have been conducted and compliance requirements have been met, then a categorical exclusion can be issued.
- MVNP staff would consult with federal, state, and local managers of invasive plants outside the park, especially land managers adjacent to potential release sites.

Standard Mitigation Measures

The following mitigation measures, which were developed to minimize the degree and severity of adverse effects, would be implemented during invasive vegetation management activities as needed.

Health and Human Safety

- An applicator holding a valid Colorado Pesticide Applicator Certification or higher would supervise or participate in all projects.
- All project participants would receive herbicide training from a Qualified Supervisor or certified project leader or co-participant.
- Project participants would abide by the personal protective equipment (PPE) requirements and rules outlined on the product label. Rubber gloves, hat, long-sleeved shirts, and eye protection may be required for application of herbicides.
- Job Hazard Analyses and/or Green-Amber-Red safety analyses and other Operational Leadership principles would be reviewed by all participants when a new project begins.
- Herbicide containers and spray tanks would be properly labeled.
- Application equipment and chemicals would be stored in appropriate storage facilities separate from food and personal items.
- Current labels and Material Safety Data Sheets (MSDS) would be maintained for all chemicals at every site where they are kept or used. All participants would review the MSDS with the project leader and understand first aid instructions described on the MSDS and label.
- If the label instructions for the herbicide and application method recommend limiting exposure to humans and pets, the area would be closed during and after treatment for the recommended time or otherwise posted with appropriate warning signs. Treatments that pose no risk to humans may be done at any time.

Visitor Experience

- Treatments would occur at the time of day when the least number of visitors would be impacted by the closure.
- Signage would inform visitors about the impacts of invasive vegetation and the importance and need for the activities.

Natural Resources

- All personnel who mix and apply herbicides would obtain an applicator's license from the Department of Agriculture in the State of Colorado or work under direct supervision of a state licensed qualified supervisor.
- In wetland and aquatic areas, use of foliar herbicide applications would be minimized. Instead, workers would employ more selective chemical and manual treatments.
- Only aquatic-labeled herbicide formulations would be used for spraying in riparian ecosystems, wetlands, or water influence zones. Even so, care will be used to minimize potential effects on sensitive riparian and aquatic habitats.
- All participants would be aware of and able to identify threatened, endangered, or rare plants or animals within project areas.
- For projects occurring around rare plants, herbicide use would be restricted to formulations and application methods that have been demonstrated to be safe for the rare plants.

Additional mitigations, such as covering non-target plants with buckets or tarps would be employed as needed.

- If aerial boom spraying or other high-capacity boom-type equipment is prescribed to apply pre-emergent herbicides to minimize cheatgrass invasion following severe fire, those techniques would not be used in known rare plant habitat unless controlled herbicide field trials have demonstrated that the prescribed herbicide would not adversely affect the rare plant species under prescribed timing and conditions. New surveys for rare plants may be required to ensure the targeted areas are safe for aerial application.
- Application methods, equipment, and rates would be selected to minimize potential for drift and off-target impacts.
- Off-road equipment and vehicles would be limited to use in areas where soil conditions are not susceptible to compaction, erosion, or rutting.
- Selection of restoration species would be limited to native species that exist naturally in the region to prevent accidental introduction of invasive species. To minimize genetic contamination, plant or seed stock would be collected or propagated from nearby sites, when practicable.
- Native plant seed for revegetation projects would be certified weed-free.
- Work would be limited around active raptor nests during the breeding season (March through July).
- Work would be restricted in sensitive wildlife habitat during lambing, calving, denning, or nesting periods, as identified by park biologists.

Cultural Resources

- Prior to major treatments around archeological/ethnographic resources or cultural landscapes, a cultural resource specialist would be notified to help identify, avoid, or minimize potential physical impacts to cultural resources.
- Treatments in previously identified areas containing archeological, historic, or ethnographic resources would be prohibited from using mechanized equipment off-road.
- Mechanical and cultural treatments that involve any kind of soil disturbance would be cleared with the park's archeologist to ensure that work would not adversely affect archeological/ethnographic resources. If soil disturbance in an identified archeological site is unavoidable, a qualified archeologist at least must be on site to oversee the work being performed.
- Protection of cultural resources would be included in training programs for the invasive plant seasonal work crew and contractors.
- A separate pre-screening process related to protecting ethnographic values linked to cultural sites and plants would be used to determine where and when herbicide use is appropriate. If so, invasive plant control techniques using chemical applications would be employed to minimize the risk of contacting sensitive historic fabric/materials or special plants and would limit the amount, degree, and persistence of the chemicals at the site. A one-foot buffer or physical shielding would be implemented while applying herbicide near

culturally significant resources. In addition, dye would not be used and herbicide only would be applied in no wind conditions.

- To avoid spills, handling, and mixing herbicides would not take place in cultural sites.

Wilderness

- Work within designated Wilderness Areas would not use mechanized access or equipment unless it is supported by results of a Minimum Requirement Analysis.

Recordkeeping and Monitoring

One of the key elements of successful evaluation is maintaining a complete and readily accessible database of invasive plant management efforts, as well as maintaining records of monitoring activities. MVNP Natural Resource and Information Technology staff members have worked together with a contractor to develop an invasive plant occurrence and treatment geodatabase that captures annual inventory, treatment, and monitoring records.

Key elements of recordkeeping and monitoring under this plan would include:

- MVNP Natural Resource staff would be responsible for maintaining records on invasive plant occurrences including location data, affected habitat, associated plant species, population size, population health/vigor, population trends, and disturbances.
- MVNP Natural Resource staff also would be responsible for maintaining and reporting treatment records, including target species, location data, treatment methods, crew members, hours worked, and treatment efficacy.
 - For treatments involving herbicides, Natural Resource staff also would record the names and EPA registration numbers of all herbicides, as well as the volume of chemical mix applied as the concentrate of all herbicides and adjuvants in the mix, the name of the Colorado Certified Pesticide Applicator, and the weather at the time of treatment.
- MVNP Natural Resource staff would fully implement a comprehensive monitoring program in order to better understand trends in priority invasive plant infestations, non-target treatment impacts, treatment efficacy, and the cost-effectiveness of various treatment types.
- MVNP Natural Resource staff would maintain a GIS-based data management system that captures spatial and attribute data on all known priority invasive plant occurrences and all treatments.
- MVNP Natural Resource staff would produce an annual report on the status of invasive plants at MVNP and YHNM, the treatments implemented for all target species in the fiscal year, and the time and cost associated with various aspects of the program.

Cooperation

- Emphasis would be placed on cooperative efforts among agencies and jurisdictions in the Montezuma County area, supporting regional and state-wide invasive plant control efforts that benefit both the park and surrounding lands.
- Formal partnerships, such as under the Service First or Wyden Amendment authorities, as interagency agreements, cooperative agreements, memoranda of understanding (MOU), would be established in exploring options for achieving operational efficiencies that meet mutual invasive plant management goals. Such arrangements would seek to:
 - Allow non-park staffs to work collaboratively inside the boundaries of MVNP and YHNM, and allow the parks' staff to work collaboratively outside the boundaries.
 - Share equipment and supplies on cooperative projects.
 - Transfer funds between organizations and agencies in fulfilling cooperative projects.

The philosophy underlying the Service First authority (Public Law No. 106-291, Section 330 as amended by Public Law No. 109-54 Section 428) is for the certain federal agencies to meet public and resource needs regardless of their organizational and land management jurisdiction. The goal of the Service First statute is for the agencies to pool resources to design, develop, and implement joint projects that will provide a greater benefit to citizens and resources than any individual agency could achieve. The Service First statute authorizes the agencies to form and promote partnerships across agency boundaries, to develop joint solutions to common problems, and to address federal land management issues in an integrated way.

The Wyden Amendment (Public Law 105-277, Section 323 as amended by Public Law 109-54 Section 434) authorizes the National Park Service and other federal agencies to enter into cooperative agreements to benefit resources within watersheds on National Park System lands. Agreements may be with willing federal, tribal, state, and local governments, private and nonprofit entities, and landowners to conduct activities on public or private lands for the purpose of protecting, restoring, and enhancing fish and wildlife habitat and other resources.

For example, in 2011 MVNP established an MOU with the Colorado Department of Transportation that allows park staff to help control invasive plants on the state's right-of-way along Highway 160 at the northern tip of the park. Similarly, in 2014 MVNP establish an MOU with the Colorado State Land Board that allows park staff to help control invasive plants on a section of land along the park's eastern boundary owned by the State of Colorado.

- Mapping data on invasive plants from MVNP and YHNM would be shared with interested federal, tribal, state, and local government partners.
- For some high-priority invasive species or infestations, opportunities would be fully evaluated for treating adjacent private lands when written approval by the landowner is

granted to the Superintendent. Formal partnership agreements with private interests would be entered as necessary.

- When requested, appropriate park staff would be available to any park neighbor to share information and advice on invasive plant management tactics and strategies.

Partners and Stakeholders

Montezuma County and Private Lands Adjoining the Park

Although the county government mainly focuses on agriculture, they have developed and adopted a new invasive plant management plan for the county that seeks collaborative management, education, and communication.

Colorado Department of Agriculture

They oversee the implementation of the state noxious weed control laws and regulations. Their operating principals include sharing information sharing and developing partnerships

Colorado Department of Transportation

There is an existing MOU for park staff to help control invasive plants in the US Highway 160 right-of-way at the MVNP entrance.

Colorado State Land Board

There is an existing MOU for park staff to help control invasive plants in the state owned Section 36 in Mancos Canyon next to MVNP's eastern boundary. There are funding support opportunities through this cooperative effort.

Colorado Department of Parks and Wildlife

The Colorado Natural Areas Program identifies and promotes areas in Colorado that retain special natural qualities. MVNP is working with them to establish parts of the park that meet this criterial.

Colorado Natural Heritage Program

This state office identifies and collects information on the rarest plant species in the State. They operate in MVNP under cooperative agreements, research permits, and a MOU to share information about rare plants including adverse environmental factors such as invasive plants and management activities.

Colorado State Historic Preservation Office

They oversee the application of the National Historic Preservation Act regulations in Colorado and have provided feedback on concerns of how implementation of the IPMP may affect archeological sites, historic structures, and other cultural resource protection matters.

Ute Mountain Ute Tribe

MVNP consults with 26 culturally affiliated tribes and pueblos regarding park resources and operations. The Ute Mountain Ute Tribe is unique among them in that the park shares several miles of common boundary with them along with the same kinds of land management issues such as invasive plants. The park would continue to seek common interests in addressing invasive plant control concerns.

Bureau of Land Management

There is an existing MOU between the local BLM office and MVNP that encourages the use of the "Service First" authority for promoting collaborative invasive plant control efforts between the two agencies including across common boundaries.

US Forest Service

MVNP has helped to control invasive plants along the park's pipeline right-of-way in the San Juan National Forest that leads to MVNP's domestic water intake on the West Mancos River. Efforts to improve collaboration would continue.

Natural Resources Conservation Service

The two agencies can gather and share information of mutual interests such as on soil and water conservation and invasive plant concerns.

Colorado Plateau Cooperative Ecosystems Studies Unit

This National Park Service office facilitates park efforts through cooperative agreements to find and fund work projects by youth groups and scientific investigations by universities and non-profit institutions.

Southwest Exotic Plant Management Team

This NPS program explicitly targets invasive plant management and landscape restoration needs at national parks over much of the Southwest. MVNP regularly hosts EPMT sponsored teams in the park performing direct control efforts on priority infestations of invasive plants.

Joint Fire Sciences Program

This is a program funded by the US Department of Agriculture and US Department of the Interior that offer grants promoting research related to fire and fuels management issues, which at Mesa Verde have included investigations into the interactions between wildfires and invasive plants.

US Fish and Wildlife Service

Close communications between the two agencies ensures that MVNP meets the intent of the Endangered Species Act in developing and implementing management actions such as the IPMP. The park wrote a Biological Assessment with the IPMP for FWS to review and approve.

Park Concessionaire

Whichever company holds the contract to run the concessions operations in MVNP must comply with certain maintenance agreements including grounds keeping in and around the facilities they operate such as Morefield Campground, the Far View Lodge area, and others. Certain levels of IPM functions, including invasive plant control, fall within their responsibilities which must be consistent with the goals and objectives of park's IPMP. The concessions maintenance plan is updated annually.

Cross-operational Roles

The IPMP promotes the idea that every park division has responsibilities in protecting the park from invasive plants and otherwise participates in the IPMP's implementation. The following are examples of ways in which all park operations can cooperate.

Maintenance

Contracts should stipulate use of weed free materials. Stockpiles of sand or gravel should be treated for invasive plants after long periods of non-use. Equipment entering the park should be thoroughly cleaned and inspected prior to park entry to minimize the transport of weed seeds. Offer staff to help with invasive plant control operations. Ensure project proposals include funding elements that support pre-construction invasive plant control and post-construction site restoration. Equipment washing stations should be set up during longer projects.

Interpretation

Using a wide variety of available media, instill among park visitors, staff, and the local community the importance of protecting the park from invasive species.

Fire and Law Enforcement

Offer staff to help with invasive plant control operations. Watch out for, record, and report the presence of high priority invasive plant species found while patrolling the park. Require invasive plant mitigation measures are carried out by guest workers such as firefighting crews from other areas. Equipment washing stations should be set up during multi-day events.

Administration

Ensure that all contracts explicitly stipulate long-term compliance with invasive plant control, site reclamation, and other resource impact mitigations covered in each project's environmental compliance documentation.

Concessions

Construction, rehabilitation, and routine operations should include stipulations on invasive plant control and site restoration similar to what the park requires.

Setting Priorities

Also see Appendix A3 for the complete decision tree process.

Early Detection Survey Priorities

Early detection survey priorities should be identified based on a combination of factors: (1) potential for a site to be invaded, (2) proximity of a site to other known occurrences and seed sources, (3) proximity to dispersal corridors, such as roads, (4) presence of susceptible high-value natural or cultural resources (e.g., rare plant habitat, cultural landscapes). Developing and validating a predictive model with reliable data to focus on park areas that are more likely to be invaded or are at higher risk of incursion by invasive plants would facilitate early detection efforts.

Sites that are at high risk for invasion include:

- Visitor use areas: road corridors, road pullouts, campgrounds, lodging facilities, visitor centers, entrance areas, parking lots, picnic areas, trailheads, certain archeological sites.
- Park facilities and structures: maintenance facilities, equipment storage areas, gravel stockpiles, boneyards, helipads/helistops, sewage lagoons, horse corals, utility corridors, water towers, employee residences.
- Construction areas: roads, buildings, utilities, and associated equipment and material staging areas.

Treatment Priorities

MVNP Natural Resource staff would use a decision-making framework for annually prioritizing invasive plant infestations for management. Annual treatment priorities would be documented in an annual Invasive Plant Management Work Plan.

Whenever possible, the Colorado Department of Agriculture's noxious weed list would be used in setting priorities for invasive plant management efforts in MVNP and YHNM. This would include reporting and treating any List A species found on park and monument lands with the objective of total eradication; report and treat any List B species subject to eradication in Montezuma County with the objective of total elimination; and working to contain and suppress populations of other List B populations.

At both MNVP and YHNM, some invasive plant species have become very well established and widespread so that the likelihood of eradication, containment, or suppression is small. In other cases, for invasive plant species that are more localized, the probability of success may be high. This probability of success factor, coupled with a species' threat level can be evaluated through a risk assessment, which should be the foundation for setting treatment priorities. A third important consideration is given to the emergence of new invasive plant species or new occurrences of existing species in the park or monument. For new species or occurrences, an aggressive rapid-response approach may be warranted in order to immediately eradicate or contain them. Thus, emerging threats may temporarily preempt other established priorities. Other considerations for setting treatment priorities include the management zone in which an infestation occurs, state and county priorities, and the probability of an occurrence within the park escaping to neighboring properties. The basic elements of this decision-making framework are summarized below:

1. Risk Assessment: MVNP Natural Resource staff would incorporate into treatment prioritization the results of a 2004 risk (invasiveness) assessment of invasive plant species known to occur on the Colorado Plateau, including at MVNP and YHNM (Watters 2004). This risk assessment evaluated invasive plants based on their ecological impact and their relative ease of control. Invasive plant species were assigned "urgency" or priority scores, ranging from high (delayed action would result in significant effort required for control), to medium (delayed action would result in a moderate increase in the effort for control), to low (delayed action would result in little increase in effort required for control). High-

ranking plants (those that have a potential ecological impact in the Risk Assessment) would be the highest priority for control.

2. **Management Zones:** Consideration would be given to which of the management zones in MVNP (Wilderness, Historic, or Developed) that an invasive plant infestation occurs. (See Map 3) Management zones do not apply to YHNM.
 - a. **Wilderness Zone.** This zone includes undeveloped areas of the park located along the steep escarpments in the northern and eastern parts of the park. The three Wilderness areas together comprise 8,500 acres or 16.2% of the park. Within this zone, emphasis is on protection of natural resources and ecological processes. This zone currently has a low priority for controlling invasive plants because access points, such as trails, leading into the Wilderness are mostly inaccessible or nonexistent. This could change if access improves in the future or if conditions change, such as after a wildfire.
 - b. **Historic Zone.** This zone makes up the vast majority of the park (approximately 43,000 acres or 82 percent of the park) and includes the bottom of Mancos Canyon and the one private holding (232 acres) within the boundary of the park. Much of the park's primary roads and many backcountry roads and trails pass through the historic zone. Backcountry access is limited to permitted researchers and park staff on official duty. Invasive plants would be given high priority for eradication if their presence alters the integrity of an historic landscape. With the exception of invasive exotic plants, exotic plants that are an integral part of a cultural landscape within these historic zones would be retained for the duration of their natural lifespan and then the park can choose to replace them in-kind. There is one Research Natural Area (RNA) located on Park Mesa. In 1996, a wildland fire burned 278 acres of this RNA and during the next year vast areas of musk thistle and cheatgrass began to develop. The unburned portion of Park Mesa remains mostly free of invasives. The invasive plants found in this RNA would be given a high priority for eradication.
 - c. **Developed Zone.** This zone, which includes certain cultural landscapes, makes up a small percentage of park land (about 1,000 acres or almost 2 percent of the park) where development and intensive human use substantially alter the natural environment. Established uses within the developed zone include entrance kiosks, campground/picnic areas, park housing, visitor center, utility areas, concession operations (lodge and restaurants), numerous archeological visitor attractions, and park headquarters complex. This zone is managed for administrative and public visitation purposes and is frequently disturbed with construction and maintenance activities. The developed zone has the highest incidences of invasive plants providing an avenue for these invasive plants to expand into surrounding natural areas. Furthermore, park visitors spend nearly all of their time in the developed zone where the proliferation of invasive plants has the greatest potential to degrade their park experience. Therefore, the developed zone would be given the highest

priority for invasive plant management to prevent the spread of invasive plants to undisturbed areas of the park.

3. Priorities for the state of Colorado and Montezuma County: The Colorado Department of Agriculture, Conservation Services Division, maintains a list of state designated noxious weeds and priorities for control. This list is subject to change and should be reviewed annually at the Conservation Services Division website:

http://www.colorado.gov/cs/Satellite/ag_Consevation/CBON/1251599399533

Furthermore, the Montezuma County Weed Program helps to set invasive plant control priorities for landowners in the county. Additional information is available at their website:

<http://www.co.montezuma.co.us/newsite/weedshome.html>

4. An infestation's potential to spread to neighboring property.
5. Is the invasive plant species or occurrence new to the park or monument, and, if so, is an aggressive rapid-response warranted?

In summary, high priority for control would be given to invasive plant species or occurrences that:

- May adversely affect natural communities and wildlife habitat in the park or monument.
- Threaten rare plant species in the park and monument.
- Occur within the historic zone or the RNA in the park.
- Occur in developed areas that are "hot spots" or pathways for infestations to spread.
- Threaten the integrity of a cultural landscape.
- Are listed by the state and/or county as high priority for eradication or control.
- Occur near the park or monument boundary and pose a threat to spread to neighboring lands.
- Are new infestations of new invasive plant species, having never occurred in the park and monument before.
- Occur in areas where seed can be rapidly dispersed to other areas of the park and monument.
- Species that have a high potential for ecological impact calculated in the Risk Assessment.

Appendix A2: Herbicide Safety and Spill Plan

The following information would be reviewed by all workers who handle herbicides. The terms “pesticides” and “herbicides” are used interchangeably.

- All personnel who mix and apply herbicides would obtain an applicator’s license from the Department of Agriculture in the State of Colorado or work under direct supervision of a state licensed qualified supervisor.
- All likely herbicides to be used in the park are described in the Invasive Plant Management Plan (IPMP) and Environmental Assessment. Before those herbicides are used in the park, yearly approval would be obtained from the NPS Regional IPM coordinator through the NPS Pesticide Use Proposal System (PUPS). Additional herbicides can be used with PUPS approval and as long as the impacts from using the additional herbicides are consistent with the IPMP.
- All personnel using herbicides would be familiar with and strictly adhere to the best management practices and mitigations described in the IPMP.
- Safety equipment would be carried by all employees in the field (first aid kits, PPE). Communication equipment (such as a park radio), herbicide labels, and MSDS would be carried by a minimum of one person in each field crew.

Herbicide Purchase

NPS guidelines (NPS-77) and policy (NPS Management Policy 4.4.5.5) indicate that pesticides should not be stockpiled and that pesticides may not be purchased unless they are authorized and are expected to be used within one year from the purchase date. Larger amounts can be purchased only when the smallest amount available for purchase is larger than the amount necessary for the project. If an approved herbicide is unavailable, any substitutions with similar or different label ingredients would require approval through the same herbicide use request and approval process.

Herbicide Storage

Herbicide storage facilities must be locked, fireproof, and ventilated; proper warning signs must be posted. Herbicides must be stored separately from all other chemical substances and the directions provided on the labeling must be followed. In addition, each type of herbicide should be stored on separate shelves. Any structure used for storage of herbicides should be posted and copies of labels, material safety data sheets (MSDSs), and inventories would be kept readily available for inspection.

Information and Equipment

A copy of the labels and material safety data sheets for herbicides being used would be available at all times during project operations. All personnel involved in the handling of herbicides would review and be familiar with relevant MSDS information and warnings. Emergency procedures, call numbers, etc. would be known to all crew members in case of pesticide exposure that requires documentation or transport to medical facilities.

Required Personal Protective Equipment (PPE) would be worn at all times when herbicides are being mixed and applied. Label requirements for specific herbicides would be followed. Applicators and handlers must wear the PPE required by the labels of each herbicide being applied.

An emergency spill kit, with directions for use, would be available when herbicides are being mixed, transported, and applied. Employees would be trained in the use of the spill kit prior to initiation of operations. The spill kit would contain at least the following equipment or equivalent:

- Shovel
- Broom
- Absorbent material
- Large plastic garbage bags
- Safety goggles
- Rubber gloves

Procedures for Mixing, Loading, and Disposing of Chemicals

The following procedures would apply to all herbicide applications:

1. Mixing of herbicides would occur at least 100 feet from well heads or surface water
2. Dilution water would be added to the spray container prior to addition of the spray concentrate.
3. Hoses used to add dilution water to spray containers would be equipped with a device to prevent back-siphoning, or a minimum 2-inch air gap.
4. Only quantities of herbicides not to exceed one day's use would be mixed.
5. Those workers mixing chemicals would wear personal protective equipment required by the label.
6. Empty containers would be triple rinsed. Rinsate would be added to the spray mix or disposed of at the application site at rates that do not exceed those on the label.
7. Unused herbicides would be stored in an herbicide storage cabinet in accordance with herbicide storage instructions provided by the manufacturer and in accordance with the Colorado Department of Agriculture.
8. Empty and rinsed herbicide containers would be punctured and disposed of according to label directions.
9. Disposable herbicide gloves and wipes used for general mixing, application and cleanup would be disposed of immediately with general waste products and not held in storage. No special labeling or handling is required.
10. Saturated absorbent materials used for spill clean-up and any contaminated soils would be bagged, labeled, and taken to the park's hazardous waste disposal facility.
11. Although all herbicide containers are labeled as a standard operating procedure, occasionally a label falls off or the lettering rubs off a container despite our best efforts to not let this happen. Any containers of unknown chemical would be labeled as hazardous waste and would be taken to the park's hazardous waste disposal facility.

Procedures for Herbicide Spill Containment

The Emergency Response Plan (ERP) for MVNP and YHNM (in progress) defines an incidental (minor) spill as a spill/release of a known hazardous substance that is not an extremely hazardous substance in quantities of 10 gallons or less (if a liquid), or 10 pounds or less (if a solid in a dry environment). A non-incidental spill (major) is one of a known hazardous substance in quantities greater than 10

gallons (if a liquid), greater than 10 pounds (if a solid in a dry environment), any amount of a solid in a wet environment, or spills/releases of an unknown or extremely hazardous substance. The procedures below would be modified to be consistent with the ERP when it is completed.

In the event of a spill, immediately notify the project supervisor. Identify the nature of the incident and extent of the spill, including the product name(s) and chemical registration number(s). Remove any injured or contaminated person to a safe place. Remove contaminated clothing and follow MSDS guidelines for emergency first aid procedures following exposure. Obtain medical help for any injured employee.

Minor Spills

Areas where chemicals are spilled would be roped off or flagged to warn people and restrict entry. Qualified personnel always would be present on the site to confine the spill and warn of danger until it is cleaned up. The spill would be confined with earthen or sand dikes if the chemical starts to spread. The spill would be soaked up with absorbent material such as paper pads, sawdust, soil, or clay. Contaminated material would be shoveled into a leak proof container for disposal and labeled. Contaminated material would be disposed of using the same method as for herbicides. The spill area would not be hosed down. Emergency phone numbers would be carried by the herbicide applicators.

Major Spills

Areas where chemicals are spilled would be roped off or flagged to warn people and restrict entry. Qualified personnel always would be present on the site to confine the spill and warn of danger until it is cleaned up. The spill would be confined with earthen or sand dikes if the chemical starts to spread. The spill would be soaked up with absorbent material such as paper pads, sawdust, soil, or clay.

The local park structural fire program and hazmat coordinator, and State herbicide authorities would be notified. Follow their instructions for further action. Whenever possible, someone familiar with the situation would remain at the site until help arrives. Emergency phone numbers would be carried by the herbicide applicators. Decontaminate the soil by removing it to a depth of at least 2 inches below the contaminated zone and place in clearly labeled leak proof containers for disposal.

Reporting

The following list is a guide for the information regarding spills that should be reported. Incidents should be reported even if there is doubt as to whether the spill is an emergency or whether someone else has reported it. Emergency phone numbers would be carried by the herbicide applicators.

