

Appendix K

Exotic Plant Management Plan and Environmental Assessment/ Assessment of Effect for the Southeast Utah Group

Biological Assessment

National Park Service

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List of Abbreviations

AEF	Assessment of Effect
APHIS	Animal and Plant Health Inspection Service
ARCH	Arches National Park
ATV	All Terrain Vehicle
BA	Biological Assessment
BLM	Bureau of Land Management
CANY	Canyonlands National Park
CE	Categorical Exclusion
DO	Director's Order
EA	Environmental Assessment
ESA	Endangered Species Act
FWS	(United States) Fish and Wildlife Service
HOVE	Hovenweep National Monument
IPM	Integrated Pest Management
NABR	Natural Bridges National Monument
NEPA	National Environmental Policy Act
NPS	National Park Service
SEUG	Southeast Utah Group
USDA	United States Department of Agriculture

I. Introduction

The purpose of this biological assessment (BA) is to determine the likely effects of implementing the preferred alternative of Southeast Utah Group's (SEUG) proposed Exotic Plant Management Plan and Environmental Assessment/ Assessment of Effect (EPMP/EA/AEF) on 14 federally listed species (endangered, threatened, candidate, and proposed). Director's Order 12 (DO-12), the NPS guidance for Conservation Planning, Environmental Impact Analysis, and Decision-making, requires a National Environmental Policy Act (NEPA)-compliant program for exotic plants management. The objective of this plan is to provide coordinated, sound integrated weed management guidance to SEUG within the framework and requirements of DO-12 and the NEPA process.

Two alternatives are analyzed in the EA; the preferred alternative is analyzed in this Biological Assessment. The preferred alternative, which proposes to use mechanical, cultural, chemical, and biological controls considers the full range of appropriate IPM techniques available both now and in the future for proactive, adaptive integrated weed management. The other alternative analyzed in the plan's environmental assessment (EA) considers a course of action using the current limited range of available techniques and tools (i.e. no chemical or biological controls).

The preferred alternative's more comprehensive approach is expected to be more economical and successful in treating and preventing unacceptable levels of exotic plants, while posing the least hazard to people, property, and environment. The preferred alternative also most clearly meets the directive established in DO 77-7 that calls for "IPM procedures to be used to determine when to control pests and whether to use mechanical, physical, chemical, cultural, or biological means..." and allows the most flexibility and creativity in using available techniques to address invasive species infestations.

Section 7 of the Endangered Species Act of 1973, as amended, requires federal agencies to use their authorities to carry out programs to conserve endangered and threatened species, and to insure that actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of listed or proposed species, or result in the destruction or adverse modification of their critical habitats. A BA must be prepared for federal actions that are "major construction activities" (defined under NEPA as a project significantly affecting the quality of the human environment) to evaluate the potential effects of the proposal on listed or proposed species. The contents of the BA are at the discretion of the federal agency, and will depend on the nature of the federal action (50 CFR 402.12(f)). The species considered in this assessment/evaluation include:

Table 1. SPECIES CONSIDERED IN BIOLOGICAL ASSESSMENT

Common Name	Scientific Name	Status	Known/Suspected to be present?	Suitable Habitat present?	Determination of Effect for Preferred Alternative
Mexican spotted owl	<i>Strix occidentalis lucida</i>	Threatened	Yes	Yes	May effect-not likely to adversely effect
Southwestern willow flycatcher	<i>Empidonax traillii extimus</i>	Endangered	Yes	Yes	May effect-not likely to adversely effect
California condor	<i>Gymnogyps californianus</i>	Endangered	No	Yes	May effect-not likely to adversely effect
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	Candidate	Yes	Yes	Will not contribute to listing
Black-footed ferret	<i>Mustela nigripe</i>	Endangered	No	Yes	May effect-not likely to adversely effect
Colorado pikeminnow	<i>Ptychocheilus lucius</i>	Endangered	Yes	Yes	May effect-not likely to adversely effect
Razorback sucker	<i>Xyrauchen texanus</i>	Endangered	Yes	Yes	May effect-not likely to adversely effect
Humpback chub	<i>Gila cypha</i>	Endangered	Yes	Yes	May effect-not likely to adversely effect
Bonytail chub	<i>Gila elegans</i>	Endangered	Yes	Yes	May effect-not likely to adversely effect
Mancos milkvetch	<i>Astragalus humillimus</i>	Endangered	No	No	No effect
Jones cycladenia	<i>Cycladenia humillis var.jonesii</i>	Threatened	No	Yes	May effect-not likely to adversely effect
Navajo sedge	<i>Carex specuicola</i>	Threatened	No	No	No effect
Mesa Verde cactus	<i>Sclerocactus mesae-verde</i>	Threatened	No	No	No effect
Sleeping Ute milkvetch	<i>Astragalus tortipes</i>	Candidate	No	No	No effect

The National Park Service is developing direction in DO 77-8 to guide habitat management for Endangered Species. Preparation of a BA is part of the NEPA process ensures that Endangered Species receive full consideration in the decision-making process.