Date:

Time of Release:

Time Discovered:

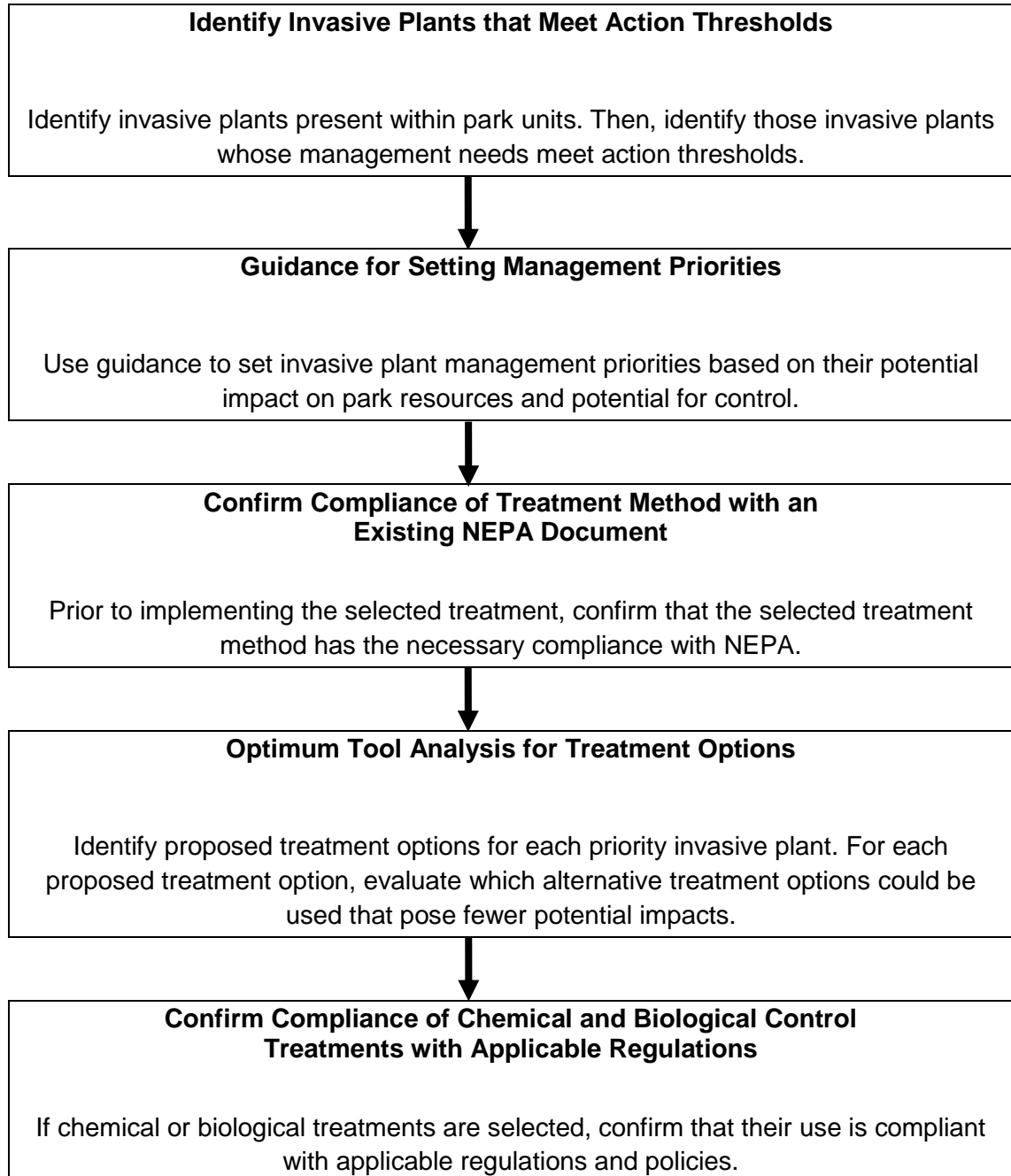
Time Reported:

Duration of Release:

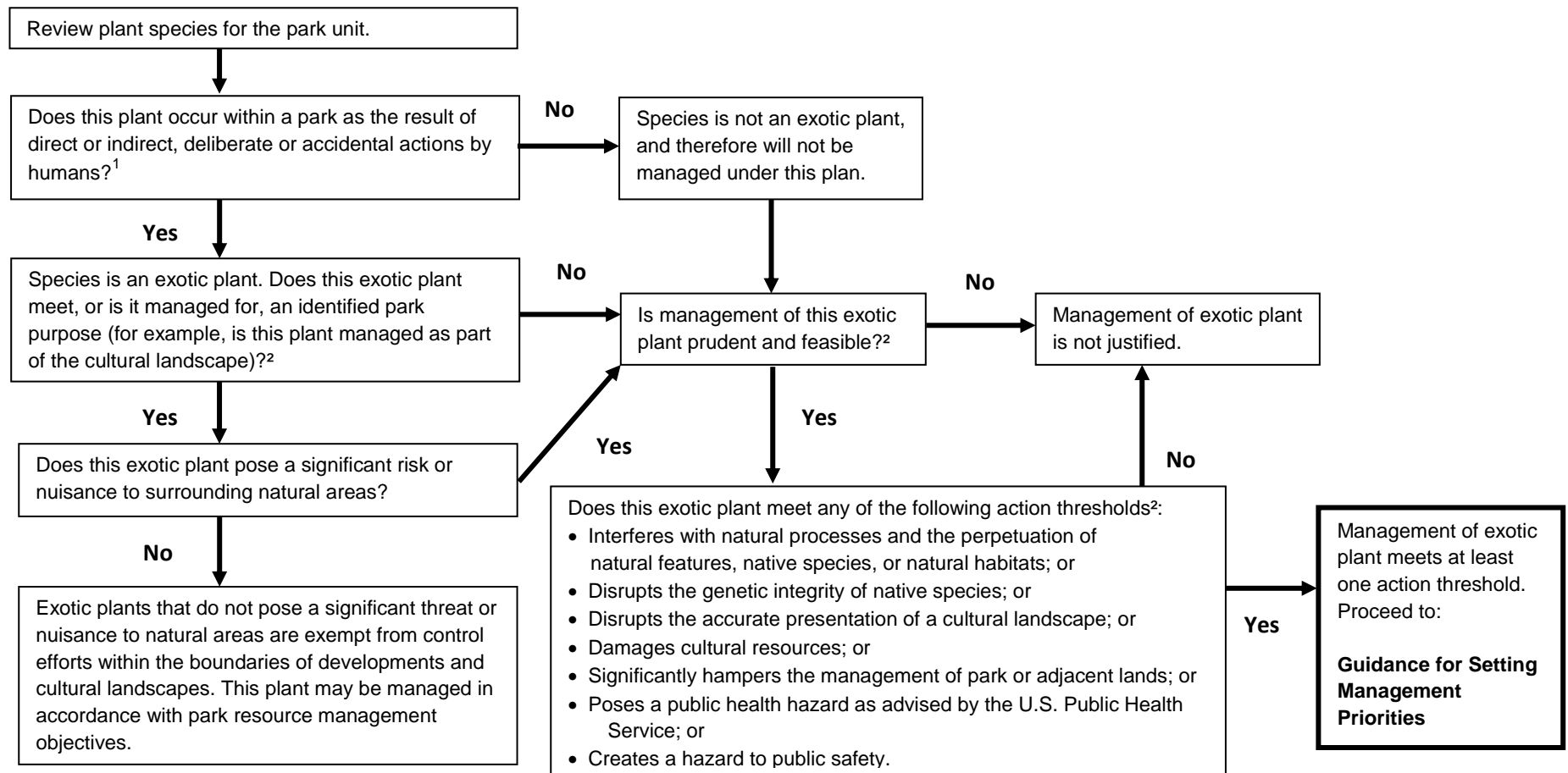
Location: (State, county, route, milepost)
Chemical name:
Chemical identification number:
Chemical data:
Known health risks:
Precautions to be taken:
Cause and source of release:
Estimated quantity (gallons) released:
Quantity (gallons) which has reached water:
Name of affected watercourse:
Number and type of injuries:
Potential future threats to environment or health:
Your name:
Telephone numbers:
Address:

Appendix A3: MVNP and YHNM Invasive Plant Management Plan Decision-Making Trees.

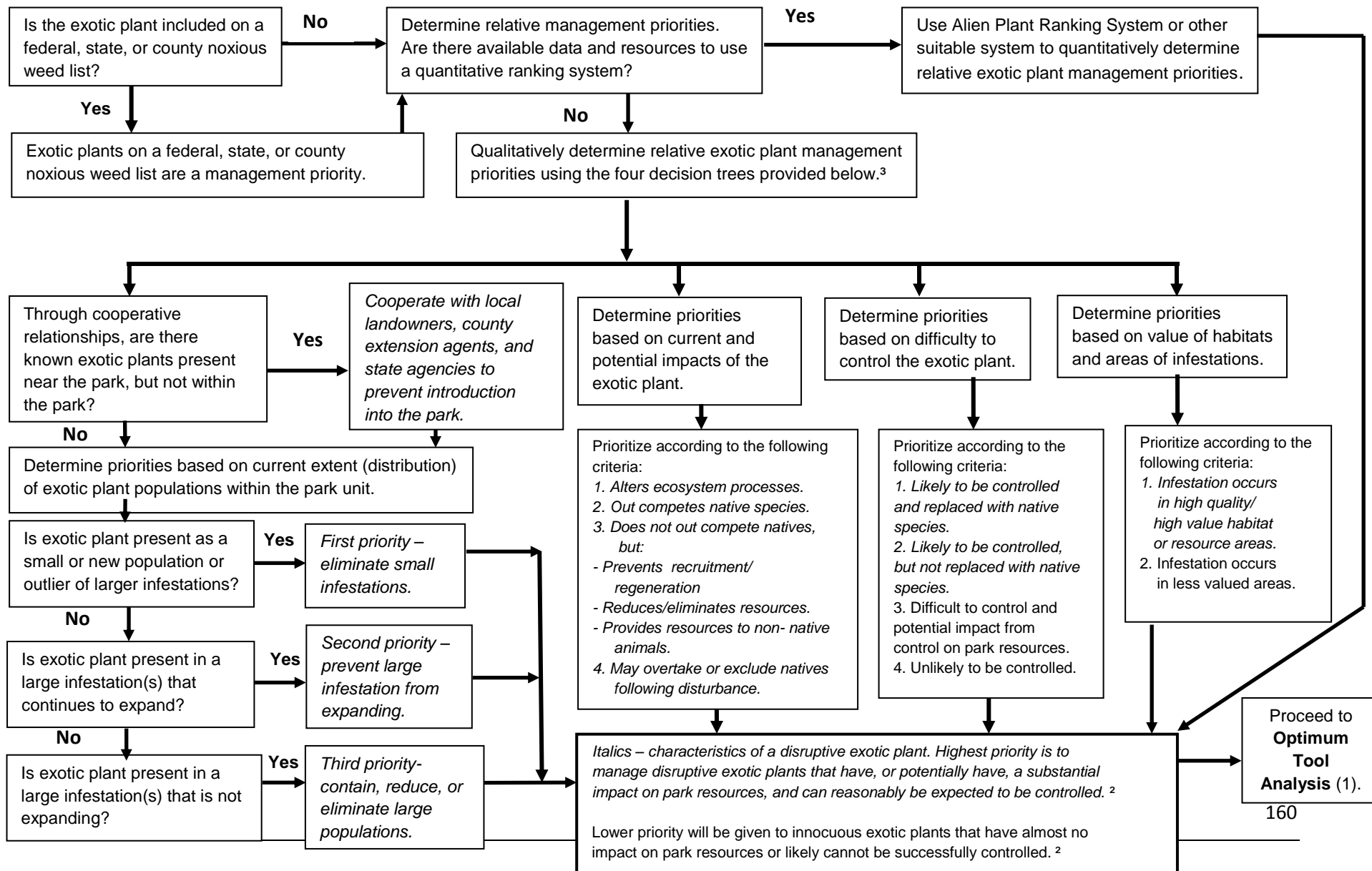
Overview



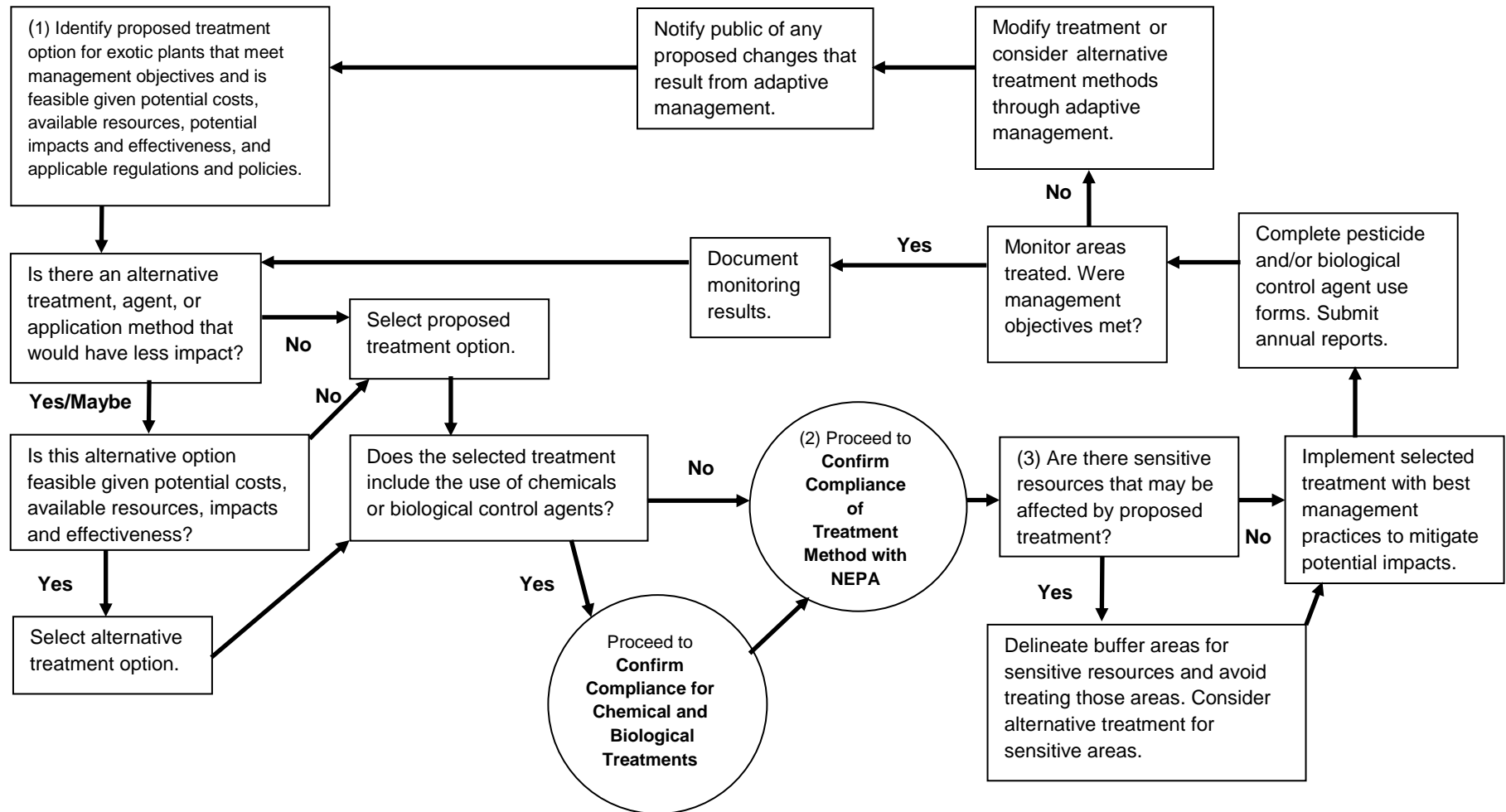
Identify Invasive Plants that Meet Action Thresholds



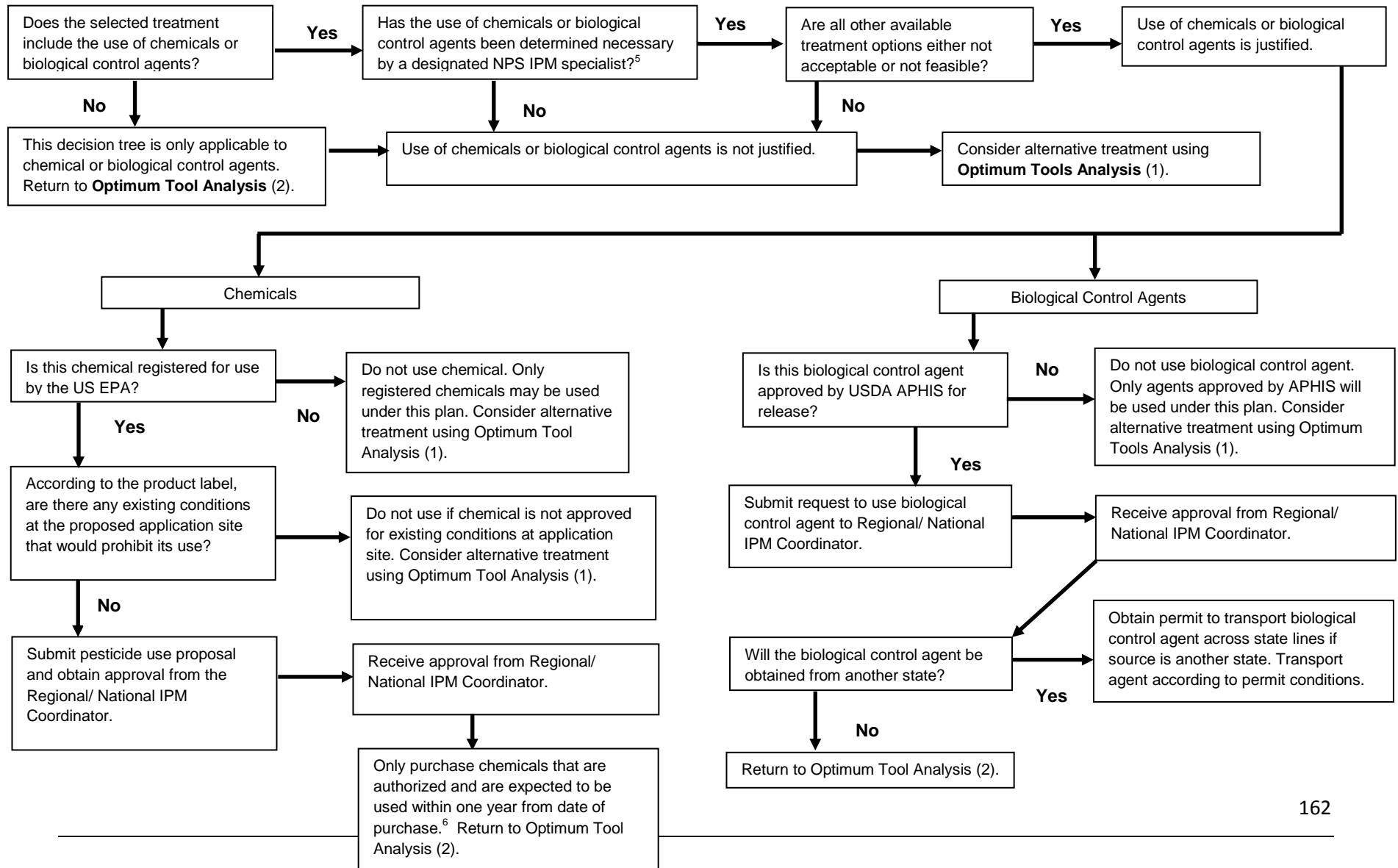
Guidance for Setting Management Priorities



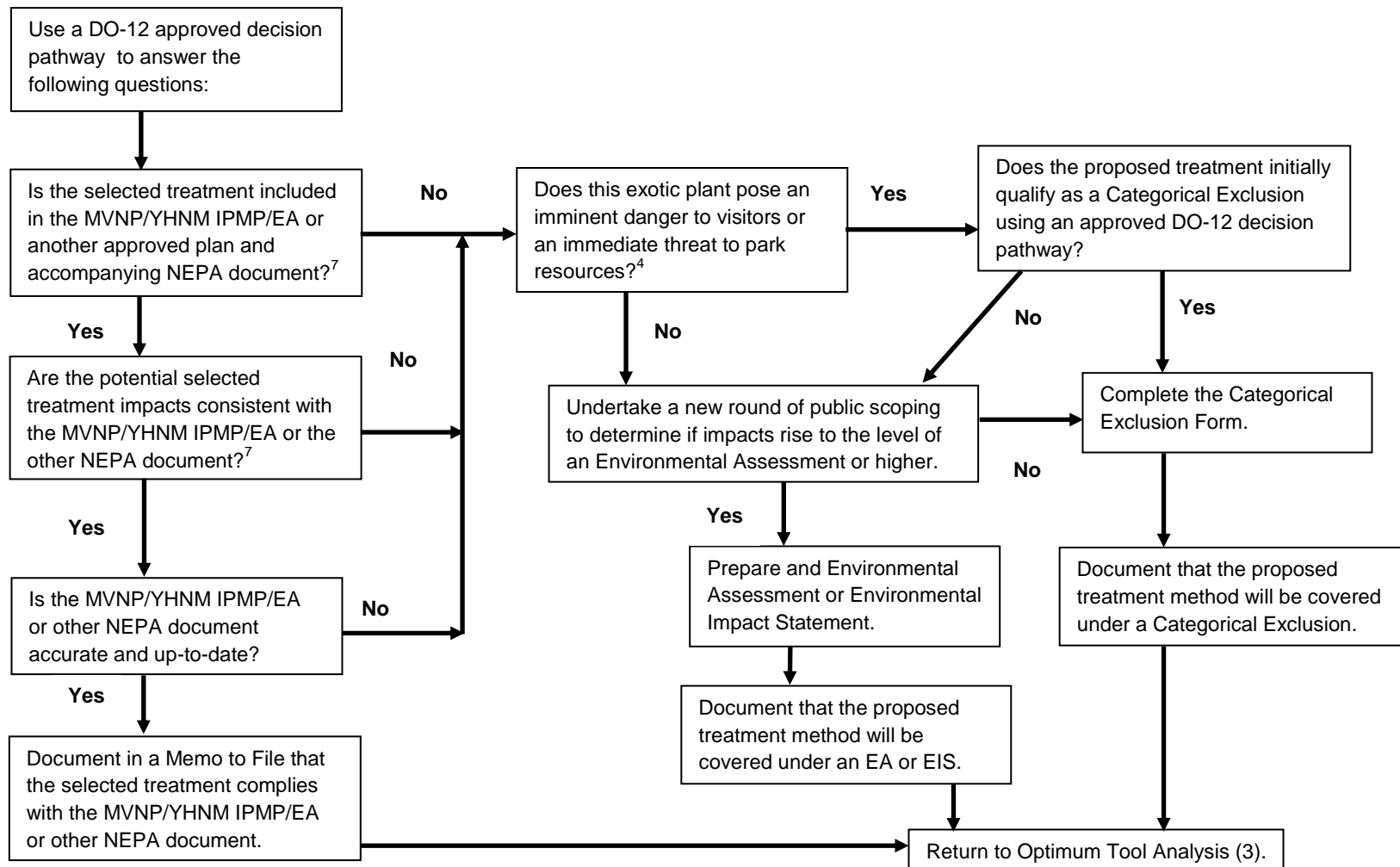
Optimum Tool Analysis for Treatment



Confirm Compliance of Chemical and Biological Control Treatments with Applicable Regulations



Confirm Compliance of Treatment Method with an Existing NEPA Document



Footnotes

- 1 National Park Service. 2006. Management Policies. Section 4.4.1.3.
- 2 National Park Service Management Policies. 2006. Section 4.4.4.2.
- 3 Adapted from the Site Weed Management Plan for Middle Niobrara Weed Awareness Group, Middle Niobrara River Valley, Nebraska 2003- 2005 (Faulkenberry 2003) and Handbook for Ranking Exotic Plants for Management and Control (Hiebert and Stubbendieck 1993)
- 4 National Park Service. 2001. Director's Order #12. Conservation Planning, Environmental Impact Analysis, and Decision Making.
- 5 National Park Service. 2006. Management Policies. Section 4.4.5.3.
- 6 National Park Service. 2006. Management Policies. Section 4.4.5.5.
- 7 Adapted from Midwest Region and Intermountain Region Environmental Screening Form

Appendix B: Herbicide Risk Assessments

Appendix B provides the reader with the executive summaries of the Human Health and Ecological Risk Assessments for the primary herbicides currently in use at MVNP and YHNM. To see the full texts of these detailed studies, go to the Forest Health Protection Pesticide Management and Coordination website of the USDA Forest Service at:

<http://www.fs.fed.us/foresthealth/pesticide/risk.shtml>

Aminopyralid Human Health and Ecological Risk Assessment – FINAL REPORT

SERA TR-052-04-04a

June 28, 2007

Patrick R. Durkin
Syracuse Environmental Research Associates, Inc.

EXECUTIVE SUMMARY

OVERVIEW

Aminopyralid is a new herbicide that has been registered by the U.S. EPA for the control of invasive weeds. The control of invasive weeds is a major component in programs conducted by both the USDA/Forest Service and the National Park Service (NPS). Both of these organizations have begun using aminopyralid in weed management programs and both organizations are considering expanding the use of aminopyralid in other weed management programs.

The U.S. EPA has judged that aminopyralid appears to be a *reduced risk* herbicide. This judgment by the U.S. EPA is supported by the current risk assessment. Aminopyralid is an effective herbicide. As with any effective herbicide applied to terrestrial weeds, adverse effects in nontarget terrestrial plants are plausible. There is no indication, however, that adverse effects on workers, members of the general public or other nontarget animal species are likely.

This assessment of aminopyralid is tempered by the lack of information on aminopyralid in the open literature. All of the information on the toxicity of aminopyralid comes from studies that have been submitted to the U.S. EPA in support of aminopyralid registration. While these studies have been reviewed and the bulk of these studies appear to have been appropriately designed, conducted and reported, the available information on aminopyralid is much less diverse than the information that is available on herbicides that have been used for many years and for which the open literature is rich and varied. This situation will exist for any new herbicide or other new pesticide.

PROGRAM DESCRIPTION

Two formulations of aminopyralid are specifically considered in this risk assessment: Milestone and Milestone VM. Both of these formulations contain the triisopropanolamine (TIPA) salt of aminopyralid (40.6 % w a.i./v, equivalent to 21.1% a.e. or 2 lbs a.e./gal). These formulations contain no inert ingredients other than water and triisopropanolamine.

The most likely uses of aminopyralid will involve applications to forest and rangelands, rights-of-way, and developed recreational areas such as campgrounds, picnic areas and trails. Application methods have and will likely continue to include backpack (selective foliar), hydraulic spray, and aerial applications. The labeled application rates for aminopyralid are 0.03 to 0.11 lb. a.e./acre. The upper bound of this range is likely to be used for rhizomatous weeds. For non-rhizomatous weeds, the application rate will generally be about 0.078 lb. a.e./acre. Again, specific application rates will vary with site-specific considerations. Consequently, the current risk assessment considers the full range of labeled application rates for broadleaf weeds as well as all labeled application methods. Dow AgroSciences, the registrant for aminopyralid, has suggested that this herbicide may be used as an alternative to herbicides such as picloram, clopyralid, 2,4-D, dicamba, monosodium methanearsonate, and metsulfuron methyl. While the decision to use any particular herbicide is based on a number of site-specific considerations, the Forest Service and NPS have begun to use aminopyralid at some sites rather than herbicides such as picloram, clopyralid, glyphosate, and dicamba.

HUMAN HEALTH RISK ASSESSMENT

Hazard Identification – Because aminopyralid is a new herbicide, no information is available in the published literature on the toxicity of aminopyralid to humans or other mammalian species. The only information on aminopyralid that is available for assessing potential hazards in humans is a series of toxicity studies that have been submitted to and evaluated by the U.S. EPA's Office of Pesticides in support of the registration for aminopyralid.

Although the mechanism of action of aminopyralid and other pyridine carboxylic acid herbicides is fairly well characterized in plants, the mechanism of action of aminopyralid in mammals is not well characterized. The weight-of-evidence suggests that aminopyralid may not have any remarkable systemic toxic effects. The effects that are most commonly seen involve effects on the gastrointestinal tract after oral exposure and these may be viewed as portal of entry effects rather than systemic toxic effects. The location of these effects within the gastrointestinal tract appears to vary among species with the ceca being the most common site of action in rats and the stomach being the most common site of action in dogs and rabbits. Mice do not seem to display any remarkable gastrointestinal effects after oral doses of aminopyralid. The reason for these differences among species is not clear but may simply reflect differences in methods of exposure (gavage versus dietary) and/or differences in anatomy.

In one acute oral toxicity study in rats using the aminopyralid TIPA formulation, lacrimation and cloudy eyes were noted in all test animals on the first day of the study but not on subsequent days. Clouding of the eyes is an unusual effect that has not been noted in other studies on aminopyralid, either the acid or the TIPA salt. The significance of this observation, if any, is unclear. Aminopyralid is rapidly absorbed and excreted and is not substantially metabolized in mammals. As a consequence of rapid absorption and excretion, gavage and dietary exposures probably lead to very different

patterns in the time-course of distribution in mammals. The oral LD50 of aminopyralid has not been determined because aminopyralid does not cause any mortality at the dose limits set by the U.S. EPA for acute oral toxicity studies – i.e., up to 5,000 mg/kg bw. Similarly, subchronic and chronic toxicity studies have failed to demonstrate any clear signs of systemic toxic effects.

Developmental studies involving gavage administration, however, have noted signs of incoordination in adult female rabbits. The incoordination was rapidly reversible and did not persist past the day of dosing. Two chronic oral bioassays have been conducted; one in mice and the other in rats, and a 1-year feeding study is available in dogs. Based on the results of the chronic bioassays as well as the lack of mutagenic activity in several mutagenicity screening assays, there is no basis for asserting that aminopyralid is a carcinogen. Similarly, based on the chronic bioassays and several additional subchronic bioassays in mice, rats, dogs, and rabbits, there is no basis for asserting that aminopyralid will cause adverse effects on the immune system or endocrine function. The potential for effects on the nervous system is less clear. Aminopyralid has also been subject to several bioassays for developmental toxicity and one multi-generation study for reproductive performance. No adverse effects on offspring have been noted in these studies other than decreased body weight in offspring that is associated with decreased food consumption and decreased body weight in adult females.

Exposure Assessment – For workers applying aminopyralid, three types of application methods are modeled: directed ground spray, broadcast ground spray, and aerial spray. In non-accidental scenarios involving the normal application of aminopyralid, central estimates of exposure for workers are approximately 0.001 mg/kg/day for aerial and backpack workers and about 0.002 mg/kg/day for broadcast ground spray workers. Upper ranges of exposures are approximately 0.012 mg/kg/day for broadcast ground spray workers and 0.006 mg/kg/day for backpack and aerial workers. All of the accidental exposure scenarios for workers involve dermal exposures. Except for the scenario involving a spill on the lower-legs for 1 hour (an upper bound dose of 0.003 mg/kg/event), the accidental exposures lead to dose estimates that are substantially lower than the general exposure levels estimated for workers. This is not uncommon and it reflects the fact that the general exposure estimates are based on field studies of workers in which accidental and/or incidental events such as spills probably occurred and in some cases was specifically noted to occur.

For the general public, acute levels of exposures range from minuscule (e.g., 1×10^{-8} mg/kg/day) to about 0.4 mg/kg bw at the typical application rate of 0.078 lb. a.e./acre. The upper bound of exposure, 0.4 mg/kg bw, is associated with the consumption of contaminated water by a child shortly after an accidental spill. This exposure scenario is highly arbitrary. The upper bound of the dose associated with the consumption of contaminated vegetation, a more plausible but still extreme exposure scenario, is about 0.1 mg/kg bw. The other acute exposure scenarios lead to much lower dose estimates – i.e., ranging from near zero to about 0.042 mg/kg for the accidental direct spray of a child. The lowest acute exposures are associated with swimming in or drinking contaminated water.

The modeled chronic or longer-term exposures are much lower than the corresponding estimates of acute exposures. The highest longer-term exposures are associated with the consumption of contaminated vegetation and the upper bound for this scenario is about 0.027 mg/kg/day. This is followed by the scenario for the longer-term consumption of contaminated fruit with an upper bound of 0.003 mg/kg/day. As with the acute exposures, the lowest longer-term exposures are associated with the consumption of surface water.

Dose-Response Assessment – The Office of Pesticide Programs of the U.S. EPA has derived a chronic RfD of 0.5 mg/kg/day for aminopyralid. This RfD is based on a chronic rat NOAEL of 50 mg/kg/day and an uncertainty factor of 100. The Office of Pesticide Programs has also derived an acute RfD of 1 mg/kg bw/day based on a NOAEL from a reproduction study of about 100 mg/kg/day. In deriving both of these RfD values, the U.S. EPA used an uncertainty factor of 100, a factor of 10 for extrapolating from animals to humans and a factor of 10 for extrapolating to sensitive individuals within the human population. Both of these RfD values are based on NOAELs for the most sensitive endpoint in the most sensitive species and studies in which LOAEL values were identified. In addition, both of the NOAEL values are supported by other studies. Thus, the RfD values recommended by the U.S. EPA are adopted directly in the current risk assessment.