II. Description of the Proposal

Purpose and Need

The purpose of this EPMP EA/AEF is to use an integrated approach to eradicate, contain, control, and prevent targeted weeds within the park units of the SEUG. The desired goal is to contain or control the spread of exotic species, and eradicate species that are the most exotic and pose the greatest threat to the biological diversity within SEUG park units, and prevent any new weeds from becoming established. The resulting pro-active management of these plants will promote the ecosystem health of the park's diverse native communities by maintaining and improving native forbs and grass species, increasing the regeneration of native cottonwoods and willows in riparian corridors, and ultimately preventing the loss of wildlife habitat and species diversity.

Under DO-12, “purpose” is defined as a statement of goals and objectives that the NPS intends to fulfill by taking action. Under this definition, the objectives of this EPMP are to:

1. Restore native plant communities to reduce the need for ongoing exotic plant management.
2. Prevent unacceptable levels of exotic plant damage, using environmentally sound, cost effective management strategies that pose the least possible risk to people, park resources, and the environment.
3. Develop an EPMP/EA/AEF that provides the necessary environmental compliance for exotic plant management treatments at the four SEUG park units.
4. Standardize exotic plant management at parks so their actions can be more effectively implemented by park managers and explained to the public.

Under DO-12, “need” is described as an existing condition that should be changed, problems that should be remedied, decisions that should be made, and policies or mandates that should be implemented. Under this definition, the following needs have been identified for this project:

Existing conditions that should be changed:

- A comprehensive exotic plant management plan is needed to reduce the threat of exotic plants to these natural and cultural resources, including cultural landscapes, at the four park units of the SEUG.

Problems that should be remedied:

- An EPMP/EA/AEF is needed to achieve compliance with NEPA for future exotic plant management projects. Resource managers need access to more exotic plant management tools. This EPMP/EA/AEF will provide clearance for a number of treatment options, thus resource managers will be able to select and implement the most appropriate management approach in the future.

Decisions that should be made:

- A comprehensive evaluation of potential impacts associated with exotic plant management is needed to educate resource managers of the potential effects of various treatment methods. Resource managers also need standardized best management practices (BMPs) to mitigate potential impacts associated with management.
- Management activities need to be standardized among parks so that treatment methods can be more effectively implemented.
- A standardized decision-making process is needed so that management decisions can be easily communicated and justified to the public. A standardized process could also help park managers and their staff to educate the public about exotic plant management programs.

Policies or mandates that should be implemented:

- An EPMP/EA/AEF is needed to ensure that relevant policies and mandates are implemented.

III. Description of Action Area

The National Park Service (NPS) proposes to implement an Exotic Plant Management Plan (EPMP) for the park units of the Southeast Utah Group (SEUG) to control exotic or non-native plants in the four park units that comprise the SEUG. See Figure 1 for location of these units within Utah and Colorado. These park units include:

- 1) Arches National Park (ARCH)
- 2) Canyonlands National Park (CANY)
- 3) Hovenweep National Monument (HOVE)
- 4) Natural Bridges National Monument (NABR)

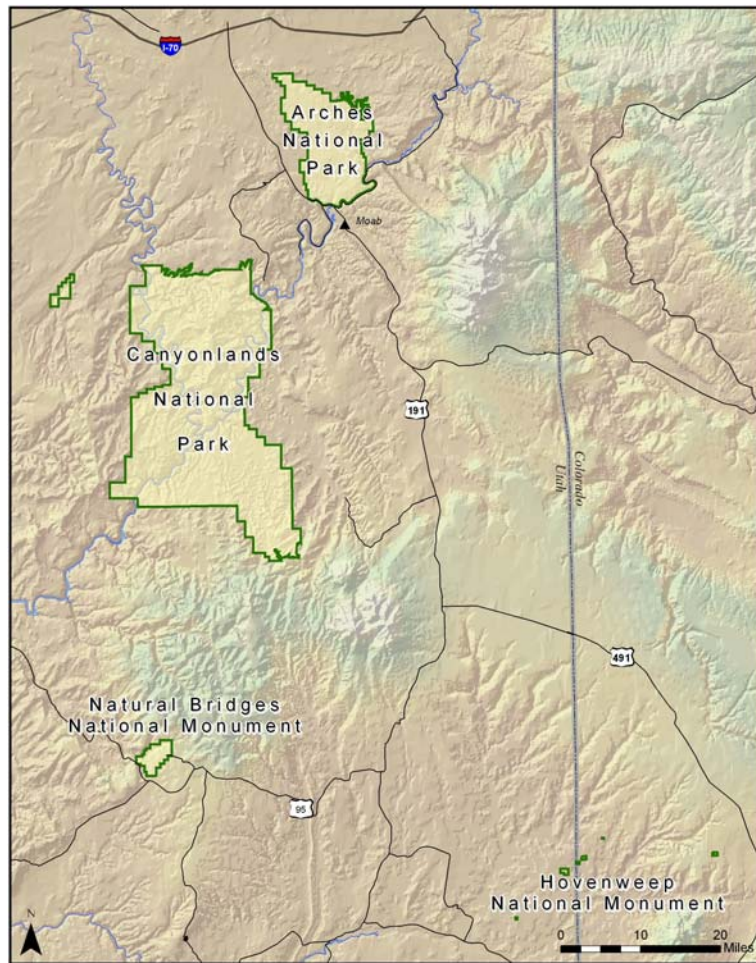


Figure 1. Location of the four park units of the Southeast Utah Group.

Out of the approximately 800 plant species found in the Southeast Utah Group parks, approximately 96 species are not native to this region. Experience in other parts of the country demonstrated that many exotic plants have the ability to eliminate all native plants within a given area in from 3-10 years (Sheley & Petroff 1999, Lesica & Shelley 1996, Tyser & Key 1988). Many exotic species can pose a serious threat to ecosystem diversity and have a high

potential to harm native plants and wildlife, especially threatened, endangered and sensitive species.

Tamarisk, Russian olive, Russian thistle, the knapweeds, cheatgrass, and perennial pepperweed have established in many sectors of the SEUG park units and are of particular concern because of their aggressiveness and ability to eventually eliminate many other native plants. These exotic weeds often alter physical environmental conditions and/or natural disturbance regimes that allow the exotic plants to spread further and form exclusive monocultures. It has been documented that exotic weeds can alter the following environmental conditions: soil temperature, soil salinity, water availability, nutrient cycles, nutrient availability, native seed germination, infiltration and runoff of precipitation, and fire severity and frequency (DiTomaso 2000, Sheley & Petroff 1999, Belnap 1995).

Other common weeds of less environmental consequence in the SEUG include African mustard, tumbling mustard, the pigweeds, lambsquarters, halogeton, white sweet clover, yellow sweet clover, storksbill, crested wheatgrass, redtop, red brome, and bur buttercup. The effects of weed populations on native plants include a decline in ecosystem diversity and health, increases in bare soil resulting in declines in watershed condition, a decrease in the overall capacity of the land to support wild ungulates, and a reduction in the quality of habitat for many wildlife species that require native plants for either cover or food (Trammell & Butler 1995).

There have been 96 exotic plant species found within SEUG (Moran 2008); these can be found in Appendix B. Twenty of these exotics are listed on the Utah and/or Colorado State Noxious Weed Lists. It is mandated by law (Utah Noxious Weed Act of 1989 and Colorado Noxious Weed Act of 1996) that, if found, these noxious plants must be controlled due to their destructive capabilities towards human, animal and natural ecosystem health. Other than these twenty species, SEUG also considers a number of other exotics harmful to the natural diversity and integrity of SEUG resources.

History of Exotic Species and their Management in SEUG parks

ARCH

Arches National Park has about fifty-three exotic plants. Controlling tamarisk (*Tamarix chinensis*) was the first exotic plant concern in Arches National Park. Evans and others (1981) evaluated control methods in the early 1980's. Thomas and others (1987) provided a brief description of tamarisk control work and plans for the future. Gary Salamacha, a ranger at Arches National Park, had actively pursued tamarisk control throughout the 1990's to 2007. He set up a permanent plant transect in one of his control sites in Salt Wash and collected data annually. Budelier and Torrence, past vegetation management specialists of the Southeast Utah Group, along with seasonal weed control staff including Joe Castello, have been actively controlling tamarisk and other exotic species such as cheatgrass (*Bromus tectorum*), Russian olive (*Elaeagnus angustifolia*), and Russian knapweed (*Centaurea repens*) since the late 1990's. They have mapped a number of populations using GPS technology, and use that as a method of monitoring exotic plant expansion.