Risk Characterization – The risk characterization for both workers and members of the general public is reasonably simple and unambiguous: based on a generally conservative and protective set of assumptions regarding both the toxicity of aminopyralid and potential exposures to aminopyralid, there is no basis for suggesting that adverse effects are likely in either workers or members of the general public even at the maximum application rate that might be used in Forest Service or NPS programs.

For workers, no exposure scenarios, acute or chronic, exceeds the RfD at the upper bound of the estimated dose associated with the highest application rate of 0.11 lb. a.e./acre. The hazard quotients for directed ground spray, broadcast ground spray, and aerial applications are below the level of concern by factors of 33 to 200 over the range of application rates considered in this risk assessment.

For members of the general public, upper bounds of hazard quotients at the highest application rate are below a level of concern by factors of 100 to 125,000 for longer term exposures. For one accidental exposure scenario, the consumption of contaminated water by a child immediately after an accidental spill of aminopyralid into a small pond, the hazard quotient is 0.6, approaching the level of concern (1.0). This is an intentionally extreme exposure scenario that typically leads to the highest hazard quotient in pesticide risk assessments similar to the current assessment on aminopyralid. The upper bounds of acute exposure scenarios for contaminated vegetation or fruit are below the level of concern by factors of 10 to 50. Acute non-accidental exposure scenarios for members of the general public that involve contaminated water are below the level of concern by factors of about 140 to 14,000.

The risk characterization given in this risk assessment is qualitatively similar to that given by the U.S. EPA: no risks to workers or members of the general public are anticipated. The current risk assessment derives somewhat higher hazard quotients than those in the U.S. EPA human health risk assessment because the current risk assessment uses a number of extreme exposure scenarios that are not used by the U.S. EPA.

ECOLOGICAL RISK ASSESSMENT

Hazard Identification – The mammalian toxicity of aminopyralid is relatively well-characterized in experimental mammals in a series of toxicity studies that are required for pesticide registration. In standard experimental toxicity studies in rats, mice, rabbits, and dogs, aminopyralid has low acute and chronic oral toxicity. It seems reasonable to assume the most sensitive effects in wildlife

mammalian species will be the same as those in experimental mammals (e.g., changes in the gastrointestinal tract, weight loss, and incoordination).

Results of acute exposure studies in birds indicate that avian species appear no more sensitive than experimental mammals to aminopyralid in terms of acute lethality. In terms of non-lethal effects, however, birds may be somewhat more sensitive than mammals to aminopyralid after gavage exposures. In developmental studies involving gavage administration, NOAEL values for mammals are in the range of 200 mg a.e./kg bw/day. In birds, the single dose gavage NOAEL is 14 mg a.e./kg bw. Birds are much less sensitive to dietary exposures compared to gavage exposures with NOAEL values for 5-day dietary exposures of over 1000 mg a.e./kg bw/day. While chronic studies (i.e., those that approach the lifespan of the animal) are not available in birds, two standard reproduction studies have been conducted in bobwhite quail and one reproduction study has been conducted in mallard ducks. One of the reproduction studies in bobwhite quail appears to be a failed study but the second study in bobwhites, although not yet reviewed by the U.S. EPA, appears to be acceptable. The study in mallards, which has been reviewed and accepted by the U.S. EPA, yielded the lowest NOAEL, 184 mg a.e./kg bw/day, comparable to the reproductive NOAEL values in mammals.

A standard set of toxicity studies are also available on terrestrial plants. Dicots (i.e., broadleaf plants) are substantially more sensitive to aminopyralid than monocots (e.g., grasses). This is consistent with the proposed uses of aminopyralid and the quantitative aspects of this difference in sensitivity are discussed further in the dose-response assessment for terrestrial plants. Relatively little information is available on the toxicity of aminopyralid to terrestrial invertebrates or terrestrial microorganisms. Relatively little information is available on the toxicity of aminopyralid to terrestrial invertebrates or terrestrial microorganisms. Based on bioassays in honeybees, earthworms, and soil microorganisms, aminopyralid does not appear to be very toxic to terrestrial invertebrates or soil microorganisms.

There is no indication that aminopyralid is likely to be toxic to aquatic animals based on standard acute and chronic bioassays in fish and invertebrates as well as one acute toxicity study in a species of frog. As would be expected from an herbicide, some aquatic plants are more sensitive than aquatic animals to the effects of aminopyralid. Duckweed, the one macrophyte on which a bioassay of aminopyralid has been conducted, does not appear to be sensitive to aminopyralid.

Exposure Assessment – In acute exposure scenarios, the highest exposure for terrestrial vertebrates involves the consumption of contaminated insects by a small bird, which could reach up to about 3 mg/kg. There is a wide range of exposures anticipated from the consumption of contaminated vegetation by terrestrial animals: central estimates range from 0.1 mg/kg for a small mammal consuming fruit to 2.1 mg/kg for a large bird with upper bound estimates of about 0.2 mg/kg for a small mammal consuming fruit and 6 mg/kg for a large bird consuming grasses. The consumption of contaminated water will generally lead to much lower levels of acute exposure – i.e., in the range of about 0.00002 to 0.007 mg/kg. A similar pattern is seen for chronic exposures. The central estimate for daily doses for a small mammal from the longer term consumption of contaminated vegetation at the application site is about 0.002 mg/kg/day, with an upper estimate of about 0.01 mg/kg/day. Dose estimates associated with the consumption of contaminated water are in the range of 0.00001 mg/kg bw/day to 0.003 mg/kg bw/day for a small mammal. Based on general relationships of body size to body volume, larger vertebrates will be exposed to proportionately lower doses than small vertebrates under comparable exposure conditions. Because of the apparently low toxicity of

aminopyralid to animals, the rather substantial variations in the different exposure assessments have little impact on the assessment of risk to terrestrial animals.

For terrestrial plants, five exposure scenarios are considered quantitatively: direct spray, spray drift, runoff, wind erosion and the use of contaminated irrigation water. Unintended direct spray is expressed simply as the application rate – i.e., 0.078 lb. a.e./acre for the typical application rate. For directed foliar applications, this scenario should be regarded as an extreme/accidental form of exposure that is not likely to occur in most applications. For broadcast applications, the direct spray scenario is much more plausible. Spray drift is based on estimates from AGDRIFT. The proportion of the applied amount transported off-site from runoff is based on standard GLEAMS modeling of clay, loam, and sand. The amount of aminopyralid that might be transported off-site from wind erosion is based on estimates of annual soil loss associated with wind erosion and the assumption that the herbicide is incorporated into the top 1 cm of soil. Exposure from the use of contaminated irrigation water is based on the same data used to estimate human exposure from the consumption of contaminated ambient water. All of these exposure scenarios are dominated by situational variability because the levels of exposure are highly dependent on site-specific conditions. Thus, the exposure estimates are intended to represent conservative but plausible ranges that could occur but these ranges may over-estimate or under-estimate actual exposures in some cases.

Exposures of aquatic plants and animals to aminopyralid are based on essentially the same information used to assess the exposure to terrestrial species from contaminated water. The peak estimated rate of contamination of ambient water associated with the application of aminopyralid is 0.1 (0.002 to 0.6) mg a.e./L at a normalized application rate of 1 lb. a.e./acre. For longer-term exposures, estimated rate of contamination of ambient water is 0.04 (0.001 to 0.26) mg a.e./L at a normalized application rate of 1 lb. a.e./acre. For the assessment of potential hazards to aquatic species, these water contamination rates are adjusted based on the application rates considered in this risk assessment.

Dose-Response Assessment – The available toxicity data support separate dose-response assessments in eight classes of organisms: terrestrial mammals, birds, terrestrial invertebrates, terrestrial plants, fish, aquatic invertebrates, aquatic algae, and aquatic macrophytes. Different units of exposure are used for different groups of organisms depending on how exposures are likely to occur and how the available toxicity data are expressed. When possible, a range of toxicity values based on the most sensitive and most tolerant species within a given group of organisms are given.

For terrestrial mammals, the dose-response assessment for aminopyralid is based on the same data as the human health risk assessment (i.e., an acute gavage NOAEL of 104 mg/kg bw and a chronic dietary NOAEL of 50 mg/kg/day). In terms of acute toxicity, birds appear to be more sensitive than mammals to aminopyralid with an acute NOAEL of 14 mg a.e./kg/day from a gavage study. In terms of longer-term toxicity, however, the toxicity value for birds is 184 mg a.e./kg bw/day, somewhat higher than the corresponding value in mammals. It should be noted that the acute NOAEL for birds is lower than the chronic NOAEL for birds. This is an atypical situation. Birds appear to be much more sensitive to aminopyralid after gavage administration than after dietary administration. This difference in sensitivity results in the lower acute NOAEL (gavage) relative to the chronic NOAEL (dietary). Basing the acute NOAEL for birds on a gavage study is a conservative, and perhaps grossly conservative, approach. This is discussed further in the risk characterization.

For terrestrial invertebrates, no mortality would be expected following acute exposure to doses up to 1075 mg/kg based on direct spray studies in honey bees. Based on a single bioassay in earthworms, soil invertebrates do not appear to be sensitive to aminopyralid with a NOEC value of 5000 mg a.e./kg soil. Similarly, a single bioassay on soil microorganisms does not suggest that adverse effects would be expected at concentrations of up to about 8 mg a.e./kg soil.

The toxicity of aminopyralid to terrestrial plants is relatively well-characterized. Aminopyralid is more toxic to dicots than monocots. The most sensitive species have a NOEC value of 0.00048 lbs a.e./acre based on seeding emergence studies (soil exposures) and a NOEC value of 0.0002 lb. a.e./acre based on foliar exposure. Tolerant species have NOEC values of 0.11 lb. a.e./acre for both soil and foliar exposures.

Aminopyralid has a low order of acute toxicity to aquatic animals, with acute NOEC values falling within a narrow range: 50 mg a.e./L for sensitive fish to 100 mg a.e./L for tolerant fish. Acute toxicity values for amphibians and aquatic invertebrates fall within this range. Algae and aquatic macrophytes are only somewhat more sensitive with NOEC values for algae in the range of 6 mg a.e./L to 23 mg a.e./L and a single NOEC of 44 mg a.e./L for an aquatic macrophyte. The lowest aquatic toxicity value is 1.36 mg a.e./L from an egg-and-fry study in fathead minnow. Aquatic invertebrates are much less sensitive to longer-term exposures to aminopyralid with NOEC values in the range of 102 mg a.e./L to 130 mg a.e./L.

Risk Characterization – Aminopyralid is an effective herbicide that is designed to damage certain types of terrestrial plants, particularly broadleaf weeds. Consequently, nontarget plants that are similar to target species in sensitivity to aminopyralid may also be adversely affected by aminopyralid applications. Aminopyralid is selective to the extent that dicots (broadleaf plants) are much more sensitive to aminopyralid than monocots (e.g. grasses). Consequently, some nontarget dicots that are directly sprayed with aminopyralid at or near effective application rates are likely to be adversely affected. Direct spray scenarios for sensitive species of plants result in risk quotients in the range of 150 to 550 over application rates from 0.03 lb. a.e./acre to 0.11 a.e./acre. For all forms of broadcast applications, the direct spray scenario seems plausible and relevant. The direct spray of nontarget species could be much less likely in directed foliar applications (e.g., backpack). Of the indirect exposure scenarios (i.e., drift, runoff, and wind erosion), drift appears to present the highest potential risks to sensitive species of plants. At distances from about 25 feet to about 300 feet downwind, hazard quotients for sensitive plant species are in the range of about 2 to 10 for ground applications and 2 to about 80 for aerial applications. Except in areas that are highly susceptible to runoff such as hard packed and predominantly clay soils, offsite losses associated with runoff do not appear to pose a substantial risk. Similarly, risks associated with transport of the herbicide by wind erosion appear to be insubstantial. All of the individual exposure scenarios for nontarget vegetation could be highly variable depending on a large number of site-specific considerations.

There is no indication that other groups of organisms will be adversely affected by aminopyralid. These groups include tolerant species of terrestrial plants (such as grasses), aquatic plants (algae or macrophytes), mammals, birds, aquatic or terrestrial invertebrates, terrestrial microorganisms, fish, and amphibians.

As with all ecological risk assessments, the current risk assessment is based on tests in only a limited number of species and under conditions that may not well-represent populations of free-ranging nontarget species. For some groups of organisms including soil microorganisms and amphibians, this

limitation is severe in that the available information is sparse and not well-suited to quantitative risk assessment. In other groups of organisms, there are uncertainties in the application of the different types of information that are available for the characterization of risk. These uncertainties are particularly evident in the assessment of potential risks to birds in which the current risk assessment takes an extremely conservative approach in the application of gavage toxicity data to the assessment of risks from dietary exposures.

Chlorsulfuron

Human Health and Ecological Risk Assessment – Final Report

November 24, 2004
SERA TR 04-43-18-01c

Prepared by Julie Klotzbach and Patrick Durkin
Syracuse Environmental Research Associates, Inc.

EXECUTIVE SUMMARY

OVERVIEW

Adverse effects on some nontarget plant species, both terrestrial and aquatic, are plausible unless measures are taken to limit exposure. For terrestrial plants, the dominant factor in the risk characterization is the potency of chlorsulfuron relative to the application rate – i.e., the typical application rate considered in this risk assessment is over 6000 times higher than the no observed effect concentration (NOEC) in direct spray assays of the most sensitive nontarget species. The highest application rate that may be considered in Forest Service programs is over 25,000 times the NOEC and about a factor of 2 above the NOEC in tolerant species. Given these relationships, damage to nontarget plant species after ground broadcast applications could extend to distances of greater than 900 feet from the application site. This risk characterization applies only to ground broadcast applications. When used in directed foliar applications (i.e., backpack), offsite drift could be reduced substantially but the extent of this reduction cannot be quantified.

Damage to aquatic plants, particularly macrophytes, is likely to be less substantial but still noteworthy. At the typical application rate, peak concentrations of chlorsulfuron in water could result in damage to aquatic macrophytes – i.e., hazard quotients ranging from 1.2 to about 24 based on an EC50 for growth inhibition. Thus, if chlorsulfuron is applied in areas where transport to water containing aquatic macrophytes is likely, it would be plausible that detectable damage could be observed. Aquatic algae do not appear to be as sensitive to chlorsulfuron and the hazard quotient is only modestly above the level of concern based on an acute NOEC. Thus, it is not clear if any substantial damage would be likely in aquatic algae.

Just as there is little reason to doubt that adverse effects on some plant species are plausible, there is no clear basis for suggesting that effects on humans or wildlife (terrestrial or aquatic animals) are likely or would be substantial. In workers involved in ground broadcast applications, the level of

concern is modestly exceeded at the highest application rate (0.25 lb./acre) and the level of concern is reached at an application rate of 0.14 lb./acre.

PROGRAM DESCRIPTION

Chlorsulfuron is recommended for pre-emergent and early post-emergent control of many annual, biennial, and perennial broadleaf weeds. Three formulations of chlorsulfuron are available in the United States: Telar® DF and Glean®, which are produced by Dupont, and Corsair™, which is produced by Riverdale. Chlorsulfuron is formulated as a dry flowable granule that is mixed with water and applied as a spray. All three formulations contain 75% (w/w) chlorsulfuron and 25% (w/w) inert ingredients. Telar DF and Corsair are labeled for non-crop, industrial use and Glean is labeled for agricultural use. None of the formulations are specifically registered for forestry use.

Chlorsulfuron is used in Forest Service programs only for the control of noxious weeds. The most common methods of ground application for chlorsulfuron involve backpack (selective foliar) and boom spray (broadcast foliar) operations. The Forest Service does not use aerial applications for chlorsulfuron. Nonetheless, since one formulation of chlorsulfuron (Glean) is registered for aerial applications, aerial applications are included in this risk assessment in the event the Forest Service may wish to consider this application method. For this risk assessment, the typical rate of 0.056 lbs/acre is used, with a range of 0.0059 to 0.25 lbs/acre. This range is based on lowest and highest labeled application rates recommended on the manufacturer's label.

The Forest Service used approximately 33 lbs of chlorsulfuron in 2002, the most recent year for which use statistics are available.

HUMAN HEALTH RISK ASSESSMENT

Hazard Identification – In experimental mammals, the acute oral LD50 for chlorsulfuron is greater than 5000 mg/kg, which indicates a low order of toxicity. Acute exposure studies of chlorsulfuron and chlorsulfuron formulations give similar results, indicating that formulations of chlorsulfuron are not more toxic than chlorsulfuron alone. The most common signs of acute, subchronic, and chronic toxicity are weight loss and decreased body weight gain. The only other commonly noted effects are changes in various hematological parameters and general gross pathological changes to several organs. None of these changes, however, suggest a clear or specific target organ toxicity. Appropriate tests have provided no evidence that chlorsulfuron presents any reproductive risks or causes malformations or cancer. Results of all mutagenicity tests on chlorsulfuron are negative. The inhalation toxicity of chlorsulfuron is not well documented in the literature. Results of a single acute inhalation study indicate that chlorsulfuron produces local irritant effects. Chlorsulfuron is mildly irritating to the eyes and skin, but does not produce sensitizing effects following repeated dermal exposure.

Limited information is available on the toxicokinetics of chlorsulfuron. The kinetics of absorption of chlorsulfuron following dermal, oral or inhalation exposures are not documented in the available literature. Chlorsulfuron does not appear to concentrate or be retained in tissues following either single or multiple dose administration. Chlorsulfuron exhibits first order elimination kinetics, with an estimated half-life in rats of < 6 hours. In all mammalian species studied, chlorsulfuron and its metabolites are extensively and rapidly cleared by a combination of excretion and metabolism. The primary excretory compartment for chlorsulfuron and its metabolites is the urine, with smaller

amounts excreted in the feces. Most of the chlorsulfuron excreted in urine is in the form of the parent compound. Studies on the toxicity of chlorsulfuron metabolites have not been conducted.

As discussed in the exposure assessment, skin absorption is the primary route of exposure for workers. Data regarding the dermal absorption kinetics of chlorsulfuron are not available in the published or unpublished literature. For this risk assessment, estimates of dermal absorption rates – both zero order and first order – are based on quantitative structure-activity relationships. These estimates of dermal absorption rates are used in turn to estimate the amounts of chlorsulfuron that might be absorbed by workers, which then are used with the available dose response data to characterize risk. The lack of experimental data regarding dermal absorption of chlorsulfuron adds substantial uncertainties to this risk assessment. Uncertainties in the rates of dermal absorption, although they are substantial, can be estimated quantitatively and are incorporated in the human health exposure assessment.

Exposure Assessment – Exposure assessments are conducted for both workers and members of the general public for the typical application rate of 0.056 lb./acre. The consequences of using the maximum application rate that might be used by the Forest Service, 0.25 lb./acre, are discussed in the risk characterization.

For workers, three types of application methods are generally modeled in Forest Service risk assessments: directed ground, broadcast ground, and aerial. Neither Telar nor Corsair, however, are registered for aerial application and estimates of exposures for workers involved in aerial application are not used in the risk characterization. Central estimates of exposure for ground workers are approximately 0.0007 mg/kg/day for directed ground spray and 0.001 mg/kg/day for broadcast ground spray. Upper ranges of exposures are approximately 0.0045 mg/kg/day for directed ground spray and 0.0085 mg/kg/day for broadcast ground spray. All of the accidental exposure scenarios for workers involve dermal exposures and all of these accidental exposures lead to estimates of dose that are either in the range of or substantially below the general exposure estimates for workers.

For the general public, the range of acute exposures is from approximately 0.0000002 mg/kg associated with the lower range for dermal exposure from an accidental spray on the lower legs to 0.09 mg/kg associated with the upper range for consumption of contaminated water by a child following an accidental spill of chlorsulfuron into a small pond. High dose estimates are also associated with consumption of contaminated fruit (approximately 0.01 mg/kg) and fish (approximately 0.008 mg/kg for subsistence populations). For chronic or longer term exposures, the modeled exposures are much lower than for acute exposures, ranging from approximately 0.000000001 mg/kg/day associated with the lower range for the normal consumption of fish to approximately 0.004 mg/kg/day associated with the upper range for consumption of contaminated fruit.

Dose-Response Assessment – The Office of Pesticide Programs of the U.S. EPA has derived a chronic RfD of 0.05 mg/kg/day for chlorsulfuron. This RfD is based on a chronic rat NOAEL of 5 mg/kg/day (Wood et al. 1980b) and an uncertainty factor of 100. In the same study, the LOAEL was 25 mg/kg/day and the effect noted was a weight loss and decreased weight gain. No frank signs of toxicity were seen at this or higher dose levels. This NOAEL for chronic toxic effects is below the NOAEL of 25 mg/kg/day for reproductive effects (Wood et al. 1981a).

Thus, doses at or below the RfD will be below the level of concern for reproductive effects. For acute/incidental exposures, the U.S. EPA uses an acute NOAEL of 75 mg/kg/day with an uncertainty factor of 300 resulting in an acute RfD of 0.25 mg/kg/day [75 mg/kg/day / 300].

Both of these values are used in the current risk assessment for characterizing risks associated with exposures to chlorsulfuron.

Risk Characterization – For both workers and members of the general public, typical exposures to chlorsulfuron do not lead to estimated doses that exceed a level of concern. For workers, the upper range of hazard quotients is below the level of concern for backpack and aerial applications but somewhat above the level of concern for ground broadcast applications at the highest application rate. For ground broadcast applications, the level of concern is reached at an application rate of 0.14 lb./acre. For members of the general public, the upper limits for hazard quotients are below a level of concern except for the accidental spill of a large amount of chlorsulfuron into a very small pond. Even this exposure scenario results in only a small excursion above the acute RfD and is not likely to be toxicologically significant, because of the short duration of exposure relative to those considered in the derivation of the RfD. Mild irritation to the skin and eyes can result from exposure to relatively high levels of chlorsulfuron. From a practical perspective, eye or skin irritation is likely to be the only overt effect as a consequence of mishandling chlorsulfuron. These effects can be minimized or avoided by prudent industrial hygiene practices during the handling of the compound.

ECOLOGICAL RISK ASSESSMENT

Hazard Identification – The mammalian toxicity of chlorsulfuron is relatively well characterized in experimental mammals; however, there is relatively little information regarding nontarget wildlife species. It seems reasonable to assume the most sensitive effects in wildlife mammalian species will be the same as those in experimental mammals (i.e., weight loss and decreased body weight gain). Results of acute toxicity and reproduction studies in birds indicate that birds appear to be no more sensitive than experimental mammals to the toxic effects of chlorsulfuron. There is very little information on the effects of chlorsulfuron in terrestrial invertebrates, as standard toxicity bioassays were not identified in the published literature or the U.S. EPA files. No significant change in mortality rate was observed following exposure of larvae of *Gastrophysa ploygoni*, a species of leaf beetle, by direct spray or in feeding studies using chlorsulfuron treated leaves, although survival from egg hatch to imago was significantly decreased by chlorsulfuron applied to the host plant.

The toxicity of chlorsulfuron to terrestrial plants was studied extensively and is well characterized. Chlorsulfuron inhibits acetolactate synthase (ALS), an enzyme that catalyzes the biosynthesis of three branched-chain amino acids, all of which are essential for plant growth. This effect is considered quantitatively in the dose-response assessment and is one of the primary effects of concern in this risk assessment. The lowest EC50 value reported following direct spray is 0.000023 lbs/acre in cherries. The lowest NOEL reported was in onion (0.0000088 lb./acre).

Terrestrial microorganisms also have an enzyme that is involved in the synthesis of branched chain amino acids, which is functionally equivalent to the target enzyme in terrestrial macrophytes. However, chlorsulfuron appears to be only mildly toxic to terrestrial microorganisms and results a field study suggest that effects are transient.

Acute toxicity studies have been conducted in several species of fish. A single study investigated the effects of chronic exposure of to chlorsulfuron in rainbow trout. Due to limited water solubility of

chlorsulfuron, full dose-response curves could not be generated. However, fish do not appear particularly susceptible to chlorsulfuron toxicity, with LC50 values in most species exceeding the limit of solubility for chlorsulfuron (250 to 980 ppm). Based on 96 hour LC50 values, the most susceptible species is the brown trout, with an LC50 value of 40 mg/L.

Chlorsulfuron also appears to be relatively non-toxic to aquatic invertebrates. Standard toxicity bioassays to assess the effects of chlorsulfuron on aquatic invertebrates were conducted in daphnia and mysid shrimp. Similar LC50 values are reported for both species. For reproductive effects, an NOEC of 20 mg/L was reported in a 21-day exposure study in *D. magna*.

The available data suggest that chlorsulfuron, like many other herbicides, is much more toxic to aquatic plants than to aquatic animals. The toxicity of chlorsulfuron has been examined in both algae and aquatic macrophytes. Studies on the mechanism of action of chlorsulfuron in aquatic plants were not identified. However, chlorsulfuron is assumed to have the same mechanism of action in aquatic plants as in terrestrial plants. Based on the results of several studies in algae, the species-dependent variation in sensitivity based on EC50 values for growth inhibition is very large, ranging from 0.011 mg/L in *Synechococcus leopoliensis* to 359 mg/L in *Porphyridium cruentum*. Results of a mesocosm study suggest chlorsulfuron can cause changes in phytoplankton communities at concentrations as low as 1: g/L. Only three studies were identified regarding the toxicity of chlorsulfuron to aquatic plants, two studies in duckweed and one study in sago pondweed. Comparison of 96-hour EC50 values for sago pondweed (0.25: g/L) and duckweed (0.7 :g/L) show that pondweed is slightly more sensitive than duckweed.

Exposure Assessment – Terrestrial animals might be exposed to any applied herbicide from direct spray, the ingestion of contaminated media (vegetation, prey species, or water), grooming activities, or contact with contaminated vegetation. In acute exposure scenarios, the highest exposures for small terrestrial vertebrates will occur after a direct spray and could reach up to about 1.36 mg/kg under typical exposure conditions. There is a wide range of exposures anticipated from the consumption of contaminated vegetation by terrestrial animals: central estimates range from 0.07 mg/kg for a small mammal to 1.51 mg/kg for a large bird under typical exposure conditions, with upper ranges of about 15 mg/kg for a small mammal and 42mg/kg for a large bird. The consumption of contaminated water will generally lead to much lower levels of exposure. A similar pattern is seen for chronic exposures. Estimated daily doses of a small mammal from the consumption of contaminated vegetation at the application site are in the range of about 0.003 mg/kg to 0.01 mg/kg. The upper ranges of exposure from contaminated vegetation far exceed doses that are anticipated from the consumption of contaminated water, which range from 0.000008 mg/kg/day to 0.000007 mg/kg/day for a small mammal. Based on general relationships of body size to body volume, larger vertebrates will receive lower doses and smaller animals, such as insects, will receive much higher doses than small vertebrates under comparable exposure conditions. Because of the apparently low toxicity of chlorsulfuron to animals, the rather substantial variations in the different exposure assessments have little impact on the assessment of risk to terrestrial animals.

For terrestrial plants, five exposure scenarios are considered quantitatively: direct spray, spray drift, runoff, wind erosion and the use of contaminated irrigation water. Unintended direct spray is expressed simply as the application rate considered in this risk assessment, 0.056 lb. a.e./acre and should be regarded as an extreme/accidental form of exposure that is not likely to occur in most Forest Service applications. Estimates for the other routes of exposure are much less. All of these exposure scenarios are dominated by situational variability because the levels of exposure are highly

dependent on site-specific conditions. Thus, the exposure estimates are intended to represent conservative but plausible ranges that could occur but these ranges may over-estimate or under-estimate actual exposures in some cases. Spray drift is based on estimates from AGDRIFT. The proportion of the applied amount transported off-site from runoff is based on GLEAMS modeling of clay, loam, and sand. The amount of chlorsulfuron that might be transported off-site from wind erosion is based on estimates of annual soil loss associated with wind erosion and the assumption that the herbicide is incorporated into the top 1cm of soil. Exposure from the use of contaminated irrigation water is based on the same data used to estimate human exposure from the consumption of contaminated ambient water and involves both monitoring studies as well as GLEAMS modeling.

Exposures to aquatic plants and animals are based on essentially the same information used to assess the exposure to terrestrial species from contaminated water. The peak estimated rate of contamination of ambient water associated with the normal application of chlorsulfuron is 0.01 (0.01 to 0.2) mg a.e./L at an application rate of 1 lb. a.e./acre. For longer-term exposures, average estimated rate of contamination of ambient water associated with the normal application of chlorsulfuron is 0.0006 (0.0009 to 0.0001) mg a.e./L at an application rate of 1 lb. a.e./acre. For the assessment of potential hazards, these contamination rates are adjusted based on the application rates considered in this risk assessment.

Dose-Response Assessment – For terrestrial mammals, the dose-response assessment is based on the same data as the human health risk assessment (i.e., an acute NOAEL of 75 mg/kg/day and a chronic NOAEL of 5 mg/kg/day). None of the exposure scenarios, acute or longer term, result in exposure estimates that exceed this NOAEL. Birds appear to be substantially less sensitive to chlorsulfuron than mammals with an acute NOAEL 1686 mg/kg/day of from a 5-day feeding study and a longer-term NOAEL from a reproduction study of 140 mg/kg/day. Toxicity data on terrestrial invertebrates are not extensive. Based on direct spray studies, no mortality would be expected at application rates of up to 107 lb./acre. Indirect effects to herbivorous insects associated with sublethal effects on treated vegetation have been noted at very low application rates – i.e., about 0.001 lb./acre to 0.002 lb./acre. Soil microorganisms do not appear to be sensitive to chlorsulfuron with an NOEC of 10 ppm (or 10:g/g soil).

The toxicity of chlorsulfuron to terrestrial plants can be characterized relatively well. A very broad range of sensitivities for various types of plants is apparent, with grasses appearing far more tolerant than most other species. For assessing the potential consequences of exposure to nontarget plants via runoff, an NOEC for seedling emergence of 0.000035 lb./acre is used for sensitive species and the corresponding value for tolerant species is 0.022 lb./acre. For assessing the impact of drift, an NOEC for vegetative vigor of 0.0000088 lb./acre is used for sensitive species and the corresponding value for tolerant species is 0.14 lb./acre.

The data on toxicity to fish and aquatic invertebrates are limited. For acute exposures, the NOEC of 30 mg/L in brown trout is used for the most sensitive species and the NOEC of 300 mg/L in rainbow trout is used for the most tolerant species. Toxicity values for chronic toxicity may be based on the available egg-and-fry/early life stage studies; only one study of chronic exposure in fish, a 77-day exposure of rainbow trout with an NOEC of 32 mg/L. This value is used directly as a longer term NOEC in tolerant species because the rainbow trout appears to be a relatively tolerant species in acute toxicity assays. Using the relative potency for acute exposures of 10 (brown trout relative to rainbow trout), NOEC for sensitive species is estimated at 3.2 mg/L. The lowest NOEC value for acute

exposure in an aquatic invertebrate is 10 mg/L in *Daphnia magna* and the highest NOEC is 35 mg/L in *Mysidopsis bahia*, a mysid shrimp.

Although mysid shrimp are saltwater species, the assumption is made that some freshwater species may be as tolerant as the most tolerant saltwater species. For long-term exposure of aquatic invertebrates, only one study was identified in the available literature – a 21-day exposure study in *Daphnia magna* reporting an NOEC for mortality of 20 mg/L. Since *Daphnia magna* were identified as the most sensitive species in acute exposure studies, they will also be considered as the most sensitive species for chronic exposure. In the absence of data in a more tolerant species, the relative potency comparing *Daphnia magna* to *Mysidopsis bahia* is used to estimate a chronic exposure NOEC for *Mysidopsis bahia*, the most tolerant species in acute exposure studies. Based on a relative potency factor of 3.5 and a chronic NOEC of 20 mg/L in *Daphnia magna*, the NOEC in *Mysidopsis bahia* is estimated to be 70 mg/L.

Aquatic plants, particularly macrophytes, appear to be much more sensitive to chlorsulfuron than aquatic animals. An NOEC of 0.00047 mg/L in *Lemna minor* is used for quantifying effects in aquatic macrophytes. This value is comparable to other studies in aquatic macrophytes. Thus, there is no basis for differentiating sensitive and tolerant species of aquatic macrophytes. There is, however, a wide range of toxicity values for aquatic algae. The most sensitive algal species appears to be *Selenastrum capricornutum*, with a 96-hour EC50 of 0.05 mg/L and a corresponding NOEC of 0.01 mg/L. The most tolerant species of freshwater algae appears to be *Cyclotella cryptica*, with an EC50 value of 276 mg/L.

Risk Characterization – Chlorsulfuron is an effective and potent herbicide and adverse effects on some nontarget plant species, both terrestrial and aquatic, are plausible unless measures are taken to limit exposure. For terrestrial plants, the dominant factor in the risk characterization is the potency of chlorsulfuron relative to the application rate. The typical application rate considered in this risk assessment, 0.056 lb./acre, is over 6000 times higher than the NOEC determined in vegetative vigor (direct spray) assay of the most sensitive nontarget species – i.e., 0.0000088 lb./acre in onions and sugar beets – and only a factor of 2.5 below the NOEC for the most tolerant species in the same assay – i.e., 0.14 lb./acre in wheat, wild rye, and some other grasses. The highest application rate that may be considered in Forest Service programs – i.e., 0.25 lb./acre – is over 25,000 times the NOEC in sensitive species and about a factor of 2 above the NOEC in tolerant species. Given these relationships, damage to nontarget plant species after ground broadcast applications could extend to distances of greater than 900 feet from the application site. This risk characterization applies only to ground broadcast applications. When used in directed foliar applications (i.e., backpack), offsite drift could be reduced substantially but the extent of this reduction cannot be quantified.

The NOEC values for soil exposures (assayed in the seedling emergence test) are 0.000035 lb./acre for sensitive species and 0.022 lb./acre for tolerant species, values that are substantially higher than those in the vegetative vigor assay. Nonetheless, the offsite movement of chlorsulfuron via runoff could be substantial under conditions that favor runoff – i.e., clay soils – and hazard quotients in the range of 75 to nearly 1000 are estimated for sensitive species over a wide range of rainfall rates – i.e., 15 inches to 250 inches per year. In very arid regions in which runoff might not be substantial, wind erosion could result in damage to nontarget plant species. The plausibility of observing such damage would, however, be highly dependent on local conditions. This risk characterization would be applicable to either broadcast ground or directed foliar applications.

Damage to aquatic plants, particularly macrophytes, is less substantial but still noteworthy. At the typical application rate, peak concentrations of chlorsulfuron in water could result in damage to aquatic macrophytes – i.e., hazard quotients ranging from 1.2 to about 24 based on an EC50 for growth inhibition. Thus, if chlorsulfuron is applied in areas where transport to water containing aquatic macrophytes is likely, it would be plausible that detectable damage could be observed.

Aquatic algae do not appear to be as sensitive to chlorsulfuron and the hazard quotient is only modestly above the level of concern based on an acute NOEC. Thus, it is not clear if any substantial damage would be likely in aquatic algae. At the upper range of the application rate covered in this risk assessment, the hazard quotient would exceed the level of concern by a factor of about 3. Again, it is not certain that this would result in any substantial adverse effect. Just as there is little reason to doubt that adverse effects on some plant species are plausible, there is no clear basis for suggesting that effects on terrestrial or aquatic animals are likely or would be substantial. Adverse effects in mammals, birds, terrestrial insects, and microorganisms are not likely using typical or worst-case exposure assumptions at the typical application rate of 0.056 lb. a.e./acre or the maximum application rate of 0.25 lb. a.e./acre. One study has suggested that latent/sublethal chlorsulfuron toxicity to one plant species could result in adverse reproductive effects in one species of beetle that consumes the leaves of the affected plant. This appears to be a highly specific plant-insect interaction and this effect has not been noted in subsequent studies by the same group of investigators using other plant-insect pairs. As with the human health risk assessment, this characterization of risk must be qualified. Chlorsulfuron has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging nontarget species. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects are anticipated in terrestrial animals.

Similarly, the risk characterization for aquatic animals is relatively simple and unambiguous. Chlorsulfuron appears to have a very low potential to cause any adverse effects in aquatic animals. All of the hazard quotients for aquatic animals are extremely low, ranging from 0.00000008 (longer term exposures in tolerant invertebrates) to 0.001 (acute exposures to sensitive aquatic invertebrates). At the maximum application rate of 0.25 lbs/acre, the risk characterization is unchanged: the highest hazard quotient 0.001 would be increased to 0.005, below the level of concern by a factor of 200.

Clopyralid

Human Health and Ecological Risk Assessment - Final Report

SERA TR 04-43-17-03c

December 4, 2004

Patrick Durkin and Mark Follansbee
Syracuse Environmental Research Associates, Inc.

EXECUTIVE SUMMARY

PROGRAM DESCRIPTION

Clopyralid is a selective herbicide used primarily in the control of broadleaf weeds. The Forest Service uses only a single commercial formulation of clopyralid, Transline. The Forest Service uses Transline almost exclusively in noxious weed control. Relatively minor uses include rights-of-way management, wildlife openings, and facilities maintenance. Transline is a liquid formulation of clopyralid that is manufactured by Dow AgroSciences and contains 40.9% clopyralid as the monoethanolamine salt and 59.1% inert ingredients. The identity of the inerts in Transline is proprietary with the exception of isopropyl alcohol (List 4) and a polyglycol (List 3). Technical grade clopyralid contains hexachlorobenzene and pentachlorobenzene as contaminants. Nominal or average concentrations of hexachlorobenzene are less than 2.5 ppm. Nominal or average concentrations of pentachlorobenzene are less than 0.3 ppm. The most common methods of ground application for Transline involve backpack (selective foliar) and boom spray (broadcast foliar) operations. Although Transline is registered for aerial applications, the Forest Service does not and does not intend to use Transline in aerial applications. The typical application rate in Forest Service programs is about 0.35 lb. a.e./acre and the range of application rates that are likely to be used in Forest Service programs is about 0.1 to 0.5 lb. a.e./acre. The total annual use of clopyralid by the Forest Service is about 2.2 percent of the agricultural use.

HUMAN HEALTH RISK ASSESSMENT

Hazard Identification – Although no information is available on the toxicity of clopyralid to humans, the toxicity of clopyralid has been relatively well-characterized in mammals. All of this information is contained in unpublished studies submitted to the U.S. EPA as part of the registration process for clopyralid.

Two different manufacturing processes may be used for clopyralid: the penta process and the electrochemical process. The limited available information indicates that technical grade clopyralid samples from the electrochemical process may be somewhat more toxic (LD50 values in the range of about 3000 mg/kg) than the penta process (LD50 > 5000 mg/kg). These differences, however, are not substantial and may be due to random variability. In experimental animals, a common symptom of acute, high-dose clopyralid exposure is central nervous system (CNS) depression. Clopyralid also has a low order of chronic toxicity. For chronic or subchronic exposures, no effects have been observed in laboratory mammals at doses of 50 mg/kg/day or less. At doses of 100 mg/kg/day or

greater, various effects have been observed in different species and different bioassays. These effects include weight loss, changes in liver and kidney weight, thickening of epithelial tissue lining the stomach, irritation of the lungs, and decreases in red blood cell counts. These effects appear to be non-specific toxicity; they do not implicate clopyralid in any specific target-organ toxicity.

Technical grade clopyralid has been subject to several chronic bioassays for carcinogenicity and none of the bioassays have shown that clopyralid has carcinogenic potential, although technical grade clopyralid does contain low levels of hexachlorobenzene. Hexachlorobenzene has shown carcinogenic activity in three mammalian species and has been classified as a potential human carcinogen by the U.S. EPA. Thus, this effect is considered both qualitatively and quantitatively in this risk assessment.

No studies specifically mentioning Transline, the formulation used in Forest Service programs, were located in the search of the studies submitted to U.S. EPA for product registration. Dow AgroSciences (2003) provided clarification of this issue and identified the studies submitted to U.S. EPA that were accepted as relevant to Transline. These studies do not indicate any substantial differences between Transline and clopyralid. This is consistent with the publically available information on the three inerts contained in transline, two of which are approved for use as food additives.

Exposure Assessment – Exposure assessments are conducted for both workers and members of the general public for the typical application rate of 0.35 lb./acre. The consequences of using the maximum application rate, 0.5 lb./acre, are discussed in the risk characterization. For both workers and members of the general public, the upper ranges of all acute exposures are below 2 mg/kg and most exposures are much lower. The highest modeled exposure is about 1.8 mg/kg and is associated with the consumption of contaminated water by a child following an accidental spill of clopyralid into a small pond. The upper ranges of non-accidental acute exposure scenarios for members of the general public are associated with doses from about 0.0002 to 0.2 mg/kg. The highest dose estimates for non-accidental exposure scenarios are associated with the consumption of fish. Exposures from dermal contact or drinking contaminated water (other than an accidental spill) are likely to be much lower.

General exposure assessments for workers are in the range of exposures modeled for the general public. For workers, three types of application methods are modeled: directed ground, broadcast ground, and aerial. Central estimates of exposure span a relatively narrow range: 0.005 to 0.008 mg/kg. The upper ranges of exposures are also similar for the different groups of workers: 0.03 to 0.05 mg/kg/day. All of the accidental exposure scenarios for workers involve dermal exposures. Because clopyralid is not readily absorbed across the skin, all of these accidental exposures lead to estimates of dose that are either in the range of or substantially below the general exposure estimates for workers.

Hexachlorobenzene is a contaminant in technical grade clopyralid. The concentration of hexachlorobenzene in technical grade clopyralid is about 2.5 ppm or less. For all exposure assessments detailed in this risk assessment, the concentration of 2.5 ppm is used.

Hexachlorobenzene is ubiquitous and persistent in the environment. The major sources of general exposure for the public to hexachlorobenzene involve industrial emissions, proximity to hazardous waste sites, and the consumption of contaminated food. Virtually all individuals are exposed to

hexachlorobenzene and virtually all individuals have detectable concentrations of hexachlorobenzene in their bodies. Based on current concentrations of hexachlorobenzene in environmental media and food, daily doses of hexachlorobenzene (i.e., background levels of exposure) are in the range of 0.000001 (1×10^{-6}) mg/kg/day. Based on the amount of hexachlorobenzene in clopyralid and the amount of clopyralid used in Forest Service programs, the use of clopyralid by the Forest Service will not substantially contribute to any wide-spread increase of ambient levels of hexachlorobenzene. Nonetheless, the potential impact of local contamination is considered for workers as well as for several acute and chronic exposure scenarios for members of the general public. For workers, the upper range of longer term exposure scenarios result in dose estimates of about 7×10^{-8} mg/kg/day to 1×10^{-7} mg/kg/day, below general background levels of exposure by about a factor of 10 to 14. For members of the general public, the upper range of longer term exposure scenarios are about 3×10^{-11} mg/kg/day to 2×10^{-8} mg/kg/day, below general background levels of exposure by about a factor of 50 to 33,000. The upper range of estimated doses associated with acute exposure scenarios for both workers and members of the general public are about 0.0005 mg/kg/day, higher than background levels of exposure by about a factor of 500.

Dose-Response Assessment – The Office of Pesticide Programs of the U.S. EPA has derived an acute RfD of 0.75 mg/kg/day and a chronic RfD of 0.15 mg/kg/day for clopyralid. The acute RfD is based on a short-term NOAEL of 75 mg/kg/day and an uncertainty factor of 100. The chronic RfD is based on a 2-year dietary NOAEL in rats of 15 mg/kg/day and an uncertainty factor of 100. Other studies in rats, mice, and dogs have noted general decreases in body weight, increases in liver and kidney weight, as well as a thickening in some epithelial tissue. Decreases in body weight and changes in organ weight are commonly observed in chronic toxicity studies and can indicate either an adaptive or toxic response. Changes in epithelial tissue are less commonly observed and the toxicological significance of this effect is unclear. The data on the toxicity of clopyralid are adequate for additional dose-response or dose-severity modeling. Because none of the anticipated exposures substantially exceed the RfD and the great majority of anticipated exposures are far below the RfD, such additional modeling is not necessary for the characterization of risk.

The contamination of technical grade clopyralid with hexachlorobenzene and pentachlorobenzene can be quantitatively considered to a limited extent. The U.S. EPA has derived RfDs for both pentachlorobenzene and hexachlorobenzene and a cancer potency factor for hexachlorobenzene.

Based on the levels of contamination of technical grade clopyralid with these compounds and the relative potencies of these compounds to clopyralid, this contamination is not significant in terms of potential systemic-toxic effects. This assessment, however, does not impact the potential carcinogenicity associated with hexachlorobenzene and this risk, based on the U.S. EPA's cancer potency parameter, is quantitatively considered in the risk characterization.

Risk Characterization – The risk characterization for potential human health effects associated with the use of clopyralid in Forest Service programs is relatively unambiguous. Based on the estimated levels of exposure and the criteria for acute and chronic exposure developed by the U.S. EPA, there is no evidence that typical or accidental exposures will lead to dose levels that exceed the level of concern for workers. In other words, all of the anticipated exposures for workers are below the acute RfD for acute exposures and below the chronic RfD for chronic exposures. For members of the general public, none of the longer-term exposure scenarios approach a level of concern and none of the acute/accidental scenarios exceed a level of concern, based on central estimates of exposure,

although the upper limit of the hazard quotient for the consumption of water after an accidental spill slightly exceeds the level of concern – i.e., a hazard quotient of 2.

Irritation and damage to the skin and eyes can result from exposure to relatively high levels of clopyralid (i.e., placement of clopyralid directly onto the eye or skin). From a practical perspective, eye or skin irritation is likely to be the only overt effect as a consequence of mishandling clopyralid. These effects can be minimized or avoided by prudent industrial hygiene practices during the handling of clopyralid.

The only reservation attached to this assessment of clopyralid is that associated with any risk assessment: *Absolute safety cannot be proven and the absence of risk can never be demonstrated.* No chemical, including clopyralid, has been studied for all possible effects and the use of data from laboratory animals to estimate hazard or the lack of hazard to humans is a process that is fraught with uncertainty. Prudence dictates that normal and reasonable care should be taken in the handling of this or any other chemical. Notwithstanding these reservations, the use of clopyralid does not appear to pose any risk of systemic toxic effects to workers or the general public in Forest Service programs.

The contamination of clopyralid with hexachlorobenzene and pentachlorobenzene does not appear to present any substantial cancer risk. Administratively, the Forest Service has adopted a cancer risk level of one in one-million ($1 \div 1,000,000$) as a trigger that would require special steps to mitigate exposure or restrict and possibly eliminate use. Based on relatively conservative exposure assumptions, the risk levels estimated for members of the general public are below this trigger level. The highest risk level is estimated at about 3 in 100 million, a factor of 33 below the level of concern. The exposure scenario associated with this risk level involves the consumption of contaminated fish by subsistence populations (i.e., groups that consume relatively large amounts of contaminated fish). The consumption of fish contaminated with hexachlorobenzene is a primary exposure scenario of concern because of the tendency of hexachlorobenzene to bioconcentrate from water into fish. This is also consistent with the general observation that exposure to hexachlorobenzene occurs primarily through the consumption of contaminated food.

ECOLOGICAL RISK ASSESSMENT

Hazard Identification – The toxicity of clopyralid is relatively well characterized in experimental mammals but few wildlife species have been assayed relative to the large number of non-target species that might be potentially affected by the use of clopyralid. Within this admittedly substantial reservation, clopyralid appears to be relatively non-toxic to terrestrial or aquatic animals, is highly selective in its toxicity to terrestrial plants, and relatively non-toxic to aquatic plants. Thus, the potential for substantial effects on non-target species appears to be remote. Consistent with this assessment of toxicity to non-target species, one long-term (8-year) field study has been conducted that indicates no substantial or significant effects on plant species diversity.

The toxicity to non-target terrestrial animals is based almost exclusively on toxicity studies using experimental mammals (i.e., the same studies used in the human health risk assessment). Some additional studies are available on birds, bees, spiders, and earthworms that generally support the characterization of clopyralid as relatively non-toxic. An additional study of the toxicity of clopyralid to non-target invertebrates also suggests that clopyralid has a low potential for risk. A caveat in the interpretation of this study is the limited detail in which the experimental data are

reported. As with terrestrial species, the available data on aquatic species, both plants and animals, suggest that clopyralid is relatively non-toxic.

The toxicity of clopyralid to terrestrial plants has been examined in substantial detail in studies that have been published in the open literature as well as studies that have been submitted to the U.S. EPA to support the registration of clopyralid. Clopyralid is a plant growth regulator and acts as a synthetic auxin or hormone, altering the plant's metabolism and growth characteristics, causing a proliferation of abnormal growth that interferes with the transport of nutrients throughout the plant. This, in turn, can result in gross signs of damage and the death of the affected plant. The phytotoxicity of clopyralid is relatively specific to broadleaf plants because clopyralid is rapidly absorbed across leaf surfaces but much less readily absorbed by the roots of plants. For the same reason, clopyralid is much more toxic/effective in post-emergent treatments (i.e., foliar application) rather than pre-emergent treatment (i.e., application to soil).

Clopyralid does not bind tightly to soil and thus would seem to have a high potential for leaching. While there is little doubt that clopyralid will leach under conditions that favor leaching—sandy soil, a sparse microbial population, and high rainfall—the potential for leaching or runoff is functionally reduced by the relatively rapid degradation of clopyralid in soil. A number of field lysimeter studies and a long-term field study indicate that leaching and subsequent contamination of ground water are likely to be minimal. This conclusion is also consistent with a monitoring study of clopyralid in surface water after aerial application.

Exposure Assessment – Terrestrial animals might be exposed to any applied herbicide from direct spray, the ingestion of contaminated media (vegetation, prey species, or water), grooming activities, or indirect contact with contaminated vegetation. In acute exposure scenarios, exposures from direct spray for small terrestrial vertebrates could reach up to about 8.5 mg/kg under the conservative assumption of 100% absorption. Acute exposures from the consumption of contaminated vegetation could lead to doses of about 6 to 9 mg/kg under typical conditions with an upper range of 17 to 27 mg/kg. In chronic exposures, estimated daily doses for a small vertebrate from the consumption of contaminated vegetation are in the range of 0.0002 to 0.2 mg/kg/day. The upper ranges of exposure from contaminated vegetation far exceed doses that are anticipated from the consumption of contaminated water – i.e., about 0.0004 mg/kg/day to 0.0007 mg/kg/day. Based on general relationships of body size to body volume, larger vertebrates will be exposed to lower doses and smaller animals, such as insects, to much higher doses than small vertebrates under comparable exposure conditions.

For terrestrial plants, five exposure scenarios are considered quantitatively: direct spray, spray drift, runoff, wind erosion and the use of contaminated irrigation water. Unintended direct spray is expressed simply as the application rates considered in this risk assessment, 0.35 lb. a.e./acre. Estimates for the other routes of exposure are much less. All of these exposure scenarios are dominated by situational variability because the levels of exposure are highly dependent on site specific conditions. Thus, the exposure estimates are intended to represent conservative but plausible ranges that could occur but these ranges may over-estimate or under-estimate actual exposures in some cases. Spray drift is based on estimates AGDRIFT. The proportion of the applied amount transported off-site from runoff is based on GLEAMS modeling of clay, loam, and sand. The amount of clopyralid that might be transported off-site from wind erosion is based on estimates of annual soil loss associated with wind erosion and the assumption that the herbicide is incorporated into the top 1 cm of soil. Exposure from the use of contaminated irrigation water is based on the

same data used to estimate human exposure from the consumption of contaminated ambient water and involves both monitoring studies as well as GLEAMS modeling.

Exposures to aquatic plants and animals are based on essentially the same information used to assess the exposure to terrestrial species from contaminated water. The peak estimated rate of contamination of ambient water associated with the normal application of clopyralid is 0.02 (0.005 to 0.07) mg a.e./L at an application rate of 1 lb. a.e./acre. For longer-term exposures, average estimated rate of contamination of ambient water associated with the normal application of clopyralid is 0.007 (0.001 to 0.013) mg a.e./L at an application rate of 1 lb. a.e./acre. For the assessment of potential hazards, these contamination rates are adjusted based on the application rates considered in this risk assessment.

Dose-Response Assessment – For terrestrial mammals, the dose-response assessment is based on the same data as the human health risk assessment (i.e., an acute NOAEL of 75 mg/kg/day and a chronic NOAEL of 15 mg/kg/day). None of the exposure scenarios, acute or longer term, result in exposure estimates that exceed this NOAEL. A comparison of gavage studies between mammals and birds suggest that birds may be more sensitive than mammals by about a factor of 3. Based on a comparison of short-term dietary NOAELs, however, birds appear to be somewhat less sensitive with an acute dietary NOAEL of about 670 mg/kg/day, a factor of about 9 above the acute NOEL of 75 mg/kg/day for mammals. Since most of the exposure assessments developed in this risk assessment involve gradual intake during the day rather than gavage like exposures, the dietary NOEL of 696 mg/kg/day is used for the risk characterization in birds. No chronic toxicity studies in birds have been encountered and the chronic NOAEL for mammals of 15 mg/kg/day is used in this risk assessment to assess the risks associated with longer term exposures.

The toxicity of clopyralid to terrestrial plants can be characterized relatively well and with little ambiguity. Clopyralid is more toxic to broadleaf plants than grains or grasses and is more toxic in post-emergence applications (i.e., foliar spray) than pre-emergence applications (i.e., soil treatment). For assessing the potential consequences of exposures to nontarget plants via runoff, the NOEC values for seed emergence are used for sensitive species (0.025 lb. a.e./acre) and tolerant species (0.5 lb. a.e./acre). For assessing the impact of drift, bioassays on vegetative vigor will be used with NOEC values of 0.0005 lb./acre for sensitive species and 0.5 lb./acre for tolerant species.

The data on toxicity to fish are limited. No chronic studies or even long-term studies on fish egg-and-fry have been encountered. The dose-response assessment uses admittedly limited data suggesting that at least some fish species may be more sensitive to clopyralid than daphnids. For acute exposures, an acute LC50 value of 103.5 mg/L is used to characterize risk for sensitive fish species and an acute LC50 value of 1645 mg a.e./L is used to characterize risk for tolerant fish species. Based on differences in acute toxicity between sensitive fish and daphnids, the longer term NOEC for sensitive species is based on the 23.1 mg a.e./L from daphnids but adjusted downward by a factor of 2 and then rounded to one significant digit – i.e. 10 mg/L. For sensitive aquatic plants, risk is characterized using the lowest reported EC50 of 6.9 mg a.e./L. Conversely, for tolerant aquatic plants, the highest reported EC50, 449 mg/L, is used. The available data on aquatic plants are not sufficient to support separate dose-response assessments for macrophytes and algae.

Risk Characterization – Clopyralid is an herbicide and the most likely damage to nontarget species will involve terrestrial plants. Sensitive plant species could be adversely affected by the off-site drift of clopyralid under a variety of different scenarios depending on local site-specific conditions that

cannot be generically modeled. If clopyralid is applied in the proximity of sensitive crops or other desirable sensitive plant species, site-specific conditions and anticipated weather patterns will need to be considered if unintended damage is to be avoided. More tolerant plant species are not likely to be affected unless they are directly sprayed or subject to substantial drift. Because of the tendency for clopyralid to move into soil rather than to be transported by runoff and because of the greater toxicity of clopyralid by foliar deposition compared to soil contamination, off-site movement of clopyralid by soil runoff does not appear to be substantial risk to nontarget plant species. Aquatic plants do not appear to be at any substantial risk from any plausible acute or chronic exposures. In the very extreme case of an accidental spill of a large amount of the herbicide into a relatively small body of standing water, sensitive aquatic plants could be damaged.

No adverse effects are anticipated in terrestrial or aquatic animals from the use of clopyralid in Forest Service programs at the typical application rate of 0.35 lb. a.e./acre. The same qualitative assessment holds for the maximum application rate of 0.5 lb. a.e./acre except for the large bird feeding exclusively on contaminated vegetation over a 90 day period. Other more plausible scenarios – i.e., the longer term consumption of vegetation contaminated by drift or the longer term consumption of contaminated water or fish – yield hazard quotients that are in the range of 0.00005 to 0.02, far below a level of concern.

The risk characterization for both terrestrial and aquatic animals is limited by the relatively few animal and plant species on which data are available compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments.

Glyphosate

Human Health and Ecological Risk Assessment - FINAL REPORT

SERA TR-052-22-03b

March 25, 2011

Patrick R. Durkin
Syracuse Environmental Research Associates, Inc.

EXECUTIVE SUMMARY

General Considerations

Glyphosate is a herbicide used in Forest Service programs primarily in conifer release, site preparation, and noxious weed control. The Forest Service identified more than 50 formulations which are explicitly considered in the current risk assessment. This risk assessment on glyphosate is dominated by three considerations: the extensive literature available on glyphosate, the availability of numerous glyphosate formulations, and the use of surfactants either as components in glyphosate formulations or as adjuvants added to glyphosate formulations prior to application. There are obvious, and in many cases substantial, differences among the toxicities of technical grade glyphosate, glyphosate formulations that do not contain a surfactant, and some glyphosate formulations that contain polyoxyethyleneamine (POEA) surfactants. While the available

information does not permit formulation-specific toxicity values, an attempt is made to discriminate between less toxic and more toxic formulations, when possible. A general classification of formulations is given in Table 5 of this risk assessment. Formulations identified as *Low Toxicity* in Table 5 can be regarded as *less toxic formulations*. Other formulations should be regarded as *more toxic formulations*, unless data on the formulation are available to justify a different classification. Additional formulations may become available subsequent to the release of this risk assessment, which may require the use of judgment to classify new formulations as more or less toxic. In general, it would be prudent to classify any formulation that contains a POEA surfactant as more toxic, except when there is a compelling reason to do otherwise. If the presence and/or toxicity of the surfactants in the formulation cannot be determined, it would be prudent to classify the formulation as more toxic.

Human Health

The toxicity data on technical grade glyphosate are extensive, including both a standard set of toxicity studies submitted to the U.S. EPA/OPP in support of the registration of glyphosate as well as a robust open literature consisting of numerous and diverse *in vivo* and *in vitro* studies. As with any complex collection of studies, the studies on technical grade glyphosate may be subject to differing interpretations. The preponderance of the available data, however, clearly indicates that the mammalian toxicity of glyphosate is low, and very few specific hazards can be identified. Doses of technical grade glyphosate that exceed around 300 mg/kg bw may cause signs of toxicity, including decreased body weight gain, changes in certain biochemical parameters in blood as well as tissues, and inhibition of some enzymes (i.e., P450) involved in the metabolism of both endogenous and exogenous compounds. At doses from about 1000 to 5000 mg/kg bw, glyphosate can cause death. The most sensitive endpoint for glyphosate—i.e., the adverse effect occurring at the lowest dose—involves developmental effects; accordingly, the EPA-derived RfDs for glyphosate are based on developmental effects. These adverse effects relate primarily to delayed development which occurs only at doses causing signs of maternal toxicity. There is no indication that technical grade glyphosate causes birth defects.

The hazard identification for glyphosate formulations is much less clear. In most Forest Service pesticide risk assessments, the active ingredient is the agent of primary concern, and consideration of other ingredients in the formulations is limited to a brief discussion in Section 3.1.14 (Adjuvants and Other Ingredients). In the current Forest Service risk assessment, however, the way in which the formulation ingredients other than glyphosate are handled is much different. Many glyphosate formulations include surfactants, and the toxicity of these surfactants is of equal or greater concern to the risk assessment than is the toxicity of technical grade glyphosate. Consequently, as justified by the available data, the hazard identification is subdivided into sections that address the toxicity of technical grade glyphosate, the toxicity of glyphosate formulations, and/or the toxicity of the surfactants.