In 2000, Schelz and Budelier compiled a list of exotic plants in the Southeast Utah Group, including Arches National Park. In the summers of 2003, 2004 and 2004, Utah State University conducted a three-year project to inventory and map invasive non-native plants for the National Park Service, Northern Colorado Plateau Network (NCPN). This report and an annual updated exotic plant species list are maintained on the NCPN website: <http://science.nature.nps.gov>.

Various authors have compiled plant lists for ARCH. I & M has the most up to date plant list on their website and is currently in the process of producing a more detailed vegetative map of ARCH.

CANY

Canyonlands National Park has about sixty exotic plants. Tamarisk (*Tamarix chinensis*), an exotic plant from Eurasia, has been the focus of much of the exotic plant control and monitoring work in CANY. Graf (1978) considered fluvial adjustments in the Green and Colorado Rivers and the spread of tamarisk. In his report he analyzed historic photos along the rivers and estimated that it spread at a rate of about 20 km/yr. He also estimated an average reduction in channel width of 27 percent, from sediments stabilized by tamarisk. Collins and Belnap (1987) discuss control and mapping efforts of tamarisk in Horseshoe Canyon. Schelz (1988) wrote a report on tamarisk control in Horseshoe Canyon. He set up five permanent transects and took a number of photos to monitor vegetation change. The technique was a line-intersect method that ran perpendicular to the stream channel.

Steve Budelier, a vegetation specialist for the NPS Southeast Utah Group from 1997 to 2000, and Ian Torrence, his replacement since 2001, have been involved with exotic plant mapping and control. Their mapping work is primarily GPS-based (Geographic Positioning System) and products can be found in the Geographic Information Systems (GIS) office at Southeast Utah Group Headquarters in Moab, Utah. In 2000, Schelz and Budelier compiled a list of exotic plants in the Southeast Utah Group, including Canyonlands National Park. In the summers of 2003 and 2004, Utah State University conducted a two-year project to inventory and map invasive non-native plants for the National Park Service, Northern Colorado Plateau Network (NCPN). This report and an annual updated exotic plant species list are maintained on the NCPN website: <http://science.nature.nps.gov>.

A number of studies have looked at various control methods and soil-plant interactions of exotics in Canyonlands (Graham 1985, Thomas et al. 1987, Kunzmann et al. 1989, Rawlings 1996, Sperry et al. 1998, 1999, 2000, Gelbard 1999, Miller and Belnap 1999, 2000, and Belnap et al. 2001). None of these studies have developed long-term monitoring plots.

Tamarisk (*Tamarix chinensis*) is the largest problem along the river and smaller riparian areas, accompanied by Russian olive (*Eleagnus angustifolia*), Russian knapweed (*Centaurea repens*), and Perennial pepperweed (*Lepidium latifolium*). Cheatgrass (*Bromus tectorum*) is problematic throughout the park.

Various authors have compiled plant lists for CANY. I & M has the most up to date plant list on their website and is currently in the process of completing a much more detailed vegetation map of CANY than that which is now available.

HOVE

There are twenty-seven exotic plant species known to occur within Hovenweep National Monument (NPS 2000d). Agricultural lands surround the monument and the exotic plant source is high and constant. Tamarisk has been found in some canyon bottoms in all the units except Cajon. It has been controlled through mechanical cutting and herbicide but the program must remain vigilant because of the constant seed source from surrounding lands. In the summers of 2003 through 2005, Utah State University conducted a three-year project to inventory and map invasive non-native plants for the National Park Service, Northern Colorado Plateau Network (NCPN). This report and an annual updated exotic plant species list are maintained on the NCPN website: <http://science.nature.nps.gov>.

NABR

There are forty-two known species of non-native plants within Natural Bridges National Monument (NPS 2008). Tamarisk has been the focus of most of the Monument's weed control efforts, with the result that the species was mostly eliminated from the Monument (Gilbert and Hendrickx 1977, Thomas et al. 1987, Kunzmann 1989). In the 1990's, park ranger Jim Dougan actively pursued tamarisk and eliminated it from the park through the use of mechanical cutting and herbicide. He did not map locations.