Because surfactants appear to be agents of concern, a central issue in the current Forest Service risk assessment involves differences in surfactants among the glyphosate formulations used by the Forest Service (Table 2) as well as glyphosate formulations for which toxicity data are available in the open literature. As detailed in Section 3.1.14, the term *POEA* (an acronym for polyoxyethyleneamine) is commonly used to designate surfactants used in some glyphosate formulations. POEA, however, is not a single surfactant. In addition, because the constituents in the surfactants are considered propriety (trade secrets or Confidential Business Information), detailed information about the constituents is not publically available. The surfactants in many glyphosate formulations used by the

Forest Service appear to consist primarily of polyethoxylated tallow amines. Nonetheless, each surfactant can be characterized as a complex mixture. In addition, the POEA surfactant used in one glyphosate formulation may be different from the POEA surfactant used in other glyphosate formulations, even among formulations provided by the same manufacturer. Thus, it is not clear whether the toxicity studies conducted on one POEA surfactant are applicable to all or any of the other glyphosate formulations currently in use.

The difference or potential difference in the composition of surfactants used in various glyphosate formulations has a practical impact on the hazard identification for the current Forest Service risk assessment. Several studies conducted outside of the United States on glyphosate formulations which are not used domestically report adverse effects of concern, including potential effects on endocrine function in rats and signs of genotoxicity in humans. In the absence of comparable studies on glyphosate formulations manufactured and used in the United States, the extent to which this information is relevant to U.S. formulations of glyphosate is unclear.

Two studies conducted in South America (Bolognesi et al. 2009; Paz-y-Mino et al. 2007) suggest that applications of glyphosate formulations may be associated with signs of chromosomal damage in human populations (Section 3.1.10.1.2). The study by Paz-y-Mino et al. (2007) has several limitations; nonetheless, the more detailed study by Bolognesi et al. (2009) suggests a temporal association between glyphosate exposure and chromosomal damage. Both of these studies involved application rates which, when expressed in units of glyphosate, are comparable to those used in Forest Service programs—i.e., about 1-4 lb. a.e./acre. Neither study, however, involved glyphosate formulations used in the United States and the relevance of these studies to U.S. formulations of glyphosate is questionable.

Developmental toxicity, endocrine function, and genotoxicity are endpoints of obvious concern in any risk assessment. Based on the studies using formulations from outside the United States, there is concern that glyphosate formulations may have an impact on these endpoints and that some of these effects could be seen under typical application conditions in the United States. In the absence of comparable studies on U.S. formulations, however, it is not clear whether the studies on glyphosate formulations used outside the United States are applicable to risks posed by U.S. formulations of glyphosate.

The quantitative risk characterization for both human health and ecological effects is expressed as the hazard quotient (HQ). For both general and accidental exposures of humans, the HQ is calculated as the estimated dose in units of mg/kg bw for acute exposures or units of mg/kg bw/day for longer-term exposures divided by the RfD of 2 mg/kg/day (U.S. EPA/OPP 1993a,b). As discussed in Section 3.3.2, the RfD is derived from a developmental study and applied to both acute and longer-term exposures. The exposure assessments on which the HQs are based are discussed in Section 3.2.2, with details provided in the EXCEL workbooks that accompany this risk assessment—i.e., Attachment 1a for backpack foliar applications, Attachment 1b for ground broadcast foliar applications, Attachment 1c for aerial foliar applications, and Attachment 2 for aquatic applications.

For both workers and members of the general public, the RfD of 2 mg a.e./kg bw/day is used to characterize risks associated with acute and longer-term exposure levels. As discussed in the exposure assessment (Section 3.2.2), all exposure assessments are based on the unit application rate of 1 lb. a.e./acre. A quantitative summary of the risk characterization for workers is presented in Table 19. Quantitative summaries of risks to members of the general public are presented in

Table 20 for terrestrial applications and Table 21 for aquatic applications. Because the HQs are based on the RfD, an HQ of 1 or less suggests that exposures are below the level of concern. HQs greater than 1 indicate that the exposure exceeds the level of concern.

Based on the HQ method, concern for workers is minimal. At the highest labeled application rate for terrestrial applications, about 8 lbs a.e./acre, the highest HQ is 0.6, the upper bound of the HQ for workers involved in ground broadcast applications.

For members of the general public, the only non-accidental exposure scenario of concern is for acute exposure involving the consumption of contaminated vegetation shortly after glyphosate is applied. For this exposure scenario, the HQ reaches a level of concern (HQ=1) at an application rate of about 1.4 lbs a.e./acre. At the maximum labeled application rate of about 8 lbs a.e./acre, the resulting HQ value would be about 5.6 with a corresponding dose of about 10.8 mg/kg bw.

Apart from the standard HQ method, there are additional concerns, including a report of systemic toxicity in California workers involved in glyphosate applications. In addition and as also noted above, two studies indicate a potential for chromosomal damage in South American populations exposed to glyphosate formulations containing surfactants applied aerially at rates within the range of those used in Forest Service programs. While these studies are not used quantitatively in the current Forest Service risk assessment and the studies suggest a potential for health effects that are not identified or confirmed using the standard HQ method.

Ecological Effects

The toxicity of technical grade glyphosate is relatively well characterized for both terrestrial and aquatic species. In addition, the toxicity of the original Roundup formulation as well as Rodeo is relatively well characterized. It is more difficult, however, to clearly define the hazards and assess risks associated with other glyphosate formulations.

As is the case with most Forest Service pesticide risk assessments, the data used to assess the risk to mammalian wildlife as well as human exposure to glyphosate and glyphosate formulations is largely the same. Thus, Section 4.1.2.1 focuses primarily on studies useful for assessing differences in pesticide sensitivity among various species of mammalian wildlife. The dose response assessment for mammalian wildlife (Section 4.3.2.1) presents a fuller discussion of concerns for reproductive toxicity raised by the recent Dallegrave et al. (2007) study conducted with a South American formulation of Roundup. In some respects, however, it is some early, detailed field studies on mammalian wildlife which have a substantial impact on the hazard identification for human health and mammalian wildlife. These early studies do not report adverse reproductive effects in populations of small mammals following applications of U.S. formulations of Roundup (Ritchie et al. 1987; Sullivan 1990).

The hazard identification subsections for other groups of ecological receptors is structured in a manner similar to the hazard identification for human health effects in that distinctions between technical grade glyphosate and glyphosate formulations are maintained as clearly as possible. For birds, terrestrial-phase amphibians, and terrestrial invertebrates, relatively complete sets of studies are available on both technical grade glyphosate and some U.S. formulations. Some studies using formulations from South America suggest adverse effects on reproduction in birds, amphibians, and terrestrial invertebrates. The types of studies conducted on the South American formulations have not been conducted on formulations that will be used in Forest Service programs. Consequently, the

applicability of the data on South American formulations to the current Forest Service risk assessment is difficult to assess because of the proprietary nature of the data on the surfactants used in different formulations of glyphosate.

Glyphosate is an effective herbicide, and the toxicity of glyphosate and glyphosate formulations to terrestrial plants is well characterized. In addition, there is a relatively detailed literature regarding the effects of glyphosate and glyphosate formulations to terrestrial microorganisms. While the mechanism of action of glyphosate in plants is also relevant to microorganisms, there is very little indication that terrestrial microorganisms will be adversely affected by glyphosate.

A large and detailed body of literature is available on the effects of glyphosate and some glyphosate formulations to aquatic organisms. Summaries of the available studies are provided in the following tables: Table 22 (fish), Table 25 (aquatic-phase amphibians), Table 26 (aquatic invertebrates), Table 27 (algae) and Table 28 (aquatic macrophytes). The discussions of each of these groups of aquatic organisms in the hazard identification are preceded by an overview of the available literature. The toxicity of the original Roundup and similar formulations containing POEA surfactants is far greater than the toxicity of technical grade glyphosate, Rodeo, or other formulations that do not contain surfactants. Among the formulations with surfactants, several non-U.S. formulations appear to be less toxic than some U.S. formulations of Roundup and Roundup-like formulations. Although data suggest that certain U.S. formulations of glyphosate that contain surfactants may be less toxic than others, these toxicity-related differences are not clearly documented in the EPA risk assessment on glyphosate (U.S. EPA/OPP 2008a) or in the open literature. As discussed in Section 2, data from Material Safety Data Sheets (MSDS) are neither well documented nor sufficiently clear to be used directly in this risk assessment.

Fish, amphibians, and most aquatic invertebrates appear to be about equally sensitive to the toxicity of technical grade glyphosate and glyphosate formulations, and any differences in response to exposure are more likely attributable to experimental conditions, particularly pH, than to species differences. The sensitivity of algae to glyphosate and glyphosate formulations varies among species; however, the data regarding differences among species of aquatic macrophytes are less complete. Nonetheless, there is evidence that *Lemna* species are much more sensitive than eelgrass to glyphosate acid, which suggests that there may be substantial species differences in the sensitivity of macrophytes to glyphosate formulations. Most studies on aquatic microorganisms seem consistent with studies on terrestrial microorganisms, indicating that aquatic microorganisms are not very sensitive to glyphosate. Some recent studies using changes in the composition of ribosomal RNA and DNA suggest that effects on aquatic microorganisms may occur at very low concentrations. While this may be the case, the functional significance of these effects is not apparent.

Terrestrial plants comprise the only group of nontarget species for which no distinction is made between more and less toxic formulations. Glyphosate is an effective postemergence herbicide. Foliar applications of glyphosate with an effective surfactant (POEA or otherwise) may pose a risk to terrestrial plants. The direct spray of a nontarget plant at an effective application rate is likely to kill or seriously injure most plants. Nonetheless, substantial differences in sensitivity to glyphosate are apparent among different species of plants. For sensitive species, offsite drift of glyphosate can pose a risk. The nature of the risk will depend on the application rate, application method, and site-specific conditions that can impact the extent of drift.

For groups of organisms other than terrestrial plants, risks associated with the use of more and less toxic formulations differ. Based on pesticide use reports from the Forest Service, typical application rates for glyphosate in Forest Service programs are in the range of 0.5 to 4 lbs a.e./acre. Applications of more toxic formulations of glyphosate at rates of up to 2.5-3 lb. a.e./acre do not appear to present any apparent risks to terrestrial animals, based on upper bound estimates of exposures. At application rates above 2.5 lb. a.e./acre, risks to mammals cannot be ruled out based on upper bound estimates of exposure, but no risks are apparent based on central estimates of exposure. At application rates above about 3.3 lb. a.e./acre, the HQs for birds modestly exceed the level of concern, but there is no basis for asserting that overt toxic effects in birds are likely. Risks to terrestrial insects are a greater concern in dietary exposures than direct spray. Based on upper bound estimates of dietary exposure at the maximum application rate of 8 lb. a.e./acre, the HQs for terrestrial insects can reach a value of 10. Concern for terrestrial invertebrates is enhanced by two toxicity studies using South American formulations of glyphosate which noted adverse effects on reproduction and development. While most field studies suggest that effects on terrestrial invertebrates are due to secondary effects on vegetation, the field studies do not directly contradict the South American toxicity studies or the HQs. The less toxic formulations of glyphosate do not appear to present any risks to terrestrial organisms other than terrestrial plants.

For the more toxic formulations, the risk characterization for aquatic organisms suggests that amphibians are the group at greatest risk both in terms of sensitivity and severity of effects. At an application rate of 1 lb. a.e./acre, the upper bound HQ for sensitive species of amphibians is 2. The corresponding HQs for sensitive species in other groups of aquatic organisms are 1.7 for fish, 1.1 for invertebrates, 1.0 for algae and aquatic macrophytes. Concern for amphibians is enhanced by the study by Howe et al. (2004) which indicates that two formulations of Roundup as well as the POEA surfactant used in some of the more toxic formulations of glyphosate are associated with the development of intersex gonads. The HQs for aquatic species will increase linearly with application rate. Because the upper bound HQs for most groups of aquatic organisms exceeds or reaches the level of concern at the relatively low application rate of 1 lb. a.e./acre, care should be exercised when applying more toxic formulations of glyphosate near surface water.

Unlike the case with more toxic formulations, risks to amphibians and aquatic invertebrates appear to be insubstantial for the less toxic formulations. Algae appear to be the group of nontarget aquatic organisms that are most sensitive to the less toxic formulations. At an application rate of 1 lb. a.e./acre, the upper bound of the HQ for sensitive species of algae is 0.8. At the maximum aquatic application rate of 3.75 lb. a.e./acre, the corresponding HQ is 3. At this upper bound HQ, some inhibition of growth might be observed, but the extent of inhibition could be minor. Risks to fish cannot be ruled out based on standard and conservative assumptions and methods for applications of less toxic formulations of glyphosate at rates in excess of about 2.5 lb. a.e./acre (acute effects). It seems most likely, however, that adverse effects would be observed in stressed populations of fish and less likely that effects would be noted in otherwise healthy populations of fish.

The label directions for the less toxic formulations of glyphosate state that a surfactant should be added to the formulations prior to application. Some surfactants are virtually nontoxic and are not likely to impact the toxicity of glyphosate. The use of a nontoxic surfactant would have no substantial impact on the risk characterization. Based on the available toxicity data in fish and aquatic invertebrates, however, some other surfactants which might be used with the less toxic formulations of glyphosate could pose a much greater risk than the glyphosate formulation itself. An approach to assessing risks associated with toxic surfactants is illustrated for fish (Section 4.4.3.1.3)

and aquatic invertebrates (Section 4.4.3.3.3). For a fixed concentration of the surfactant in a field solution, reducing the application volume will diminish the impact of the surfactant.

Imazapic

Human Health and Ecological Risk Assessment – Final Report

SERA TR 04-43-17-04b

December 23, 2004

Patrick Durkin and Mark Follansbee
Syracuse Environmental Research Associates, Inc.

EXECUTIVE SUMMARY

OVERVIEW

The USDA Forest Service uses two commercial formulations of the herbicide imazapic, Plateau and Plateau DG, in its vegetation management programs. This document is an update to a risk assessment of imazapic formulations that was prepared for the USDA Forest Service in 2001. Adverse effects in human or other animal species do not appear to be plausible. There is no route of exposure or scenario suggesting that workers or members of the general public will be at any substantial risk from exposure to imazapic. For workers, no exposure scenarios, acute or chronic, exceed the RfD even at the upper ranges of estimated dose. For members of the general public, the upper limits for hazard quotients are below a level of concern except for the accidental spill of a large amount of imazapic into a very small pond. While imazapic has been tested in only a limited number of animal species and under conditions that may not well-represent populations of free-ranging nontarget animals, the available data are sufficient to assert that no adverse effects on animals are anticipated.

Imazapic is an effective herbicide and even tolerant plants that are directly sprayed with imazapic at normal application rates are likely to be damaged. Some sensitive plant species could be affected by the off-site drift of imazapic depending on local site-specific conditions in areas relatively close to the application site. Damage to terrestrial plants from runoff is possible in some areas but is not likely to be substantial. Under conditions in which runoff is favored – i.e., clay soils and relatively high rainfall rates – some aquatic macrophytes could also be affected by peak but not longer-term concentrations of imazapic. No effects in unicellular algae are anticipated.

PROGRAM DESCRIPTION

Imazapic is used in the control of grasses, broadleaves, and vines, and for turf height suppression in non-cropland areas. The Forest Service will typically use imazapic in noxious weed control and rights-of-way management. The Forest Service may use two commercial formulations of imazapic, Plateau and Plateau DG. Both of these formulations contain the ammonium salt of imazapic as the active ingredient. Plateau is a liquid formulation that contains imazapic (22.2%) at a concentration of

2 lbs per gallon and Plateau DG is a dispersible granule formulation that contains the ammonium salt of imazapic (70%).

Imazapic may be applied by directed foliar, broadcast foliar or aerial (Plateau only) methods. The most common method of application in Forest Service programs will involve broadcast foliar applications. For Plateau, the labeled application rates range from 2 to 12 ounces of Plateau per acre, corresponding to 0.03125 to 0.1875 lbs a.e. imazapic/acre. For Plateau DG, the labeled application rates range from 1 to 2 water soluble pouches of Plateau DG per acre, corresponding to about 0.0625 to 0.1875 lbs imazapic per acre. For this risk assessment, the typical application rate will be taken as 0.1 lb. a.e./acre with a range of 0.03125 to 0.1875 lbs a.e. imazapic/acre.

HUMAN HEALTH RISK ASSESSMENT

Hazard Identification – In experimental mammals, the acute oral LD₅₀ for imazapic is greater than 5000 mg/kg, which indicates a low order of acute toxicity. Nevertheless, oral doses as low as 175 mg/kg bw/day were associated with increases in maternal mortality in a multiple dose study designed to assess the potential of imazapic to cause birth defects. While it is not clear if the maternal mortality at 175 mg/kg bw/day was attributable to the chemical or experimental dosing errors, a somewhat higher dose of 700 mg/kg bw/day was clearly associated with increased mortality attributed to the toxicity of imazapic.

Imazapic does not appear to be toxic to experimental rodents at relatively high concentrations in the diet but is toxic to dogs, causing adverse effects on muscle, blood, and liver. The NOAEL in rats is about 1625 mg/kg bw in the 13-week study or 1133 mg/kg bw in the 2-year study. Dogs, however, appear to be more sensitive than rodents, and the major signs of toxicity include adverse effects on the muscle, blood, and liver. Chronic exposure to imazapic at doses as low as 150 mg/kg bw have been associated with treatment-related effects on skeletal muscle. In several standard tests required for pesticide registration, imazapic has failed to show any indication of adverse effects on development or reproduction and no carcinogenic or mutagenic activity.

Data regarding the dermal absorption kinetics of imazapic are not available in the published or unpublished literature. For this risk assessment, estimates of dermal absorption rates—both zero order and first order—are based on quantitative structure-activity relationships. The lack of experimental data regarding dermal absorption of imazapic adds uncertainty to this risk assessment. Uncertainties in the rates of dermal absorption, however, can be expressed quantitatively and this uncertainty is incorporated in the exposure assessment.

Based on standard studies required for pesticide registration, imazapic appears to be essentially non-irritating and non-sensitizing to the skin and minimally irritating to the eyes. Concentrations of imazapic in the air that would be much higher than any plausible concentrations in human exposure scenarios have been associated with lung congestion in rats. The potential inhalation toxicity of imazapic is not of substantial concern to this risk assessment, however, because of the implausibility of inhalation exposure involving high concentrations of this compound.

Exposure Assessment – Exposure assessments are conducted for both workers and members of the general public for the typical application rate of 0.1 lb./acre. The consequences of using the maximum application rate that might be used by the Forest Service, 0.1875 lb./acre, are discussed in the risk characterization.

For workers, three types of application methods are modeled: directed ground, broadcast ground, and aerial. Central estimates of exposure for workers are approximately 0.001 mg/kg/day, with somewhat higher amount for backpack and aerial workers (about 0.0015 mg/kg/day) and a somewhat lower rate for ground broadcast workers (about 0.0006 mg/kg/day). Upper ranges of exposures are approximately 0.008 mg/kg/day for directed ground spray and aerial applications and 0.004 mg/kg/day for broadcast ground spray. All of the accidental exposure scenarios for workers involve dermal exposures and all of these accidental exposures lead to estimates of dose that are either in the range of or substantially below the general exposure estimates for workers.

For the general public, the range of acute exposures is from approximately 0.0000007 mg/kg associated with the lower range for the consumption of contaminated water from a stream by a child to 0.5 mg/kg associated with the upper range for consumption of contaminated water by a child following an accidental spill of imazapic into a small pond. High dose estimates are also associated with the direct spray of a child (0.145 mg/kg/day). Other acute exposures are lower by about an order of magnitude. For chronic or longer term exposures, the modeled exposures are much lower than for acute exposures, ranging from approximately 0.0000000002 mg/kg/day associated with the lower range for the normal consumption of fish to approximately 0.004 mg/kg/day associated with the upper range for consumption of contaminated fruit.

Dose-Response Assessment – The Office of Pesticide Programs of the U.S. EPA has derived a chronic RfD of 0.5 mg/kg/day for imazapic. This chronic RfD is based on a chronic LOAEL in dogs of 5000 ppm in the diet corresponding to an estimated daily dose of 137 mg/kg/day and an uncertainty factor of 300 (i.e., 0.456 mg/kg/day which rounds to 1 significant digit as 0.5 mg/kg/day). The dog LOAEL is based on adverse effects on skeletal muscle. In the current risk assessment, this chronic RfD is used to characterize risks to both acute and chronic exposures.

Risk Characterization – Typical exposures to imazapic do not lead to estimated doses that exceed a level of concern. For workers, no exposure scenarios, acute or chronic, exceed the RfD even at the upper ranges of estimated dose. For members of the general public, the upper limits for hazard quotients are below a level of concern except for the accidental spill of a large amount of imazapic into a very small pond.

Although there are several uncertainties in the exposure assessments for workers and the general public, the upper limits for hazard quotients associated with the longer-term exposures are sufficiently below a level of concern that the risk characterization is relatively unambiguous: based on the available information and under the foreseeable conditions of application, there is no route of exposure or scenario suggesting that the workers or members of the general public will be at any substantial risk from exposure to imazapic even at the upper range of the application rate considered in this risk assessment.

Mild irritation to the eyes can result from exposure to relatively high levels of imazapic. From a practical perspective, eye irritation is likely to be the only overt effect as a consequence of mishandling imazapic. These effects can be minimized or avoided by prudent handling of the compound.

ECOLOGICAL RISK ASSESSMENT

Hazard Identification – Larger mammals, such as dogs and rabbits, may be more sensitive to imazapic than smaller mammals such as mice and rats. Essentially no toxic effects have been observed in rats and mice even at very high dietary concentrations of imazapic over prolonged periods of time. The chronic NOAEL in rats is about 1133 mg/kg bw/day. In dogs, however, imazapic has been associated with effects on muscle, blood, and liver at a dietary LOAEL of 5000 ppm, corresponding to an average daily dose of about 150 mg/kg bw over a period of two years. In rabbits, increased mortality has been noted after repeated oral (gavage) exposure to doses from 175 mg/kg bw/day to 700 mg/kg bw/day. The chronic toxicity of imazapic to birds is comparable to that in dogs with a NOAEL of 113 mg/kg bw/day and a LOAEL of 170 mg/kg bw/day. Only one bioassay is available on terrestrial invertebrates (i.e., the honey bee with an acute LD50 of greater than 1075 mg/kg bw).

The toxicity of imazapic to terrestrial plants has been assayed in both pre-emergence and postemergence studies. In the pre-emergence study, no effects on emergence were noted for any plants (NOEC = 0.064 lb./acre) except ryegrass (NOEC = 0.032 lb./acre and EC25 of 0.055 lb./acre). NOEC values for survival were also 0.064 lb./acre except for ryegrass, which evidenced an NOEC of 0.016 lb./acre. Imazapic was much more toxic in the post-emergence assay, with 21-day NOEC values for visual injury of 0.001 lb./acre for cabbage, cucumber, and tomato; 0.002 lb. ai/acre for onion, oat, and radish; 0.004 lb./acre for ryegrass, 0.008 for soybean, 0.016 for corn, and 0.032 for lettuce.

Aquatic animals appear to be relatively insensitive to imazapic exposures, with LC50 values of >100 mg/L for both acute toxicity and reproductive effects. Aquatic macrophytes may be much more sensitive, with an acute EC50 of 6.1: g/L in duck weed (*Lemna gibba*). Aquatic algae appear to be much less sensitive, with EC50 values of greater than 45: g/L. No toxicity studies have been located on the effects of imazapic on amphibians or microorganisms.

Exposure Assessment – Terrestrial animals might be exposed to any applied herbicide from direct spray, the ingestion of contaminated media (vegetation, prey species, or water), grooming activities, or indirect dermal contact with contaminated vegetation. In acute exposure scenarios, the highest exposures for small terrestrial vertebrates will occur after a direct spray and could reach up to about 2.4 mg/kg at an application rate of 0.1 lb. a.e./acre. There is a wide range of exposures anticipated from the consumption of contaminated vegetation by terrestrial animals: central estimates range from 0.125 mg/kg for a small mammal to 2.69 mg/kg for a large bird with upper ranges of about 0.27 mg/kg for a small mammal and 7.6 mg/kg for a large bird. The consumption of contaminated water leads to much lower levels of exposure. A similar pattern is seen for chronic exposures. Estimated daily doses for a small mammal from the consumption of contaminated vegetation at the application site are in the range of about 0.0001 mg/kg to 0.01 mg/kg. The upper ranges of exposure from contaminated vegetation far exceed doses that are anticipated from the consumption of contaminated water, which range from 0.0000001 mg/kg/day to 0.00000044 mg/kg/day for a small mammal. Based on general relationships of body size to body volume, larger vertebrates will be exposed to lower doses and smaller animals, such as insects, to much higher doses than small vertebrates under comparable exposure conditions. Because of the apparently low toxicity of imazapic to animals, the rather substantial variations in the different exposure assessments have little impact on the assessment of risk to terrestrial animals.

For terrestrial plants, five exposure scenarios are considered quantitatively: direct spray, spray drift, runoff, wind erosion and the use of contaminated irrigation water. Unintended direct spray is expressed simply as the application rate considered in this risk assessment, 0.1 lb. a.e./acre and should be regarded as an extreme/accidental form of exposure that is not likely to occur in most Forest Service applications. Estimates for the other routes of exposure are much less. All of these exposure scenarios are dominated by situational variability because the levels of exposure are highly dependent on site-specific conditions. Thus, the exposure estimates are intended to represent conservative but plausible ranges that could occur but these ranges may over-estimate or under-estimate actual exposures in some cases. Spray drift is estimated using AgDRIFT. The proportion of the applied amount transported off-site from runoff is based on GLEAMS modeling of clay, loam, and sand. The amount of imazapic that might be transported off-site from wind erosion is based on estimates of annual soil loss associated with wind erosion and the assumption that the herbicide is incorporated into the top 1 cm of soil. Exposure from the use of contaminated irrigation water is based on the same data used to estimate human exposure from the consumption of contaminated ambient water and involves both monitoring studies as well as GLEAMS modeling.

Exposures to aquatic plants and animals are based on essentially the same information used to assess the exposure to terrestrial species from contaminated water. The peak concentrations of imazapic in contamination water is estimated at 0.0005 mg/L (0.00005 to 0.01) mg a.e./L per 1 lb. a.e./acre. For longer-term exposures, average estimated rate of contamination of ambient water associated with the normal application of imazapic is 0.00002 (0.00001 to 0.00003) mg a.e./L at an application rate of 1 lb. a.e./acre. For the assessment of potential hazards, these contamination rates are adjusted based on the application rates considered in this risk assessment.

Dose-Response Assessment – For terrestrial mammals, the dose-response assessment is based on the same data as the human health risk assessment (i.e., an acute NOAEL of 350 mg/kg/day and a chronic NOAEL of 45 mg/kg/day). None of the exposure scenarios, acute or longer term, result in exposure estimates that exceed the applicable NOAEL. Birds appear to be somewhat less sensitive to imazapic than mammals. The 5-day dietary NOEL of 1100 mg/kg/day in bobwhite quail is used to characterize risks to birds associated with acute exposures. For chronic toxicity, NOAEL for birds is taken as 113 mg/kg bw/day from a dietary reproduction study. The only data available on terrestrial invertebrates is the standard bioassay in honey bees in which the NOAEL based on mortality was 387 mg/kg bw, very close to the NOAEL of 350 mg/kg bw in mammals. The toxicity data for terrestrial plants involves standard bioassays for pre-emergent and postemergent applications. For exposures involving the off-site drift of imazapic, the range of NOAEL values for post-emergence applications is 0.001 lb./acre for sensitive species and 0.032 for tolerant species. For exposures involving off-site runoff, the range of NOAEL values for preemergence applications is 0.032 lb./acre for sensitive species and 0.064 lb./acre for tolerant species.

Imazapic does not appear to be very toxic to aquatic fish or invertebrates. The available data are not sufficient to identify sensitive and tolerant species because the screening tests conducted at nominal concentrations 100 mg/L failed to demonstrate adverse effects in either acute or longer-term exposures. *Lemna gibba*, an aquatic macrophyte, is much more sensitive to imazapic than aquatic animals. An NOEC of 0.00127 mg/L in *Lemna minor* is used for quantifying effects in aquatic macrophytes. By comparison to *Lemna gibba*, unicellular aquatic algae appear to be relatively insensitive to imazapic and a concentration of 50 µg/L is taken as an LOEC for moderate growth inhibition and is used for the risk characterization.

Risk Characterization – There is very little indication that the use of imazapic in Forest Service programs will lead to substantial unintended adverse effects. Imazapic is an effective herbicide and even tolerant plants that are directly sprayed with imazapic at normal application rates are likely to be damaged. Some sensitive plant species could be affected by the off-site drift of imazapic depending on local site-specific conditions within a relatively small distance from the application site – i.e., up to about 50 feet in ground applications and somewhat over 100 feet in aerial applications. Damage to terrestrial plants from runoff is possible in some areas but is not likely to be substantial. Under conditions in which runoff is favored – i.e., clay soils and relatively high rainfall rates – some aquatic macrophytes could also be affected by peak concentrations of imazapic. No effects in unicellular algae are anticipated.

Adverse effects in terrestrial or aquatic animals do not appear to be likely. The weight of evidence suggests that no adverse effects in mammals, birds, fish, and terrestrial or aquatic invertebrates are plausible using typical or worst-case exposure assumptions at the typical application rate of 0.1 lb./acre or the maximum application rate of 0.1875 lb./acre.

As in any ecological risk assessment, this risk characterization must be qualified. Imazapic has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging nontarget animals. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects on animals are anticipated based on the information that is available.

Imazapyr

Human Health and Ecological Risk Assessment - FINAL REPORT

SERA TR-052-29-03a

December 16, 2011

Patrick R. Durkin

Syracuse Environmental Research Associates, Inc.

EXECUTIVE SUMMARY

Imazapyr is an herbicide used in Forest Service vegetation management programs, primarily in the Southern United States, to control a variety of grasses, broadleaf weeds, vines, and brush species. Imazapyr may also be used to control aquatic macrophytes. The present document provides risk assessments for human health and ecological effects to support an assessment of the human health and environmental consequences of using this herbicide. There are numerous formulations of imazapyr. Toxicity data, however, are available only on Arsenal, a formulation supplied by BASF, because toxicity data are available on this formulation. Nonetheless, these human health and ecological risk assessments encompass all formulations of the

isopropylamine salt of imazapyr registered for forestry or other related applications, including applications for the control of emergent aquatic vegetation.

The quantitative risk characterization in both the human health and in the ecological risk assessments is based on the hazard quotient (HQ), which is defined as the anticipated exposure divided by the toxicity value. Although the current risk assessments are based on the unit application rate of 1 lb. a.e./acre, other applications are considered in the risk characterization up to the maximum labeled rate of 1.5 lbs a.e./acre.

Imazapyr is an effective herbicide for the control of both terrestrial and aquatic vegetation. Under some conditions, terrestrial applications of imazapyr could damage nontarget terrestrial vegetation. Effective aquatic applications of imazapyr will most certainly damage aquatic macrophytes and may damage some species of algae. While imazapyr is an effective terrestrial herbicide, the exposure scenarios developed for terrestrial and aquatic plants in the current risk assessments lead to a wide range of HQs, some of which are far below the level of concern and others which exceed the level of concern substantially. This apparent ambiguity relates to the attempt made in the exposure assessments to encompass a wide range of potential exposures associated with different weather patterns and other site-specific variables. Thus, for applications of imazapyr in areas where potential effects on nontarget plants are a substantial concern, refinements to the exposure scenarios for nontarget plants would be appropriate.

While adverse effects on plants may be anticipated, there is no basis for asserting that applications of imazapyr will pose any substantial risk to humans or other species of animals. The U.S. EPA/OPP classifies imazapyr as *practically non-toxic* to mammals, birds, honeybees, fish, and aquatic invertebrates. This classification is clearly justified. None of the expected (non-accidental) exposures to these groups of animals raise substantial concern; indeed, most accidental exposures raise only minimal concern. The major uncertainties regarding potential toxic effects in animals are associated with the lack of toxicity data on reptiles and amphibians.

Terrestrial or aquatic applications of any effective herbicide are likely to alter vegetation within the treatment area, which may lead to secondary effects on terrestrial or aquatic animals as well as nontarget plants. While these concerns are acknowledged, they are common to any effective method for vegetation management, including mechanical methods that do not involve herbicide use.

INTRODUCTION

Chemical Specific Information

This document provides risk assessments for human health effects and ecological effects to support an assessment of the environmental consequences of using imazapyr in Forest Service vegetation management programs. This risk assessment is an update to previous USDA Forest Service risk assessments of imazapyr (SERA 1999, 2004a).

The previous risk assessments cover only terrestrial applications of imazapyr. Imazapyr is now registered by the U.S. EPA for the control of emergent aquatic weeds. This new use is covered in

the updated risk assessment along with the uses of imazapyr in terrestrial applications. Moreover, the number of formulations considered in this updated risk assessment is greater because imazapyr is now off-patent. Accordingly, in addition to the formulations considered in the previously conducted risk assessments (i.e., Arsenal, Arsenal AC, Chopper, and Stalker), this update considers a number of new formulations, as discussed further in Section 2.2.

In the preparation of this risk assessment, an updated literature search of imazapyr was conducted using TOXLINE. The open literature on imazapyr is sparse. There are published reviews and commentaries regarding the human health or ecological effects of imazapyr (Cox 1996; Entrix 2003; Gagne et al. 1991; Peoples 1984; Pless 2005; Tu et al. 2001, 2003). Generally, these reviews are used only to identify published studies to ensure adequate coverage of the literature. Similarly, the recent risk assessment on imazapyr conducted by AMEC Geomatrix (2009) for the Washington State Department of Agriculture was reviewed as a source of information.

Almost all of the relevant mammalian toxicology studies and most of the ecotoxicology studies are unpublished reports submitted to the U.S. EPA as part of the registration process for imazapyr. The most recent Forest Service risk assessment on imazapyr (SERA 2004a), identifies numerous registrant submissions on imazapyr and imazapyr formulations. Of these, 127 submissions (i.e., full copies of the studies submitted to the U.S. EPA) were kindly provided by the U.S. EPA Office of Pesticide Programs. The U.S. EPA/OPP no longer provides full copies of registrant studies for risk assessments conducted in support of activities outside of U.S. EPA/OPP. Consequently, summaries of the studies contained in SERA (2004a) are included in this updated risk assessment on imazapyr. The registrant-submitted studies are cited using standard author/year designations and are identified in Section 5 (References) as MRID04. Information on other registrant-submitted studies is taken from various U.S. EPA/OPP risk assessments and designated in the body of the current Forest Service risk assessment only by MRID number with a reference to the U.S. EPA risk assessment from which the information is taken.

Since the preparation of the SERA (2004a) risk assessment on imazapyr, the U.S. EPA completed the Reregistration Eligibility Decision (RED) document for imazapyr (U.S. EPA/OPP 2006a) as well as an ecological risk assessment for the California Red Legged Frog (U.S. EPA/OPP 2007a). Both of these documents as well as risk assessments by the U.S. EPA/OPP Health Effects Division (U.S. EPA/OPP 2005a) and the U.S. EPA/OPP Environmental Fate and Effects Division (U.S. EPA/OPP 2005a) are key sources of information in the current Forest Service risk assessment on imazapyr. Additional sources of information include files from the U.S. EPA/OPP E-Docket that are associated with the 2006 RED (U.S. EPA/OPP 2005c-m). As a final point, a recent U.S. EPA/OPP ecological risk assessment for the aquatic application of imazapyr (U.S. EPA/OPP 2010d) was consulted.

The U.S. EPA/OPP is in the process of reviewing the registration of many pesticides (http://www.epa.gov/oppsrrd1/registration_review). The review of imazapyr, however, is not scheduled to begin until 2014 (U.S. EPA/OPP 2010a, p. 19). Thus, while the registration review

may have an impact on the next Forest Service risk assessment on imazapyr, the EPA review process has no impact on the current Forest Service risk assessment.

As noted above, many registrant-submitted studies are reviewed in the SERA (2004a) risk assessment. In the meantime, several new studies were submitted to the EPA. Although the EPA no longer releases full studies, cleared reviews of some of the new studies are available and were obtained from the EPA web site (<http://www.epa.gov/pesticides/foia/reviews.htm>). All studies for which cleared reviews are available are cited in the current risk assessment using standard author/year designations and are identified in Section 5 (References) as ClrRev. The cleared reviews most often take the form of Data Evaluation Records (DERs), which are discussed further below. 19

In any risk assessment based largely on registrant-submitted studies, as is the case with imazapyr, the Forest Service is sensitive to concerns of potential bias. The general concern might be expressed as follows:

If the study is paid for and/or conducted by the registrant, the study may be designed and/or conducted and/or reported in a manner that will obscure any adverse effects that the compound may have.

This concern is largely without foundation. While any study (published or unpublished) can be falsified, concerns with the design, conduct and reporting of studies submitted to the U.S. EPA for pesticide registration are minor. The design of the studies submitted for pesticide registration is based on strict guidelines for both the conduct and reporting of studies. These guidelines are developed by the U.S. EPA and not by the registrants. Full copies of the guidelines for these studies are available at <http://www.epa.gov/opptsfrs/home/guidelin.htm>. All studies are conducted under Good Laboratory Practices (GLPs). GLPs are an elaborate set of procedures which involve documentation and independent quality control and quality assurance that substantially exceed the levels typically seen in open literature publications. As a final point, the EPA reviews each submitted study for adherence to the relevant study guidelines. These reviews most often take the form of Data Evaluation Records (DERs). While the nature and complexity of DERs varies according to the nature and complexity of the particular studies, each DER involves an independent assessment of the study to ensure that the EPA Guidelines are followed. In addition, each DER undergoes internal review (and sometimes several layers of review).

Despite the real and legitimate concerns with risk assessments based largely on registrant-submitted studies, data quality and data integrity are not substantial concerns. The major limitation of risk assessments based solely on registrant-submitted studies involves the nature and diversity of the available studies. The studies required by the U.S. EPA are based on a relatively narrow set of criteria in a relatively small subset of species and follow standardized protocols. The relevance of this limitation to the current risk assessment on imazapyr is discussed throughout the document.

This risk assessment is accompanied by two EXCEL workbooks. One workbook covers all terrestrial broadcast applications of imazapyr including directed foliar, ground broadcast, and aerial applications (Attachment 1). The second workbook covers aquatic applications of imazapyr (Attachment 2). The relationship of these workbooks to the risk assessment is discussed further in the following section.

General Information

This document has four chapters, including the introduction, program description, risk assessment for human health effects, and risk assessment for ecological effects or effects on wildlife species. Each of the two risk assessment chapters has four major sections, including an identification of the hazards, an assessment of potential exposure to this compound, an assessment of the dose-response relationships, and a characterization of the risks associated with plausible levels of exposure.

This is a technical support document which addresses some specialized technical areas. Nevertheless an effort was made to ensure that the document can be understood by individuals who do not have specialized training in the chemical and biological sciences. Certain technical concepts, methods, and terms common to all parts of the risk assessment are described in plain language in a separate document (SERA 2007a). The human health and ecological risk assessments presented in this document are not, and are not intended to be, comprehensive summaries of all of the available information. The information presented in the appendices and the discussions in chapters 2, 3, and 4 of the risk assessment are intended to be detailed enough to support a review of the risk analyses.

As discussed in Section 1.1, the current Forest Service risk assessment is an update to previous risk assessments on imazapyr (SERA 1999, 2004a). At some point in the future, the Forest Service will update this risk assessment again and welcomes input from the general public and other interested parties on the selection of studies included in the risk assessment. This input is helpful, however, only if recommendations for including additional studies specify why and/or how the new or not previously included information would be likely to alter the conclusions reached in the risk assessments.

As with all Forest Service risk assessments, almost no risk estimates presented in this document are given as single numbers. Usually, risk is expressed as a central estimate and a range, which is sometimes quite large. Because of the need to encompass many different types of exposure as well as the need to express the uncertainties in the assessment, this risk assessment involves numerous calculations, most of which are relatively simple. They are included in the body of the document.

Some of the calculations, however, are cumbersome. For those calculations, EXCEL workbooks (sets of EXCEL worksheets) are included as attachments to this risk assessment. The worksheets provide the detail for the estimates cited in the body of the document. Documentation for the use of these workbooks is presented in SERA (2010a, 2011a).

The EXCEL workbooks are an integral part of the risk assessment. The worksheets contained in these workbooks are designed to isolate the numerous calculations from the risk assessment narrative. In general, all calculations of exposure scenarios and quantitative risk characterizations are derived and contained in the worksheets. In these worksheets as well as in the text of this risk assessment, the hazard quotient is the ratio of the estimated exposure to a toxicity value, typically a no adverse effect level or concentration (i.e., NOAEL or NOAEC). Both the rationale for the calculations and the interpretation of the hazard quotients are contained in this risk assessment document.

Metsulfuron Methyl

Human Health and Ecological Risk Assessment – Final Report

SERA TR 04-43-17-01c

December 9, 2004

Julie Klotzbach and Patrick Durkin
Syracuse Environmental Research Associates, Inc.

EXECUTIVE SUMMARY

OVERVIEW

Metsulfuron methyl is an effective and potent herbicide. Adverse effects on some nontarget terrestrial plant species and, to a lesser degree, some aquatic plant species are plausible unless measures are taken to limit exposure. For terrestrial plants, the dominant factor in the risk characterization is the potency of metsulfuron methyl relative to the application rate. The typical application rate considered in this risk assessment, 0.03 lb./acre, is over 800 times higher than the NOEC in the vegetative vigor (direct spray) assay of the most sensitive nontarget species – i.e., 0.000037 lb./acre – and approximately 8 times higher than the NOEC for the most tolerant species in the same assay – i.e., 0.0039 lb./acre. The highest application rate that may be considered in Forest Service programs – i.e., 0.15 lb./acre – is over 4000 times the NOEC in sensitive species and a factor of about 40 above the NOEC in tolerant species. Given these relationships, damage to sensitive nontarget species could be expected in ground broadcast applications at distances of about 500 feet from the application site in areas in which off-site drift is not reduced by foliar interception. This risk characterization applies only to ground broadcast applications. When used in directed foliar applications (i.e., backpack), offsite drift could be reduced substantially but the extent of this reduction cannot be quantified.

Damage to aquatic plants, particularly macrophytes, appears substantially less than for terrestrial plants. Except for the hazard quotient of 2 associated with acute exposures based on the peak concentrations of metsulfuron methyl, all hazard quotients are below the level of concern, with a range of 0.002 to 2 for acute exposures and 0.02 to 0.08 for chronic exposures. Thus, if metsulfuron

methyl is applied in areas where transport to water containing aquatic macrophytes is likely, it would be plausible that detectable damage could be observed.

Aquatic algae do not appear to be as sensitive to metsulfuron methyl. The highest hazard quotient observed for acute exposure is 0.03 associated with the upper range for the most sensitive species. For chronic exposures, the highest hazard quotient is 0.001 associated with the upper range for the most sensitive species. Therefore, it is not anticipated that adverse effects in aquatic algae would result from exposure to metsulfuron methyl at application rates used by the Forest Service.

Just as there is little reason to doubt that adverse effects on some plant species are plausible, there is no clear basis for suggesting that effects on terrestrial or aquatic animals are likely or would be substantial.

PROGRAM DESCRIPTION

Metsulfuron methyl is a selective pre-emergence and post-emergence sulfonyl urea herbicide used primarily to control many annual and perennial weeds and woody plants. The Forest Service uses only one commercial formulation of metsulfuron methyl, Escort® XP. Escort is manufactured by Du Pont as a dry flowable granule. The composition of the product is 60% metsulfuron methyl and 40% inert ingredients.

Metsulfuron methyl is used in Forest Service programs primarily for the control of noxious weeds. Minor uses include conifer release and rights-of-way management. The most common methods of ground application for Escort XP involve backpack (selective foliar) and boom spray (broadcast foliar) operations. The Forest Service does not use aerial applications for Escort XP. Nonetheless, Escort XP is registered for aerial applications and aerial applications are included in this risk assessment in the event the Forest Service may wish to consider this application method.

For this risk assessment, the typical rate of 0.03 lbs/acre, with a range 0.0125 to 0.15 lbs/acre, is used to reflect Forest Service practice. This range is based on lowest and highest labeled application rates recommended on the manufacturer's label. The Forest Service used approximately 235 lbs of metsulfuron methyl in 2002, the most recent year for which use statistics are available. Much greater amounts of metsulfuron methyl are used in agriculture (e.g., about 35,543 lbs in 1992).

HUMAN HEALTH RISK ASSESSMENT

Hazard Identification –In experimental mammals, the acute oral LD50 for metsulfuron methyl is greater than 5000 mg/kg, which indicates a low order of toxicity. In addition, non-lethal signs of toxicity were apparent after single oral doses as low as 50 mg/kg. The most common sign of acute, subchronic, and chronic toxicity is decreased body weight gain. The only other commonly noted effect involves changes in various hematological parameters as well as changes in absolute and relative organ weights. None of these changes, however, suggest a clear or specific target organ toxicity. There is speculation that the effects of metsulfuron methyl on the blood might be related to saccharin, which is a metabolite of metsulfuron methyl. At very high doses, saccharin caused hematological effects in mice. Appropriate tests have provided no evidence that metsulfuron methyl presents any reproductive risks or causes malformations or cancer. Metsulfuron methyl also is irritating to the skin and eyes, but does not produce sensitizing effects following repeated dermal exposure.

Limited information is available on the toxicokinetics of metsulfuron methyl. The kinetics of absorption of metsulfuron methyl following dermal, oral or inhalation exposure are not documented in the available literature. Metsulfuron methyl is eliminated from the body by a combination of excretion of the unchanged compound and metabolism. In all species, metsulfuron methyl is eliminated rapidly with a half-time of 1 day or less and exhibits first order elimination kinetics. Most of the material is excreted as the unchanged compound. The primary excretory compartment for metsulfuron methyl and its metabolites is the urine, with smaller amounts excreted in the feces. In rats, metabolism of metsulfuron methyl appears to follow two main pathways, either hydrolysis to the corresponding sulfonamide or cleavage of the heterocyclic ring.

As discussed in the exposure assessment, skin absorption is the primary route of exposure for workers. Data regarding the dermal absorption kinetics of metsulfuron methyl are not available in the published or unpublished literature. For this risk assessment, estimates of dermal absorption rates—both zero order and first order—are based on quantitative structure-activity relationships. These estimates of dermal absorption rates are used in turn to estimate the amounts of metsulfuron methyl that might be absorbed by workers, which then are used with the available dose-response data to characterize risk. The lack of experimental data regarding dermal absorption of metsulfuron methyl adds substantial uncertainties to this risk assessment. Uncertainties in the rates of dermal absorption, although they are substantial, can be estimated quantitatively and are incorporated in the human health exposure assessment.

The inhalation toxicity of metsulfuron methyl is not well documented in the literature. Available studies indicate that metsulfuron methyl induces irritant effects at very high exposure levels. Regardless, the potential inhalation toxicity of metsulfuron methyl is not of substantial concern to this risk assessment because of the implausibility of inhalation exposure involving high concentrations of this compound.

Exposure Assessment – Exposure assessments are conducted for both workers and members of the general public for the typical application rate of 0.03 lb./acre. The consequences of using the maximum application rate that might be used by the Forest Service, 0.15 lb./acre, are discussed in the risk characterization.

For workers, three types of application methods are generally modeled in Forest Service risk assessments: directed ground, broadcast ground, and aerial. Although Escort is registered for aerial applications (helicopter and sometimes fixed wing), the Forest Service does not currently use this method. Nonetheless, the aerial application method is included in this risk assessment in the event that the Forest Service considers using aerial applications. Central estimates of exposure for ground workers are approximately 0.0004 mg/kg/day for directed ground spray and 0.0007 mg/kg/day for broadcast ground spray. Upper ranges of exposures are approximately 0.0024 mg/kg/day for directed ground spray and 0.0045 mg/kg/day for broadcast ground spray. All of the accidental exposure scenarios for workers involve dermal exposures and all of these accidental exposures lead to estimates of dose that are either in the range of or substantially below the general exposure estimates for workers.

For the general public, the range of acute exposures is from approximately 0.000000014 mg/kg associated with the lower range for consumption of contaminated stream water by a child to

0.034 mg/kg/day associated with the upper range for consumption of contaminated water by a child following an accidental spill of metsulfuron methyl into a small pond. For chronic or longer term exposures, the modeled exposures are much lower than for acute exposures, ranging from approximately 0.0000000026 mg/kg/day associated with the lower range for the normal consumption of fish to approximately 0.0024 mg/kg/day associated with the upper range for consumption of contaminated fruit.

Dose-Response Assessment – The Office of Pesticide Programs of the U.S. EPA has derived a chronic RfD of 0.25 mg/kg/day for metsulfuron methyl. This RfD is based on a chronic rat NOAEL of 25 mg/kg/day (500 ppm in the diet) (Burns 1994) and an uncertainty factor of 100. In the same study, the LOAEL was 250 mg/kg/day (5000 ppm in the diet) and the only effect noted was a decrease in body weight. No frank signs of toxicity were seen at this or higher dose levels. The U.S. EPA (2002) did not explicitly derive an acute/single dose RfD for metsulfuron methyl. However, the U.S. EPA Office of Pesticides (U.S. EPA 2002) reported a short- and intermediate term oral exposure NOAEL of 34 mg/kg/day (for decreased body weight), a LOAEL of 342 mg/kg/day and a margin of exposure of 100. Thus, a functional acute RfD could be calculated as 0.34 mg/kg/day [34 mg/kg/day ÷ 100]. However, since there is not a substantial difference between the functional acute RfD value of 0.34 mg/kg/day value and the chronic RfD value of 0.25 mg/kg/day, this risk assessment will take the more conservative approach and use the chronic RfD of 0.25 mg/kg/day to characterize all risks of acute or short-term exposures.

Risk Characterization – Typical exposures to metsulfuron methyl do not lead to estimated doses that exceed a level of concern. For workers, no exposure scenarios, acute or chronic, exceeds the RfD even at the upper ranges of estimated dose. For members of the general public, all upper limits for hazard quotients are below a level of concern. Thus, based on the available information and under the foreseeable conditions of application, there is no route of exposure or scenario suggesting that workers or members of the general public will be at any substantial risk from longer-term exposure to metsulfuron methyl.

Irritation to the skin and eyes can result from exposure to relatively high levels of metsulfuron methyl. From a practical perspective, eye or skin irritation is likely to be the only overt effect as a consequence of mishandling metsulfuron methyl. These effects can be minimized or avoided by prudent industrial hygiene practices during the handling of the compound.

ECOLOGICAL RISK ASSESSMENT

Hazard Identification – The mammalian toxicity of metsulfuron methyl is relatively well characterized in experimental mammals; however, there is relatively little information regarding nontarget wildlife species. It seems reasonable to assume the most sensitive effects in wildlife mammalian species will be the same as those in experimental mammals (i.e., decreased body weight gain). Several acute toxicity studies and two reproduction studies are available on the toxicity of metsulfuron methyl to birds. These studies indicate that birds appear to be no more sensitive than experimental mammals to the toxic effects of metsulfuron methyl, with the major effect again being decrease body weight gain. There are also several acute assays on the honey bee that indicate that bees are no more sensitive than either mammals or birds to metsulfuron methyl. At exposure rates that exceed the highest recommended application rate by about a factor of 3, metsulfuron methyl appears to be somewhat toxic to the Rove beetle, *Aleochara bilineata*, causing a 15% decrease in egg hatching.

The toxicity of metsulfuron methyl to terrestrial plants was studied extensively and is well characterized. Metsulfuron methyl inhibits acetolactate synthase (ALS), an enzyme that catalyzes the biosynthesis of three branched-chain amino acids, all of which are essential for plant growth. Terrestrial microorganisms also have an enzyme that is involved in the synthesis of branched chain amino acids, which is functionally equivalent to the target enzyme in terrestrial macrophytes. There are laboratory and field studies on the effects of metsulfuron methyl to soil microorganisms. These studies suggest that transient effects on soil bacteria are plausible. The available data suggest that metsulfuron methyl, like other herbicides, is much more toxic to aquatic plants than to aquatic animals. Frank toxic effects in fish are not likely to be observed at concentrations less than or equal to 1000 mg/L. Aquatic plants are far more sensitive than aquatic animals to the effects of metsulfuron methyl, with macrophytes appearing more sensitive than algae. Similar EC50 values were observed in studies in duckweed and Northern watermilfoil. *Selenastrum capricornutum* appear to be the most sensitive species of algae and *Anabaena flosaquae* and *Navicula pelliculosa* appear to be the most tolerant species.

Exposure Assessment – Terrestrial animals might be exposed to any applied herbicide from direct spray, the ingestion of contaminated media (vegetation, prey species, or water), grooming activities, or contact with contaminated vegetation. In acute exposure scenarios, the highest exposures for small terrestrial vertebrates will occur after a direct spray and could reach up to about 0.7 mg/kg under typical exposure conditions assuming 100% absorption. There is a wide range of exposures anticipated from the consumption of contaminated vegetation by terrestrial animals: central estimates range from 0.04 mg/kg for a small mammal to 0.8 mg/kg for a large bird under typical exposure conditions, with upper ranges of about 0.08 mg/kg for a small mammal and 2.3 mg/kg for a large bird. The consumption of contaminated water will generally lead to much lower levels of exposure. A similar pattern is seen for chronic exposures. The central estimated for daily doses for a small mammal from the consumption of contaminated vegetation at the application site is about 0.002 mg/kg/day, with an upper estimate of about 0.007 mg/kg/day. Exposures from contaminated vegetation far exceed doses that are anticipated from the consumption of contaminated water, which has a central estimate of about 0.0000009 mg/kg/day and an upper range of about 0.000002 for a small mammal. Based on general relationships of body size to body volume, larger vertebrates will be exposed to lower doses and smaller animals, such as insects, to much higher doses than small vertebrates under comparable exposure conditions. Because of the apparently low toxicity of metsulfuron methyl to animals, the rather substantial variations in the different exposure assessments have little impact on the assessment of risk to terrestrial animals.

For terrestrial plants, five exposure scenarios are considered quantitatively: direct spray, spray drift, runoff, wind erosion and the use of contaminated irrigation water. Unintended direct spray is expressed simply as the application rate considered in this risk assessment, 0.03 lb. a.e./acre and should be regarded as an extreme/accidental form of exposure that is not likely to occur in most Forest Service applications. Estimates for the other routes of exposure are much less. All of these exposure scenarios are dominated by situational variability because the levels of exposure are highly dependent on site-specific conditions. Thus, the exposure estimates are intended to represent conservative but plausible ranges that could occur but these ranges may over-estimate or under-estimate actual exposures in some cases. Spray drift estimates are based on AgDRIFT modeling. The proportion of the applied amount transported off-site from runoff is based on GLEAMS modeling of clay, loam, and sand. The amount of metsulfuron methyl that might be transported off-site from wind erosion is based on estimates of annual soil loss associated with wind erosion and the

assumption that the herbicide is incorporated into the top 1 cm of soil. Exposure from the use of contaminated irrigation water is estimated using the same data used to estimate human exposure from the consumption of contaminated ambient water and involves both monitoring studies as well as GLEAMS modeling.

Exposures to aquatic plants and animals are based on essentially the same information used to assess the exposure to terrestrial species from contaminated water. The peak estimated rate of contamination of ambient water associated with the normal application of metsulfuron methyl is 0.002 (0.00001 to 0.01) mg a.e./L at an application rate of 1 lb. a.e./acre. For longer-term exposures, average estimated rate of contamination of ambient water associated with the normal application of metsulfuron methyl is 0.0002 (0.0001 to 0.0004) mg a.e./L at an application rate of 1 lb. a.e./acre. For the assessment of potential hazards, these contamination rates are adjusted based on the application rates considered in this risk assessment.

Dose-Response Assessment – For terrestrial mammals, the dose-response assessment for metsulfuron methyl is based on the same data as the human health risk assessment (i.e., the chronic NOAEL of 25 mg/kg/day from a 2-year feeding study in rats is used to assess both acute and chronic risk). None of the exposure scenarios, acute or longer term, result in exposure estimates that exceed this NOAEL. Birds appear to be substantially less sensitive to metsulfuron methyl than mammals with an acute NOAEL of 1043 mg/kg/day from a 5-day feeding study and a longer-term NOAEL from a reproduction study of 120 mg/kg/day. For terrestrial invertebrates, based on direct spray studies in honey bees, no mortality would be expected following acute exposure to doses up to 270 mg/kg. Soil microorganisms are sensitive to metsulfuron methyl at concentrations of 5 ppm (or 5 µg/g soil), but most effects appear to be transient.

The toxicity of metsulfuron methyl to terrestrial plants is relatively well characterized. Metsulfuron methyl is a potent herbicide that causes adverse effects in a variety of target and nontarget plant species. Results of pre-emergent and post-emergent application studies in a variety of plant species yield LOELs ranging from 0.00022 to 0.0036 lbs/acre. For assessing the potential consequences of exposure to nontarget plants via runoff, an LOEC for seedling emergence of 0.00022 lb./acre is used for sensitive species and the corresponding value for tolerant species is 0.00089 lb./acre. For assessing the impact of drift, an LOEC for vegetative vigor of 0.00022 lb./acre is used for sensitive species and the corresponding value for tolerant species is 0.0036 lb./acre.

The data on toxicity to fish and aquatic invertebrates were obtained in only a few species –rainbow trout, bluegill sunfish and *Daphnia magna*. Metsulfuron methyl has a low order of toxicity to fish. Mortality is not likely to occur in fish exposed to metsulfuron methyl concentrations less than or equal to 1000 mg/L. For acute exposures in fish, the NOEC of 10 mg/L in rainbow trout is used for the most sensitive species and the NOEC of 1000 mg/L in bluegill sunfish is used for the most tolerant species. Toxicity values for chronic toxicity may be based on the available egg-and-fry/early life stage studies; only one study of chronic exposure in fish, a 90-day exposure of rainbow trout, yielding and NOEC of 4.5 mg/L. This value is used directly as a longer term NOEC in sensitive species because the rainbow trout appears to be a relatively sensitive species in acute toxicity assays. Using the relative potency for acute exposures of 100 (rainbow trout 100-times more sensitive than bluegill sunfish), an NOEC for tolerant species is estimated at 450 mg/L. Similarly, aquatic invertebrates do not appear to be sensitive to metsulfuron methyl. Since the only studies identified in aquatic invertebrates were in a single species, data obtained in *Daphnia magna* are used for both the sensitive and tolerant species. For acute exposure, a 48-hour NOEC for immobility of 420 mg/L is

used. For chronic exposures, the NOEC of 17 mg/L for growth inhibition is used, although higher chronic NOECs, ranging from 100 to 150 mg/L, have been reported for survival, reproduction and immobility. Aquatic plants appear to be much more sensitive to metsulfuron methyl than aquatic animals. An NOEC for plant damage of 0.00016 mg/L in duckweed is used to quantify effects for both acute and chronic exposure in aquatic macrophytes. This value is comparable to other studies in aquatic macrophytes and this is no basis for differentiating sensitive and tolerant species of aquatic macrophytes. For algae, the same data are used to quantify risk for both acute and chronic exposures. The most sensitive algal species appears to be *Selenastrum capricornutum*, with a 120-hour NOEC of 0.01 mg/L and the most tolerant species appear to be *Anabaena flosaquae* and *Navicula pelliculosa*, both with a 120-hour NOEC of 0.09 mg/L.

Risk Characterization – Metsulfuron methyl is an effective and potent herbicide. Adverse effects on some nontarget terrestrial plant species and, to a lesser degree, some aquatic plant species are plausible under some conditions. For terrestrial plants, the dominant factor in the risk characterization is the potency of metsulfuron methyl relative to the application rate. The typical application rate considered in this risk assessment, 0.03 lb./acre, is over 800 times higher than the NOEC in the vegetative vigor (direct spray) assay of the most sensitive nontarget species – i.e., 0.000037 lb./acre – and approximately 8 times higher than the NOEC for the most tolerant species in the same assay – i.e., 0.0039 lb./acre. The highest application rate that may be considered in Forest Service programs – i.e., 0.15 lb./acre – is over 4000 times the NOEC in sensitive species and a factor of about 40 above the NOEC in tolerant species. Given these relationships, damage to sensitive nontarget species could be expected in ground broadcast applications at distances of about 500 feet from the application site in areas in which off-site drift is not reduced by foliar interception. This risk characterization applies only to ground broadcast applications. When used in directed foliar applications (i.e., backpack), offsite drift could be reduced substantially but the extent of this reduction cannot be quantified.

The NOEC values for soil exposures (assayed in the seedling emergence test) are 0.000037 lb./acre for sensitive species and 0.0056 lb./acre for tolerant species. The offsite movement of metsulfuron methyl via runoff could be substantial under conditions that favor runoff – i.e., clay soils – and hazard quotients in the range of about 40 to nearly 500 are estimated for sensitive species over a wide range of rainfall rates – i.e., 15 inches to 250 inches per year. In very arid regions in which runoff might not be substantial, wind erosion could result in damage to nontarget plant species. The plausibility of observing such damage would, however, be highly dependent on local conditions. This risk characterization for the potential effects of runoff would be applicable to either broadcast ground or directed foliar applications.

Damage to aquatic plants, particularly macrophytes, appears substantially less than for terrestrial plants. All hazard quotients for aquatic macrophytes were based on an NOEC of 0.000016 mg/L in duckweed for both acute and chronic exposures. No sensitive or tolerant species were identified. Except for the hazard quotient of 2 associated with acute exposures based on the peak concentrations of metsulfuron methyl, all hazard quotients are below the level of concern, with a range of 0.002 to 2 for acute exposures and 0.02 to 0.08 for chronic exposures. Thus, if metsulfuron methyl is applied in areas where transport to water containing aquatic macrophytes is likely, it would be plausible that detectable damage could be observed.

Aquatic algae do not appear to be as sensitive to metsulfuron methyl. The highest hazard quotient observed for acute exposure is 0.03 associated with the upper range for the most sensitive species,

based on an NOEC for growth inhibition. For chronic exposures, the highest hazard quotient is 0.001 associated with the upper range for the most sensitive species. Both values were based on an acute NOEC. Therefore, it is not anticipated that adverse effects in aquatic algae would result from exposure to metsulfuron methyl at application rates used by the Forest Service.

Just as there is little reason to doubt that adverse effects on some plant species are plausible, there is no clear basis for suggesting that effects on terrestrial or aquatic animals are likely or would be substantial. Adverse effects in mammals, birds, terrestrial insects, and microorganisms are not likely using typical or worst-case exposure assumptions at the typical application rate of 0.03 lb. a.e./acre or the maximum application rate of 0.15 lb. a.e./acre. This characterization of risk, however, must be qualified. Metsulfuron methyl has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging nontarget species. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects are anticipated in terrestrial animals.

Similarly, the risk characterization for aquatic animals is relatively simple and unambiguous. Metsulfuron methyl appears to have a very low potential to cause any adverse effects in aquatic animals. All of the hazard quotients for aquatic animals are extremely low, with a range in fish from 0.0000000003 (acute exposures in tolerant fish) to 0.00003 (longer-term exposures to sensitive fish). It should be noted that confidence in this risk characterization is reduced by the lack of chronic toxicity studies in potentially tolerant fish – i.e., bluegill sunfish trout. At the maximum application rate of 0.15 lbs/acre, all of the hazard quotients would be increased by a factor of about 5. However, this difference has no impact on the risk characterization for fish. Hazard quotients in aquatic invertebrates range from 0.0000000007 (acute exposure in *Daphnia*) to 0.0000007 (acute exposure in *Daphnia*). Thus, there is no basis for asserting that adverse effects on aquatic animals are likely.

Sulfometuron Methyl

Human Health and Ecological Risk Assessment – Final Report

SERA TR 03-43-17-02c

December 13, 2004

Julie Klotzbach and Patrick Durkin
Syracuse Environmental Research Associates, Inc.

EXECUTIVE SUMMARY

OVERVIEW

Sulfometuron methyl is an effective and potent herbicide. Adverse effects on some nontarget terrestrial plant species and, to a lesser degree, some aquatic plant species are plausible under some conditions. For terrestrial plants, the dominant factor in the risk characterization is the potency of sulfometuron methyl relative to the application rate. The typical application rate considered in this risk assessment, 0.045 lb./acre, is about 1875 times higher than the NOEC in the vegetative vigor (direct spray) assay of the most sensitive non-target species – i.e., 0.000024 lb./acre – and almost 60

times higher than the NOEC for the most tolerant species in the same assay – i.e., 0.00078 lb./acre. The highest application rate that may be considered in Forest Service programs – i.e., 0.38 lb./acre – is over 15,000 times the NOEC in sensitive species and a factor of about 490 above the NOEC in tolerant species. Given these relationships, damage to sensitive nontarget species could be expected in ground broadcast applications at distances of about 900 feet from the application site in areas in which off-site drift is not reduced by foliar interception. This risk characterization applies only to ground broadcast applications. When used in directed foliar applications (i.e., backpack), offsite drift could be reduced substantially but the extent of this reduction cannot be quantified.

Damage to aquatic plants, particularly macrophytes, appears substantially less than for terrestrial plants. All hazard quotients for aquatic macrophytes were based on an NOEC of 0.00021 mg/L in duckweed for both acute and chronic exposures. Except for the hazard quotient of 4 associated with acute exposures based on the peak concentrations of sulfometuron methyl, all hazard quotients are below the level of concern, with a range of 0.01 to 0.4 for acute exposures and 0.002 to 0.01 for chronic exposures. Thus, if sulfometuron methyl is applied in areas where transport to water containing aquatic macrophytes is likely, it would be plausible that detectable but transient damage could be observed.

Aquatic algae do not appear to be as sensitive to sulfometuron methyl. The highest hazard quotient observed for acute exposure is 0.4 associated with the upper range for the most sensitive species. For chronic exposures, the highest hazard quotient is 0.001 associated with the upper range for the most sensitive species. Therefore, it is not anticipated that adverse effects in aquatic algae would result from exposure to sulfometuron methyl at application rates used by the Forest Service.

Just as there is little reason to doubt that adverse effects on some plant species are plausible, there is no clear basis for suggesting that effects on terrestrial or aquatic animals are likely or would be substantial.

PROGRAM DESCRIPTION

Sulfometuron methyl is a non-selective, sulfonyl urea herbicide used in the control the growth of broadleaf weeds and grasses. The only commercial formulations of sulfometuron methyl used by the Forest Service are Oust and Oust XP[®]. Oust and Oust XP are manufactured by Du Pont as a water dispersible granule. The composition of the product is 75% sulfometuron methyl and 25% inert ingredients.

Sulfometuron methyl is used in Forest Service programs primarily for the control of noxious weeds. Minor uses include conifer release and rights-of-way management. The most common methods of ground application for Oust and Oust XP involve backpack (selective foliar) and boom spray (broadcast foliar) operations. The Forest Service does not use aerial applications for Oust or Oust XP. Nonetheless, both formulations are registered for aerial applications and aerial applications are included in this risk assessment in the event the Forest Service may wish to consider this application method. For this risk assessment, the typical rate of 0.045 lbs/acre. A range of application rates will be taken as 0.03 lbs/acre to 0.38 lbs/acre to reflect plausible ranges that the Forest Service may use. An upper range of 0.38 lb./acre is used to assess the consequences of using the highest labeled rate should the Forest Service need to consider this option. The lower range is the lowest rate reported by the Forest Service.

HUMAN HEALTH RISK ASSESSMENT

Hazard Identification – In experimental mammals, the acute oral LD50 for sulfometuron methyl is greater than 17,000 mg/kg, which indicates a low order of toxicity. The lowest dose reported to cause any apparent effects after single gavage administration to rats is 5000 mg/kg. Acute exposure studies of sulfometuron methyl and the sulfometuron methyl formulation Oust give similar results, indicating that formulations of sulfometuron methyl are not more toxic than sulfometuron methyl alone. The most common signs of toxicity involve changes in blood that are consistent with hemolytic anemia (i.e., a lysis or destruction of blood cells that results in a decreased number of red blood cells) and decreased body weight gain. It is plausible that the hemolytic anemia caused by sulfometuron methyl is attributable, at least partially, to sulfonamide and saccharin, which are metabolites of sulfometuron methyl. Appropriate tests have provided no evidence that sulfometuron methyl causes malformations or cancer. Sulfometuron methyl is irritating to the skin and eyes, but does not produce sensitizing effects following repeated dermal exposure.

There is some concern regarding potential reproductive and teratogenic effects from exposure to sulfometuron methyl. Gavage studies in rabbits suggest that sulfometuron methyl exposure may increase the number of fetuses with anomalies as well as the proportion of fetal anomalies per litter. In addition to the two teratogenicity studies in rabbits, there are three reproduction studies involving dietary exposure of rats to sulfometuron methyl, in which effects were observed in dams (decreases in maternal body weight gain associated with decreased food consumption) and offspring (decreased fetal weight, decreased numbers of pups, and decreases in brain weights). As detailed in the dose-response assessment, these effects were not consistently dose-related and do not appear to be the most sensitive effect for sulfometuron methyl. Limited information is available on the toxicokinetics of sulfometuron methyl. The kinetics of absorption of sulfometuron methyl following dermal, oral or inhalation exposure, are not documented in the available literature. In both mammals and bacteria, sulfometuron methyl is degraded by cleavage of the sulfonyl urea bridge to form sulfonamide and a dimethyl pyrimidine urea or pyrimidine amine. Sulfonamide may be further degraded by demethylation to the free benzoic acid which, in turn, may undergo a condensation reaction to form saccharin. Sulfometuron methyl does not appear to concentrate in tissues and is eliminated fairly rapidly, with a half-life in goats ranging from 28 to 40 hours. In goats, nearly all the administered sulfometuron methyl dose was excreted in urine. Studies on the toxicity of sulfometuron methyl metabolites have not been conducted, however, the toxicity of the metabolites of sulfometuron methyl is likely to be encompassed by the available mammalian toxicity studies.

As discussed in the exposure assessment, skin absorption is the primary route of exposure for workers. Data regarding the dermal absorption kinetics of sulfometuron methyl are not available in the published or unpublished literature. For this risk assessment, estimates of dermal absorption rates – both zero order and first order – are based on quantitative structure-activity relationships. These estimates of dermal absorption rates are used in turn to estimate the amounts of sulfometuron methyl that might be absorbed by workers, which then are used with the available dose-response data to characterize risk. The lack of experimental data regarding dermal absorption of sulfometuron methyl adds substantial uncertainties to this risk assessment. Uncertainties in the rates of dermal absorption, although they are substantial, can be estimated quantitatively and are incorporated in the human health exposure assessment.

The inhalation toxicity of sulfometuron methyl is not well documented in the literature. Available studies indicate that sulfometuron methyl induces irritant effects at very high exposure levels. Regardless, the potential inhalation toxicity of sulfometuron methyl is not of substantial concern to this risk assessment because of the implausibility of inhalation exposure involving high concentrations of this compound.

Exposure Assessment – Exposure assessments are conducted for both workers and members of the general public for the typical application rate of 0.045 lb./acre. The consequences of using the maximum application rate that might be used by the Forest Service, 0.38 lb./acre, are discussed in the risk characterization.

For workers, three types of application methods are generally modeled in Forest Service risk assessments: directed ground, broadcast ground, and aerial. Although Oust and Oust XP are registered for aerial applications (helicopter and sometimes fixed wing), the Forest Service does not currently use this method. Nonetheless, the aerial application method is included in this risk assessment in the event that the Forest Service considers it an option. Central estimates of exposure for ground workers are approximately 0.0006 mg/kg/day for directed ground spray and 0.001 mg/kg/day for broadcast ground spray. Upper ranges of exposures are approximately 0.004 mg/kg/day for directed ground spray and 0.007 mg/kg/day for broadcast ground spray. All of the accidental exposure scenarios for workers involve dermal exposures and all of these accidental exposures lead to estimates of dose that are either in the range of or substantially below the general exposure estimates for workers.

For the general public, the range of acute exposures is from approximately 1.2×10^{-7} mg/kg associated with the lower range for consumption of contaminated stream water by a child to 0.094 mg/kg/day associated with the upper range for consumption of contaminated water by a child following an accidental spill of sulfometuron methyl into a small pond. For chronic or longer term exposures, the modeled exposures are much lower than for acute exposures, ranging from approximately 2.3×10^{-11} mg/kg/day associated with the lower range for the normal consumption of fish by the general public to approximately 0.0016 mg/kg/day associated with the upper range for consumption of contaminated fruit.

Dose-Response Assessment – According to a Federal Registry Notice (U.S. EPA 1997), the U.S. EPA has derived an RfD of 0.24 mg/kg/day. This RfD is based on a NOAEL for bladder toxicity of 500 ppm dietary sulfometuron methyl (equivalent to 24.4 mg/kg/day) and a 100-fold safety factor. Although an RfD has been derived by U.S. EPA, a more conservative provisional reference dose of 0.02 mg/kg/day, which was used in the previous Forest Service risk assessment on sulfometuron methyl (Durkin 1998), was derived from data reported in the 2-year feeding study in rats by Mullin (1984). The provisional reference dose is based on the 2 mg/kg/day (50 ppm) NOAEL for hematological effects in male rats and an uncertainty factor of 100:10 for species-to-species extrapolation and 10 for sensitive subgroups in the human population. The provisional RfD of 0.02 mg/kg/day is used in the current risk assessment for characterizing risks associated with chronic exposure to sulfometuron methyl. The U.S. EPA has not derived an acute/single dose RfD for sulfometuron methyl. A NOAEL of 86.6 mg/kg/day was reported for decreased maternal and fetal body weights in rats following 10-day gestational exposure of dams (Lu 1981). Using a NOAEL 86.6 mg/kg/day and margin of exposure of 100, a provisional acute RfD is calculated as 0.87 mg/kg/day and will be used for characterizing risks associated with acute exposure to sulfometuron methyl.

Risk Characterization – Typical exposures to sulfometuron methyl do not lead to estimated doses that exceed a level of concern. For workers, no exposure scenarios, acute or chronic, exceeds the RfD at the upper ranges of estimated dose associated with the typical application rate of 0.045 lb. a.e./acre. For members of the general public, all upper limits for hazard quotients are below a level of concern for the typical application rate. Thus, based on the available information and under the foreseeable conditions of application, there is no route of exposure or scenario suggesting that workers or members of the general public will be at any substantial risk from acute or longer term exposures to sulfometuron methyl.

Irritation and damage to the skin and eyes can result from exposure to relatively high levels of sulfometuron methyl. From a practical perspective, eye or skin irritation is likely to be the only overt effect as a consequence of mishandling sulfometuron methyl. These effects can be minimized or avoided by prudent industrial hygiene practices during the handling of sulfometuron methyl.

ECOLOGICAL RISK ASSESSMENT

Hazard Identification – The mammalian toxicity of sulfometuron methyl is relatively well characterized in experimental mammals; however, there is relatively little information regarding non-target wildlife species. In standard experimental toxicity studies, sulfometuron methyl has low acute and chronic oral toxicity. It seems reasonable to assume the most sensitive effects in wildlife mammalian species will be the same as those in experimental mammals (i.e., changes to blood and decreased body weight gain). Results of acute exposure studies in birds indicate that avian species appear no more sensitive than experimental mammals to the toxic effects of sulfometuron methyl. Chronic exposure studies in birds were not identified in the available literature. Results of two acute exposure studies in honey bees indicate that bees are no more sensitive than either mammals or birds to sulfometuron methyl. However, the available data are not sufficient to determine whether this apparent low level of toxicity can be generalized to other species of terrestrial invertebrates.

The toxicity of sulfometuron methyl to terrestrial plants was studied extensively and is well characterized. Sulfometuron methyl inhibits acetolactate synthase (ALS), an enzyme that catalyzes the biosynthesis of three branched-chain amino acids, all of which are essential for plant growth. Bioassays have been conducted on pre-emergence and post-emergence toxicity to several species. Results of both pre-emergent and postemergent bioassays show that terrestrial plants are highly susceptible to the effects of sulfometuron methyl. Concern for the sensitivity of non-target plant species is further increased by field reports of substantial and prolonged damage to crops or ornamentals after the application of sulfometuron methyl in both an arid region, presumably due to the transport of soil contaminated with sulfometuron methyl by wind, and in a region with heavy rainfall, presumably due to the wash-off of sulfometuron methyl contaminated soil. Sulfometuron methyl exposure inhibited growth of several soil microorganisms and caused significant growth inhibition in *Salmonella typhimurium* after exposure periods of less than 3 hours.

As with potential effects on terrestrial species and as would be expected for a herbicide, the available data suggest that sulfometuron methyl is much more toxic to aquatic plants than to aquatic animals. The results of studies in fish suggest that frank toxic effects are not likely to be observed at concentrations less than or equal to 150 mg/L. Sulfometuron methyl also appears to be relatively non-toxic to aquatic invertebrates, based on acute bioassays in daphnids, crayfish, and field-collected species of other aquatic invertebrates. The most sensitive aquatic species tested appears to be the African clawed frog. In acute and chronic exposure studies, exposure to

sulfometuron methyl produced alterations in limb development, organogenesis, and metamorphosis. Aquatic plants appear more sensitive than aquatic animals to the effects of sulfometuron methyl, although there appear to be substantial differences in sensitivity among species of macrophytes and unicellular algae. The macrophytes, however, appear to be generally more sensitive. There are no published or unpublished data regarding the toxicity of sulfometuron methyl to aquatic bacteria or fungi. By analogy to the effects on terrestrial bacteria and aquatic algae, it seems plausible that aquatic bacteria and fungi will be sensitive to the effects of sulfometuron methyl.

Exposure Assessment – Terrestrial animals might be exposed to any applied herbicide from direct spray, the ingestion of contaminated media (vegetation, prey species, or water), grooming activities, or indirect contact with contaminated vegetation. In acute exposure scenarios, the highest exposures for terrestrial vertebrates involve the consumption of contaminated insects by a small bird, which could reach up to about 5 mg/kg. There is a wide range of exposures anticipated from the consumption of contaminated vegetation by terrestrial animals: central estimates range from 0.06 mg/kg for a small mammal to 1.2 mg/kg for a large bird under typical exposure conditions, with upper ranges of about 0.1 mg/kg for a small mammal and 3.4 mg/kg for a large bird. The consumption of contaminated water will generally lead to much lower levels of exposure. A similar pattern is seen for chronic exposures. The central estimate for daily doses for a small mammal from the longer term consumption of contaminated vegetation at the application site is about 0.0009 mg/kg/day, with an upper estimate of about 0.004 mg/kg/day.

Longer term exposures from contaminated vegetation far exceed doses that are anticipated from the consumption of contaminated water, which has a central estimate of about 0.0000003 mg/kg/day and an upper range of about 0.0000005 for a small mammal. Based on general relationships of body size to body volume, larger vertebrates will be exposed to lower doses than small vertebrates under comparable exposure conditions. Because of the apparently low toxicity of sulfometuron methyl to animals, the rather substantial variations in the different exposure assessments have little impact on the assessment of risk to terrestrial animals.

For terrestrial plants, five exposure scenarios are considered quantitatively: direct spray, spray drift, runoff, wind erosion and the use of contaminated irrigation water. Unintended direct spray is expressed simply as the application rate considered in this risk assessment, 0.045 lb. a.e./acre and should be regarded as an extreme/accidental form of exposure that is not likely to occur in most Forest Service applications. Estimated levels of exposure for the other scenarios are much less. All of these exposure scenarios are dominated by situational variability because the levels of exposure are highly dependent on site-specific conditions. Thus, the exposure estimates are intended to represent conservative but plausible ranges that could occur but these ranges may over-estimate or under-estimate actual exposures in some cases. Spray drift is based on estimates AGDRIFT. The proportion of the applied amount transported off-site from runoff is based on GLEAMS modeling of clay, loam, and sand. The amount of sulfometuron methyl that might be transported off-site from wind erosion is based on estimates of annual soil loss associated with wind erosion and the assumption that the herbicide is incorporated into the top 1 cm of soil. Exposure from the use of contaminated irrigation water is based on the same data used to estimate human exposure from the consumption of contaminated ambient water and involves both monitoring studies as well as GLEAMS modeling.

Exposures of aquatic plants and animals to sulfometuron methyl are based on essentially the same information used to assess the exposure to terrestrial species from contaminated water. The peak estimated rate of contamination of ambient water associated with the normal application of sulfometuron methyl is 0.001 (0.00006 to 0.02) mg a.e./L at an application rate of 1 lb. a.e./acre. For longer-term exposures, average estimated rate of contamination of ambient water associated with the normal application of sulfometuron methyl is 0.00004 (0.00001 to 0.00007) mg a.e./L at an application rate of 1 lb. a.e./acre. For the assessment of potential hazards, these contamination rates are adjusted based on the application rates considered in this risk assessment.

Dose-Response Assessment –For terrestrial mammals, the dose-response assessment for chronic exposure to sulfometuron methyl is based on the same data as the human health risk assessment (i.e., the chronic NOAEL of 2 mg/kg/day from a 2-year feeding study in rats is used to assess chronic risk). All of the potential longer-term exposures of terrestrial mammals to sulfometuron methyl are substantially below the NOAEL of 2 mg/kg/day. For acute exposure, the dose response assessment is also based on the same data as the human health risk assessment (i.e. the chronic NOAEL in rats of 87 mg/kg/day from a 10-day gestational exposure study is used to assess acute risk). All of the potential acute exposures of terrestrial mammals to sulfometuron methyl are also substantially below the NOAEL of 87 mg/kg/day. Birds appear to exhibit the same low order of toxicity to sulfometuron methyl as mammals, with an acute NOAEL of 312 mg/kg based on changes in body weight observed following a single gavage administration to mallard ducks. No chronic exposure studies of birds to sulfometuron methyl were identified in the available literature. Since results of acute exposure studies suggest that the sensitivity of birds to sulfometuron methyl is similar to that of mammals, in the absence of chronic exposure data in birds the chronic NOAEL of 2 mg/kg/day in rats is used for birds. For terrestrial invertebrates, based on direct spray studies in honey bees, no mortality would be expected following acute exposure to doses up to 1075 mg/kg. Although limited data are available, soil microorganisms appear sensitive to sulfometuron methyl at concentrations of about 70:g/L. The toxicity of sulfometuron methyl to terrestrial plants is relatively well characterized. Sulfometuron methyl is a potent herbicide that causes adverse effects in a variety of target and non-target plant species. Results of pre-emergent and post-emergent application studies in a variety of plant species yield NOELs ranging from 0.0000086 to 0.00078 lbs/acre. For assessing the potential consequences of exposure to nontarget plants via runoff, an LOEC for seedling emergence of 0.0000086 lb./acre is used for sensitive species and the corresponding value for tolerant species is 0.00025 lb./acre. For assessing the impact of drift, an LOEC for vegetative vigor of 0.000024 lb./acre is used for sensitive species and the corresponding value for tolerant species is 0.00078 lb./acre.

The data on toxicity to fish and aquatic invertebrates were obtained in several species. Fish do not appear to be highly sensitive to sulfometuron toxicity. However, investigations of acute toxicity have been hampered by the limited water solubility of sulfometuron methyl. For acute exposures in fish, the NOEC of 7.3 mg a.i./L in fathead minnow is used for the most sensitive species and the NOEC of 150 mg a.i./L in bluegill sunfish and rainbow trout is used for the most tolerant species. However, since both of these values were the highest concentration tested in both studies, identification of a most sensitive and a most tolerant species cannot be made with certainty. Toxicity values for chronic toxicity may be based on the available egg-and-fry/early life stage studies; only one study of chronic exposure in fish is available, a 30-day exposure of fathead minnow yielding an NOAEC of 1.17 mg a.i./L. This value is used for both the most sensitive and tolerant species for chronic exposure. For acute exposure of aquatic invertebrates, the most sensitive species appear to be *Alonella* sp. and *Cypria* sp., with LOAEC values of 75 mg a.i./L. *Daphnia* are the most tolerant species,

with an NOEC of 1800 mg a.i./L. Comparison of LOAEC values for *Daphnia* (2400 mg a.i./L) and *Alonella* and *Cypria* (75 mg a.i./L) show that *Daphnia* have a relative potency factor of 32 (i.e. *Daphnia* are 32 times more tolerant than *Alonella* and *Cypria* to acute exposure of sulfometuron methyl). For chronic exposure of aquatic invertebrates, data are only available from a single study in *Daphnia* with an NOEC of 6.1 mg/L. This value is used for the most tolerant species for chronic exposure. Although no data are available to determine the most sensitive species for chronic exposures, parallels can be drawn to the acute exposure studies. As discussed above, the relative potency factor comparing *Daphnia* to *Alonella* and *Cypria* based on acute LOAEC values is 32. Using the relative potency factor for acute exposures of 32 and the chronic NOEC in *Daphnia* of 6.1 mg/L, an NOEC for *Alonella* and *Cypria* is estimated to be 0.19 mg/L. This surrogate NOEC for chronic exposure in *Alonella* and *Cypria* will be used to estimate the chronic NOEC for the most sensitive species.

Aquatic plants appear to be much more sensitive to sulfometuron methyl than aquatic animals. An NOEC for growth inhibition of 0.00021 mg/L in duckweed is used to quantify effects for both acute and chronic exposure in aquatic macrophytes. Data are also available in *Hydrilla* and yield a similar NOEC. However, based on the limited data available as well as difference in experimental protocols, it is not possible to identify a most sensitive and most tolerant species for aquatic macrophytes. For algae, the most sensitive algal species appears to be *Selenastrum capricornutum*, with a 72-hour NOEC of 0.0025 mg/L and the most tolerant species appears to be *Navicula pelliculosa*, both with a 120-hour NOEC of 0.37 mg/L. The same data are used to quantify risk for both acute and chronic exposures.

Risk Characterization – Sulfometuron methyl is an effective and potent herbicide. Adverse effects on some nontarget terrestrial plant species and, to a lesser degree, some aquatic plant species are plausible under some conditions. For terrestrial plants, the dominant factor in the risk characterization is the potency of sulfometuron methyl relative to the application rate. The typical application rate considered in this risk assessment, 0.045 lb./acre, is about 1875 times higher than the NOEC in the vegetative vigor (direct spray) assay of the most sensitive non-target species – i.e., 0.000024 lb./acre – and almost 60 times higher than the NOEC for the most tolerant species in the same assay – i.e., 0.00078 lb./acre. The highest application rate that may be considered in Forest Service programs – i.e., 0.38 lb./acre – is over 15,000 times the NOEC in sensitive species and a factor of about 490 above the NOEC in tolerant species. Given these relationships, damage to sensitive nontarget species could be expected in ground broadcast applications at distances of about 900 feet from the application site in areas in which off-site drift is not reduced by foliar interception. This risk characterization applies only to ground broadcast applications. When used in directed foliar applications (i.e., backpack), offsite drift could be reduced substantially but the extent of this reduction cannot be quantified.

The NOEC values for soil exposures (assayed in the seedling emergence test) are 0.0000086 lb./acre for sensitive species and 0.00026 lb./acre for tolerant species. The offsite movement of sulfometuron methyl via runoff could be substantial under conditions that favor runoff – i.e., clay soils – and hazard quotients in the range of about 90 to nearly 2900 are estimated for sensitive species over a wide range of rainfall rates – i.e., 15 inches to 250 inches per year. In very arid regions in which runoff might not be substantial, wind erosion could result in damage to nontarget plant species. The plausibility of observing such damage would, however, be highly dependent on local conditions. This risk characterization for the potential effects of runoff would be applicable to either broadcast ground or directed foliar applications.

Damage to aquatic plants, particularly macrophytes, appears substantially less than for terrestrial plants. All hazard quotients for aquatic macrophytes were based on an NOEC of 0.00021 mg/L in duckweed for both acute and chronic exposures. No sensitive or tolerant species were identified. Except for the hazard quotient of 4 associated with acute exposures based on the peak concentrations of sulfometuron methyl, all hazard quotients are below the level of concern, with a range of 0.01 to 4 for acute exposures and 0.002 to 0.01 for chronic exposures. Thus, if sulfometuron methyl is applied in areas where transport to water containing aquatic macrophytes is likely, it would be plausible that detectable but transient damage could be observed. Aquatic algae do not appear to be as sensitive to sulfometuron methyl. The highest hazard quotient observed for acute exposure is 0.4 associated with the upper range for the most sensitive species, based on an NOEC for growth inhibition. For chronic exposures, the highest hazard quotient is 0.001 associated with the upper range for the most sensitive species. Both values were based on an acute NOEC. Therefore, it is not anticipated that adverse effects in aquatic algae would result from exposure to sulfometuron methyl at application rates used by the Forest Service.

There is no clear basis for suggesting that effects on terrestrial animals are likely or would be substantial. Adverse effects in mammals, birds, terrestrial insects, and microorganisms are not likely using typical or worst-case exposure assumptions at the typical application rate of 0.045 lb. a.e./acre. The hazard quotients associated with the upper range for chronic consumption of vegetation by a large mammal (hazard quotient = 0.2) or large bird (hazard quotient = 0.3) feeding exclusively on treated vegetation slightly exceeds the level of concern of 0.1 associated with the maximum application rate of 0.38 lb. a.e./acre. As with the human health risk assessment, this characterization of risk must be qualified. Sulfometuron methyl has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging non-target species. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects are anticipated in terrestrial animals. Similarly, the risk characterization for aquatic animals is relatively simple and unambiguous. Sulfometuron methyl appears to have a very low potential to cause any adverse effects in aquatic animals. All of the hazard quotients for aquatic animals are extremely low, with a range of 0.000000002 (lower range for acute exposures in tolerant aquatic invertebrates) to 0.004 (longer-term exposures to amphibians). It should be noted that confidence in this risk characterization is reduced by the lack of chronic toxicity studies in potentially tolerant fish and potentially sensitive aquatic invertebrates and lack of data in amphibians (data only available in a single species). Even with these uncertainties, there is no basis for asserting that adverse effects on aquatic animals are likely.

Triclopyr

Human Health and Ecological Risk Assessment - Final Report

SERA TR-052-25-03a

May 24, 2011

Patrick R. Durkin
Syracuse Environmental Research Associates, Inc.

EXECUTIVE SUMMARY

The triethylamine salt (TEA) and the butoxyethyl ester (BEE) of triclopyr are used in Forest Service programs primarily for conifer or hardwood release, noxious weed control, site preparation, and rights-of-way management. Aquatic weed control is a minor use (TEA salt).

Potential risks associated with terrestrial applications are greatest for workers as well as women consuming vegetation contaminated with triclopyr. The central estimates of the HQs indicate that workers will not be subject to hazardous levels of triclopyr during applications of triclopyr TEA at the unit application rate of 1 lb. a.e./acre. For triclopyr BEE, the central estimates of the HQs range from 0.7 to 1.2 based on the chronic RfD. At the upper bounds of the estimated exposures for all application methods, the HQs for both triclopyr TEA (HQs = 1.6 to 3) and triclopyr BEE formulations (HQs = 6 to 12) exceed the level of concern (HQ=1), based on the chronic RfD. For a young woman consuming contaminated vegetation, the upper bound HQ is 27 for acute exposures and 6 for longer-term exposures. In addition, some of the central estimates of exposure to triclopyr or TCP involving a young woman consuming contaminated vegetation or fruit also exceed the level of concern. All of these HQs apply to an application rate of 1 lb. a.e./acre and will scale proportionately to the application rate. Because triclopyr has been shown to cause adverse developmental effects in mammals, the high HQs associated with terrestrial applications are of particular concern in terms of the potential for adverse reproductive outcomes in humans. Adverse developmental effects in experimental mammals have been observed, however, only at doses that cause frank signs of maternal toxicity. The available toxicity studies suggest that overt and severe toxicity would not be associated with any of the upper bound HQs and this diminishes concern for reproductive effects in humans.

Qualitatively, the risk characterization for ecological effects is parallel in many respects to the risk characterization for human health effects. At an application rate of 1 lb. a.e./acre, HQs exceed the level of concern for exposures involving the consumption of contaminated vegetation by mammals and birds. HQs are greatest for large mammals. As with the human health risk assessment, the high HQs suggest the potential for adverse effects, but not overt toxic effects, in large mammals. Based on a very cursory probabilistic assessment, exposures of mammalian wildlife that would be associated with upper bound HQs are probably rare occurrences.

With the exception of aquatic plants, substantial risks to nontarget species (including humans) associated with the contamination of surface water are low, relative to risks associated with contaminated vegetation. Applications of triclopyr BEE in excess of about 1.5 to 3 lbs a.e./acre could

be associated with acute effects in sensitive species of fish or invertebrates, in cases of substantial drift or off-site transport of triclopyr via runoff.

INTRODUCTION

Chemical Specific Information

This document provides human health and ecological risk assessments of the environmental consequences of using triclopyr in Forest Service vegetation management programs. These risk assessments update previous USDA Forest Service risk assessments on triclopyr (SERA 1996, 2003).

In the preparation of this risk assessment, an updated literature search of triclopyr was conducted using TOXLINE. In addition, a FOIA has been submitted to the U.S. EPA/OPP for a current list of all registrant submitted studies. Additional sources of information were used including the U.S. EPA Reregistration Eligibility Decision document on triclopyr and related risk assessments (U.S. EPA/OPP 1998a,b,c) as well as a more recent EPA ecological risk assessment on triclopyr (U.S. EPA/OPP 2009a). Other sources of relevant literature were identified through reviews and risk assessments in the open literature (Antunes-Kenyon and Kennedy 2004; Cal EPA 1986; Cessna et al. 2002; Cox 2000; Dost 2003; Dow AgroSciences 2009; ENSR 2007; Ganapathy 1997; Kegley et al. 2008; Neary et al. 1993; NPIC 2002; Petty et al. 2003; Sassaman et al. 1984; Smith and Oehme 1991; Tu et al. 2001; U.S. DOE-BPA 2000; Washington State Dept. Ecology 2004; Wolt et al. 1997). Generally, these reviews are used only to identify published studies to ensure adequate coverage of the literature. In some cases, information taken from reviews is used directly in this risk assessment and this is specifically noted in the text as appropriate.

In the previous Forest Service risk assessment (SERA 2003), 1117 registrant submissions on triclopyr and triclopyr formulations were identified. Of these, 142 submissions—i.e., full copies of the studies submitted to the U.S. EPA—were kindly provided by the U.S. EPA Office of Pesticide Programs. These submissions included all key studies cited in the RED (U.S. EPA/OPP 1998a) as well as some additional studies submitted after the completion of the RED. The U.S. EPA/OPP no longer provides full copies of registrant studies for risk assessments conducted in support of activities outside of U.S. EPA/OPP. Consequently, summaries of the 142 submissions from SERA (2003) are included in the current Forest Service risk assessment and are cited in the bibliography (Section 5) as MRID03.

During the development of this risk assessment, some of the summaries of the MRID studies given in SERA (2003) were found to be incomplete and additional registrant submitted studies of interest were identified. Two sets of requests for registrant submitted studies were made to Dow AgroSciences, one of the registrants for triclopyr. Dow AgroSciences kindly provided 77 submissions, most of which were full studies. These additional submissions are identified in the bibliography as MRID 2003r, MRID10, and MRID11. These studies are cited in the text in standard author and date format. In some cases, information on other registrant-submitted studies is taken from various U.S. EPA/OPP risk assessments. In these cases, the information is designated in the text of the current risk assessment only by MRID number.

The U.S. EPA/OPP is in the process of reviewing the registration of many pesticides (http://www.epa.gov/opsrrd1/registration_review). The review of triclopyr, however, is not scheduled to begin until 2014, and the U.S. EPA has not yet opened a docket for the registration review (U.S. EPA/OPP 2010, p. 14).

General Information

This document has four chapters, including the introduction, program description, risk assessment for human health effects, and risk assessment for ecological effects or effects on wildlife species. Each of the two risk assessment chapters has four major sections, including an identification of the hazards, an assessment of potential exposure to this compound, an assessment of the dose-response relationships, and a characterization of the risks associated with plausible levels of exposure.

This is a technical support document which addresses some specialized technical areas. Nevertheless an effort was made to ensure that the document can be understood by individuals who do not have specialized training in the chemical and biological sciences. Certain technical concepts, methods, and terms common to all parts of the risk assessment are described in plain language in a separate document (SERA 2007a). The human health and ecological risk assessments presented in this document are not, and are not intended to be, comprehensive summaries of all of the available information. The information presented in the appendices and the discussions in chapters 2, 3, and 4 of the risk assessment are intended to be detailed enough to support a review of the risk analyses.

As discussed in Section 1.1, the current Forest Service risk assessment is an update to previous risk assessments on triclopyr (SERA 1996, 2003). At some point in the future, the Forest Service will update this risk assessment again and welcomes input from the general public and other interested parties on the selection of studies included in the risk assessment. This input is helpful, however, only if recommendations for including additional studies specify why and/or how the new or not previously included information would be likely to alter the conclusions reached in the risk assessments.

As with all Forest Service risk assessments, almost no risk estimates presented in this document are given as single numbers. Usually, risk is expressed as a central estimate and a range, which is sometimes quite large. Because of the need to encompass many different types of exposure as well as the need to express the uncertainties in the assessment, this risk assessment involves numerous calculations, most of which are relatively simple and are included in the body of the document. Some of the calculations, however, are cumbersome. For those calculations, EXCEL workbooks (sets of EXCEL worksheets) are included as attachments to this risk assessment. The worksheets provide the detail for the estimates cited in the body of the document. Documentation for the use of these workbooks is available in SERA (2010a).

The EXCEL workbooks are an integral part of the risk assessment. The worksheets contained in these workbooks are designed to isolate the large number of calculations from the risk assessment narrative. In general, all calculations of exposure scenarios and quantitative risk characterizations (i.e., HQs) are derived and contained in the worksheets. The rationale for the calculations and the interpretation of the HQs are contained in this risk assessment document.

Seven EXCEL workbooks accompany this risk assessment covering both triclopyr and 3,5,6-trichloro-2-pyridinol (TCP), a major metabolite of triclopyr:

Attachment 1: Terrestrial Applications of Triclopyr TEA

Attachment 2: Terrestrial Applications of Triclopyr BEE

Attachment 3: Emergent Aquatic Applications of Triclopyr TEA

Attachment 4: Submergent Aquatic Applications of Triclopyr TEA
Attachment 5: TCP in Terrestrial Applications of Triclopyr (TEA and BEE)
Attachment 6: TCP in Emergent Aquatic Applications of Triclopyr TEA
Attachment 7: TCP in Submergent Aquatic Applications of Triclopyr TEA

Appendix C: Recent Herbicide Use and Target Species History

2012 Target Species	HERBICIDE VOLUMES (gal)									ADJUVANT VOLUMES (gal)			
	Escort XP	Garlon 4 Ultra	Gly-4 Plus	Habitat or Imazapyr 2SL	Journey	Milestone	Plateau	Telar DF	Transline	Antidrift	Marking Dye	Methylated Seed Oil	Nonionic Surfactant
Exotic Plant Control	0.01	0.08	1.24	0.51	0.01	0.72	0.49	0.05	0.12	0.00	2.06	0.24	1.52
<i>Acroptilon repens</i>	0.000	0.000	0.000	0.002	0.000	0.525	0.000	0.000	0.000	0.000	1.667	0.000	0.851
<i>Aegilops cylindrica</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.018	0.035	0.000
<i>Bromus inermis</i>	0.000	0.000	1.020	0.486	0.000	0.000	0.006	0.000	0.000	0.000	0.041	0.000	0.077
<i>Bromus tectorum</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.231	0.000	0.000	0.000	0.000	0.000	0.000
<i>Cardaria draba</i>	0.000	0.000	0.000	0.018	0.000	0.000	0.036	0.048	0.000	0.000	0.000	0.028	0.036
<i>Carduus nutans</i>	0.000	0.000	0.033	0.000	0.000	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.044
<i>Centaurea biebersteinii</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Centaurea diffusa</i>	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.058	0.000	0.000	0.000	0.116
<i>Cirsium arvense</i>	0.000	0.000	0.000	0.000	0.000	0.145	0.000	0.000	0.000	0.000	0.333	0.000	0.246
<i>Cirsium vulgare</i>	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001
<i>Cynoglossum officinale</i>	0.000	0.000	0.174	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Erodium cicutarium</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.000
<i>Euphorbia esula</i>	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
<i>Lepidium latifolium</i>	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Lepidium perfoliatum</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000
<i>Linaria dalmatica</i>	0.003	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.058	0.000	0.000	0.003	0.115
<i>Salsola tragus</i>	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000
<i>Tamarix ramosissima</i>	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Ulmus pumila</i>	0.000	0.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.175	0.000
<i>Verbascum thapsus</i>	0.000	0.001	0.013	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.037
Archeological Sites	0.000	0.000	0.080	0.000	0.000	0.000	0.040	0.000	0.000	0.000	0.000	0.000	0.000
Facility Maintenance	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Road Maintenance	0.000	0.000	0.017	0.000	2.223	0.000	0.000	0.017	0.000	0.012	0.000	2.223	0.000
Trail Maintenance	0.000	0.000	0.000	0.000	0.000	0.000	0.170	0.000	0.000	0.000	0.000	0.000	0.000

2012 Target Species	GROSS ACRES									
	Escort XP	Garlon 4 Ultra	Gly-4 Plus	Habitat or Imazapyr 2SL	Journey	Milestone	Plateau	Telar DF	Transline	Total
Exotic Plant Control	80.56	1.60	352.17	7.31	0.09	335.61	15.53	6.70	80.56	880.12
<i>Acroptilon repens</i>	0.000	0.000	0.000	0.144	0.000	114.691	0.000	0.000	0.000	114.84
<i>Aegilops cylindrica</i>	0.000	0.000	0.000	0.000	0.000	0.000	2.708	0.000	0.000	2.71
<i>Bromus inermis</i>	0.000	0.000	8.318	3.343	0.000	0.000	1.982	0.000	0.000	13.64
<i>Bromus tectorum</i>	0.000	0.000	0.000	0.000	0.000	0.000	7.226	0.000	0.000	7.23
<i>Cardaria draba</i>	0.000	0.000	0.000	3.690	0.000	0.000	0.100	0.541	0.000	4.33
<i>Carduus nutans</i>	0.000	0.000	83.069	0.000	0.000	37.614	0.000	0.000	0.000	120.68
<i>Centaurea biebersteinii</i>	0.000	0.000	0.000	0.000	0.000	0.810	0.000	0.000	0.000	0.81
<i>Centaurea diffusa</i>	40.280	0.000	0.000	0.000	0.000	0.845	0.000	0.000	40.280	81.41
<i>Cirsium arvense</i>	0.000	0.000	0.000	0.000	0.000	140.758	0.000	0.000	0.000	140.76
<i>Cirsium vulgare</i>	0.000	0.000	0.000	0.000	0.000	9.002	0.000	0.000	0.000	9.00
<i>Cynoglossum officinale</i>	0.000	0.000	244.961	0.000	0.000	0.000	0.000	0.000	0.000	244.96
<i>Erodium cicutarium</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.610	0.000	0.000	0.61
<i>Euphorbia esula</i>	0.000	0.000	0.000	0.000	0.091	0.000	0.000	0.000	0.000	0.09
<i>Lepidium latifolium</i>	0.000	0.000	0.100	0.100	0.000	0.000	0.000	0.000	0.000	0.20
<i>Lepidium perfoliatum</i>	0.000	0.000	0.000	0.000	0.000	0.000	2.291	0.000	0.000	2.29
<i>Linaria dalmatica</i>	40.280	0.000	0.036	0.036	0.000	0.000	0.000	6.155	40.280	86.79
<i>Salsola tragus</i>	0.000	0.000	0.000	0.000	0.000	9.115	0.610	0.000	0.000	9.73
<i>Tamarix ramosissima</i>	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.10
<i>Ulmus pumila</i>	0.000	1.167	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.17
<i>Verbascum thapsus</i>	0.000	0.330	15.686	0.000	0.000	22.769	0.000	0.000	0.000	38.78
Archeological Sites	0.000	0.000	2.666	0.000	0.000	0.000	2.618	0.000	0.000	5.28
Facility Maintenance	0.000	0.000	0.000	0.000	0.000	0.000	2.291	0.000	0.000	2.29
Road Maintenance	0.000	0.000	11.440	0.000	10.675	0.000	0.000	9.338	0.000	31.45
Trail Maintenance	0.000	0.000	0.000	0.000	0.000	0.000	2.991	0.000	0.000	2.99
Grand Total	80.56	1.60	366.28	7.31	10.77	335.61	23.43	16.03	80.56	922.14

2013 Target Species	HERBICIDE VOLUMES (gal)									ADJUVANT VOLUMES (gal)			
	Escort XP	Garlon 4 Ultra	Gly-4 Plus	Habitat or Imazapyr 2SL	Journey	Milestone	Plateau	Telar DF	Transline	Antidrift	Marking Dye	Methylated Seed Oil	Nonionic Surfactant
Exotic Plant Control	0.0000	0.1570	1.2316	1.0160	0.0020	0.2629	0.0000	0.0019	0.0000	0.0000	0.4245	0.0000	2.0000
<i>Acroptilon repens</i>	0.000	0.000	0.000	0.001	0.000	0.033725	0.000	0.000	0.000	0.000	0.13714	0.000	0.220266
<i>Aegilops cylindrica</i>	0.000	0.000	0.49455	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Bromus inermis</i>	0.000	0.000	0.41333	0.870044	0.000	0.000	0.000	0.000	0.000	0.000	0.06101	0.000	0.394345
<i>Bromus tectorum</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Cardaria draba</i>	0.000	0.002	0.00	0.000	0.000	0.0011	0.000	0.00001	0.000	0.000	0.000	0.000	0.0275
<i>Carduus nutans</i>	0.000	0.000	0.25357	0.139142	0.000	0.097273	0.000	0.000	0.000	0.000	0.14378	0.000	0.598597
<i>Centaurea biebersteinii</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Centaurea diffusa</i>	0.000	0.000	0.000	0.000	0.000	0.001105	0.000	0.0009	0.000	0.000	0.000	0.000	0.04525
<i>Cirsium arvense</i>	0.000	0.000	0.000	0.00581	0.000	0.072905	0.000	0.000	0.000	0.000	0.06353	0.000	0.267069
<i>Cirsium vulgare</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Cynoglossum officinale</i>	0.000	0.000	0.00833	0.000	0.000	0.00002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Elaeagnus angustifolia</i>	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0005
<i>Erodium cicutarium</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Euphorbia esula</i>	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.0001	0.000	0.000	0.000	0.000	0.001
<i>Lepidium latifolium</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Lepidium perfoliatum</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Linaria dalmatica</i>	0.000	0.000	0.000	0.000	0.000	0.0009	0.000	0.0009	0.000	0.000	0.000	0.000	0.045
<i>Salsola tragus</i>	0.000	0.000	0.06182	0.000	0.000	0.004197	0.000	0.000	0.000	0.000	0.000	0.000	0.1475
<i>Tamarix ramosissima</i>	0.000	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
<i>Ulmus pumila</i>	0.000	0.055	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0005
<i>Verbascum thapsus</i>	0.000	0.000	0.000	0.000	0.000	0.05163	0.000	0.000	0.000	0.000	0.01904	0.000	0.251462

2013 Target Species	GROSS ACRES											
	Escort XP	Garlon 4 Ultra	Gly-4 Plus	Habitat or Imazapyr 2SL	Journey	Milestone	Plateau	Telar DF	Transline	Total		
Exotic Plant Control	0.00	0.52	454.46	40.30	0.04	498.74	0.00	71.23	0.00	1065.29	994.07	
Acroptilon repens	0.000	0.000	0.000	0.09877515	0.000	29.52685	0.000	0.000	0.000	29.63		
Aegilops cylindrica	0.000	0.000	9.336879	0.000	0.000	0.000	0.000	0.000	0.000	9.34		
Bromus inermis	0.000	0.000	12.10358	19.22025956	0.000	0.000	0.000	0.000	0.000	31.32		
Bromus tectorum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00		
Cardaria draba	0.000	0.003992	0.000	0.000	0.000	15.82069	0.000	0.003992	0.000	15.83		
Carduus nutans	0.000	0.000	221.3997	19.22025956	0.000	146.6517	0.000	0.000	0.000	387.27		
Centaurea biebersteinii	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00		
Centaurea diffusa	0.000	0.000	0.000	0.000	0.000	35.93704	0.000	35.59196	0.000	71.53	35.94	
Cirsium arvense	0.000	0.000	0.000	1.76401991	0.000	108.5571	0.000	0.000	0.000	110.32		
Cirsium vulgare	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00		
Cynoglossum officinale	0.000	0.000	202.2829	0.000	0.000	0.108387	0.000	0.000	0.000	202.39		
Elaeagnus angustifolia	0.000	0.124988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.12		
Erodium cicutarium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00		
Euphorbia esula	0.000	0.000	0.000	0.000	0.039609	0.000	0.000	0.039609	0.000	0.08		0.04
Lepidium latifolium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00		
Lepidium perfoliatum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00		
Linaria dalmatica	0.000	0.000	0.000	0.000	0.000	35.59196	0.000	35.59196	0.000	71.18		35.59
Salsola tragus	0.000	0.000	9.336879	0.000	0.000	21.75981	0.000	0.000	0.000	31.10		
Tamarix ramosissima	0.000	0.019876	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.02		
Ulmus pumila	0.000	0.369613	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.37		
Verbascum thapsus	0.000	0.000	0.000	0.000	0.000	104.7911	0.000	0.000	0.000	104.79		

* The values highlighted in red are mixtures or repeat treatments so the acreages for these two species are duplicated and should be cut in half for the final figures.

2014 TARGET SPECIES	HERBICIDE VOLUME (gal.)										ADJUVANT VOLUME (gal.)	
	Alligare	AquaNeat	Garlon 4 Ultra	Gly-4 Plus	Habitat	Journey	Milestone VM	Plateau	Telar XP	Transline	Methylated Seed Oil	S-90 Nonionic Surfactant
Exotic Plant Control	3.258	0.000	0.250	9.082	0.090	0.796	1.267	0.166	0.001	0.609	1.255	3.257
<i>Acroptilon repens</i>	-	-	-	-	-	-	0.404	0.162	-	0.609	0.684	0.485
<i>Bromus inermis</i>	2.625	-	-	7.750	-	-	-	-	-	-	-	0.825
<i>Bromus tectorum</i>	-	-	-	-	-	0.100	-	-	-	-	0.050	-
<i>Cardaria draba</i>	-	-	-	-	-	-	0.001	-	0.000	-	-	0.001
<i>Carduus nutans</i>	0.533	-	-	0.302	-	0.100	0.272	-	0.001	-	0.050	0.752
<i>Centaurea biebersteinii</i>	-	-	-	0.017	-	-	0.003	-	0.000	-	-	0.006
<i>Centaurea diffusa</i>	0.050	-	-	0.000	-	0.275	0.035	-	0.000	-	0.215	0.080
<i>Cirsium arvense</i>	-	-	-	0.290	-	-	0.313	-	-	-	-	0.625
<i>Cirsium vulgare</i>	-	-	-	-	-	-	0.001	-	-	-	-	0.001
<i>Cynoglossum officinale</i>	-	-	-	0.154	-	-	-	-	-	-	-	-
<i>Euphorbia essula</i>	-	-	-	-	-	-	-	0.001	-	-	0.001	-
<i>Lepidium latifolium</i>	-	-	-	0.214	-	-	0.000	0.003	0.000	-	0.003	0.001
<i>Lepidium perfoliatum</i>	-	-	-	0.060	-	0.030	-	-	-	-	0.030	-
<i>Linaria dalmatica</i>	0.050	-	-	-	-	0.289	0.035	-	-	-	0.221	0.080
<i>Marrubium vulgare</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tamarix ramosissima</i>	-	-	0.250	-	0.010	-	-	-	-	-	-	-
<i>Thalspi arvense</i>	-	-	-	-	-	0.002	-	-	-	-	0.001	-
<i>Ulmus pumila</i>	-	-	-	-	0.080	-	-	-	-	-	-	-
<i>Verbascum thapsis</i>	-	-	-	0.295	-	-	0.204	-	-	-	-	0.403
Total Vegetation Control	-	0.225	0.001	0.810	0.360	0.505	0.035	0.305	0.003	-	-	0.205
TOTAL VOLUME	3.258	0.225	0.251	9.892	0.450	1.301	1.302	0.471	0.004	0.609	2.305	3.462

Gross acres of invasive plant species targeted for control at MVNP in 2014.

SPECIES	COMMON NAME	GROSS ACRES
<i>Acroptilon repens</i>	Russian knapweed	42.46
<i>Bromus inermis</i>	smooth brome	28.98
<i>Bromus tectorum</i>	cheatgrass	0.02
<i>Cardaria draba</i>	whitetop	0.01
<i>Carduus nutans</i>	musk thistle	118.34
<i>Centaurea biebersteinii</i>	spotted knapweed	0.31
<i>Centaurea diffusa</i> *	diffuse knapweed	109.71
<i>Cirsium arvense</i>	Canada thistle	23.01
<i>Cirsium vulgare</i>	bull thistle	0.04
<i>Cynoglossum officinale</i>	houndstongue	152.74
<i>Euphorbia esula</i>	leafy spurge	0.01
<i>Lepidium latifolium</i>	perennial pepperweed	7.51
<i>Lepidium perfoliatum</i>	clasping pepperweed	1.36
<i>Linaria dalmatica</i> *	Dalmatian toadflax	109.73
<i>Marrubium vulgare</i>	horehound	0.00
<i>Tamarix ramosissima</i>	tamarisk	15.15
<i>Thlaspi arvense</i>	field penny-cress	0.02
<i>Ulmus pumila</i>	Siberian elm	9.66
<i>Verbascum thapsus</i>	mullein	46.26
Total Vegetation Control		16.75
TOTAL		682.09

*Acreage figures only reflect work accomplished on national park land, not any of the work done on neighboring lands as part of park partnerships.

Gross acres of invasive plant species targeted for control at YHNM in 2014.

SPECIES	COMMON NAME	GROSS ACRES
<i>Acroptilon repens</i>	Russian knapweed	33.95
<i>Cardaria draba</i>	whitetop	30.95
<i>Carduus nutans</i>	musk thistle	16.77
<i>Marrubium vulgare</i>	horehound	4.88
<i>Tamarix ramosissima</i>	tamarisk	0.00
TOTAL		86.55

*Acreage figures exceed the total acreage of YHNM because the same acres could be treated for more than one target species, resulting in multiple counting.

Appendix D: Current Invasive Plant Control Priorities

Scientific Name	Common Name	Colorado Noxious Weed List	Park Treatment Priority
<i>Aegilops cylindrica</i>	jointed goatgrass	B List	Medium
<i>Acroptilon repens</i>	Russian knapweed	B List	High
<i>Agropyron cristatum</i>	crested wheatgrass	-	Medium
<i>Arctium minus</i>	burdock	C List	Medium
<i>Bassia scoparia</i>	kochia, Mexican fireweed	-	Medium
<i>Bromus inermis</i>	smooth brome	-	Medium
<i>Bromus tectorum</i>	cheatgrass	C List	Medium
<i>Cardaria draba</i>	whitetop, hoary cress	B List	High
<i>Carduus nutans</i>	musk thistle	B List	High
<i>Centaurea diffusa</i>	diffuse knapweed	B List	High
<i>Centaurea maculosa</i>	spotted knapweed	B List	High
<i>Cirsium arvense</i>	Canada thistle	B List	High
<i>Cirsium vulgare</i>	bull thistle	B List	High
<i>Cynoglossum officinale</i>	houndstongue	B List	High
<i>Elaeagnus angustifolia</i>	Russian olive	B List	High
<i>Euphorbia esula</i>	leafy spurge	B List	High
<i>Leucanthemum vulgare</i>	ox-eye daisy	B List	Eradicated
<i>Lepidium latifolium</i>	perennial pepperweed	B List	High
<i>Lepidium perfoliatum</i>	clasping pepperweed	-	High
<i>Linaria dalmatica</i>	Dalmatian toadflax	-	High
<i>Marrubium vulgare</i>	horehound	-	Medium
<i>Phalaris arundinacea</i>	reed canarygrass	-	Medium
<i>Rumex crispus</i>	curly dock	-	Medium
<i>Salsola</i> sp.	Russian thistle	-	Medium
<i>Salvia aethiopsis</i>	Mediterranean sage	A List	Eradicated
<i>Tamarix</i> sp.	tamarisk, salt cedar	B List	High
<i>Thinopyrum intermedium</i>	intermediate wheatgrass	-	Medium
<i>Thlaspi arvense</i>	field pennycress	-	High
<i>Ulmus pumila</i>	Siberian elm	-	High
<i>Verbascum thapsus</i>	common mullein	C List	High

Priorities for treating invasive alien species vary between the Colorado Department of Agriculture and MVNP/YHNM. The impacts that some invasive plant species have on agricultural and economic interests do not always intersect with the ecological impacts in national park lands.

It should be noted as well that several invasive plant species at MVNP and YHNM cause significant impacts but for which currently there is no viable or NPS-approved treatment in natural areas (such as field bindweed), so they are not listed on the park's table in this appendix but are on the

Colorado Noxious Weed List. Over 80 species of non-native plants have been recorded in MVNP and YHNM, not all of them are known to cause serious ecological harm (such as dandelion and yellow sweet clover), and thus they are not on any priority lists. See Appendix A3 for a more detailed discussion of invasive plant control prioritizing.

Whenever possible, the Colorado Department of Agriculture's noxious weed list will be used in setting priorities for invasive plant management efforts in MVNP and YHNM. Currently there are no known A Listed species growing in the park or monument, but if they are detected they would immediately elevated to top priorities including reporting and treatment with the objective of total eradication. MVNP and YHNM would report and treat any List B species subject to eradication in Montezuma County with the objective of total elimination and work to contain and suppress populations of other List B populations.

List A Species

List A species in Colorado that are designated by the Commissioner of the Colorado Department of Agriculture for eradication.

List B Species

List B weed species are species for which the Commissioner of the Colorado Department of Agriculture, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species.

List C Species

List C weed species are species for which the Commissioner of the Colorado Department of Agriculture, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands. The goal of such plans will not be to stop the continued spread of these species but to provide additional education, research, and biological control resources to jurisdictions that choose to require management of List C species.

Watch List Species

Watch List weed species that have been determined to pose a potential threat to the agricultural productivity and environmental values of the lands of the state. The Watch List is intended to serve advisory and educational purposes only. Its purpose is to encourage the identification and reporting of these species to the Commissioner of the Colorado Department of Agriculture in order to facilitate the collection of information to assist the Commissioner in determining which species should be designated as noxious weeds. Currently there are no known occurrences of Watch List Species in MVNP or YHNM.