Even with these earlier efforts, tamarisk has resprouted and is again the main exotic plant species in terms of area occupied (Dewey and Andersen 2005). In the summers of 2003 through 2005, Utah State University conducted a three-year project to inventory and map invasive non-native plants for the National Park Service, Northern Colorado Plateau Network (NCPN). This report and an annual updated exotic plant species list are maintained on the NCPN website: <http://science.nature.nps.gov>. In 2008 SEUG Resource Management staff began efforts to treat tamarisk resprouts in the canyons.

IV. Description of Proposed Treatments

Please refer to Appendix A for a list of exotic plants for both Colorado and Utah.

Alternatives were framed through discussions among the SEUG park staff with assistance from Intermountain Region Planning and Environmental Quality personnel. The alternatives cover the range of what is physically possible, acceptable by policy, and feasible for local managers; i.e. all reasonable alternatives. Criteria used in the selection of reasonable alternatives include:

- Potential for protecting the park's natural and cultural resources,
- Effectiveness, efficiency, and economy of eradicating or controlling exotic plant infestations
- Ability to ensure human safety

Two reasonable alternatives, or those alternatives that are economically and technically feasible, were then identified. Under both alternatives, this plan considers all treatment methods that are currently being implemented by SEUG park units, or that may be used in the foreseeable future. Proposed treatments include:

a. Cultural Treatments

Cultural treatments are practices that promote the growth of desirable plants and reduce the opportunities for exotic plants to grow. Examples include irrigation and seeding of native plant species. Cultural treatment methods involve manipulating treatment areas to present exotic plants with effective native competitors. Examples of cultural treatments that are implemented by the parks include:

- Prevention
- Reseeding and Planting
- Irrigation

Prevention

Preventing establishment is an economical way to manage exotic plants. Under the preferred alternative, the following prevention actions could be implemented:

- Any feed, forage, mulch, fill, gravel, and other like materials brought into a park should be certified free of exotic plant seed (“certified weed-free”). Certified weed-free hay is often smooth brome, crested wheat grass, and alfalfa, which are not native to this country. While certified weed-free hay may include exotics, it may be the best option available. However, parks will encourage the use of hay composed only of native forage. Weed-free hay that does not include exotic plants should be readily available.
- Sources of “clean fill” (weed-free) will be used, where available, if construction fill will be obtained from within parks. If not feasible, fill not designated as “clean fill” may be used but should be closely monitored for exotic plant growth. Construction equipment will otherwise avoid exotic plant infestations, to the extent feasible.
- Brush horses and pack animals thoroughly and have their hooves cleaned before entering a park.
- Feed horses and pack animals only food that is “certified weed free” starting 96 hours before entering a park.
- Any seed or plant materials used for restoration efforts within a park should be “certified weed-free”.
- Require inspections and cleaning of contractors’ and fire fighters’ equipment, vehicles, and materials to prevent importation of nonnative plant seed or materials into a park.
- Require commercial users that disturb established vegetation to provide bonds that are retained until sites are returned to a specified condition.
- Develop BMPs to limit the amount and impact of ground-disturbing activities.
- Train park staff and volunteers on how to identify priority exotic plants. Park employees and volunteers should report any observations of exotic plants to

the resource manager immediately. A phone number for the point of contact could be provided to staff and volunteers.

- Develop information for the public and park staff on exotic plants. This information may include signs, interpretive displays, brochures, and programs.

Reseeding and Planting

Reseeding is used to encourage the re-establishment of native plants and to prevent the establishment of exotic plants. Native shrubs or trees can also be replanted after exotic shrubs and trees are removed to help restore habitat structure. Unless native plants are reestablished, the removal of one exotic plant may result in the establishment of another undesirable exotic plant. Reseeding will not be required in areas where native plant diversity is good within and surrounding treated infestations of exotics.

Under the preferred alternative, any planned in-park development or disturbance activities should be required to include sufficient time for plant salvage to be completed prior to disturbance. Any areas that are disturbed could be reseeded as soon as possible to facilitate the reestablishment of native plants. Restoration may also be necessary in dense infestation areas that no longer support native species or where viability of native species seed banks has been exhausted. Following treatment and removal of exotic plants, these areas will be reseeded using native plant materials. Any materials used in re-vegetation (including mulch and organic fertilizers) could be free of non-native plant seeds or materials. In addition, locally grown, native plant materials could be used where possible. All plant materials used could be “certified weed-free.”

Irrigation

Irrigation may be used on a limited basis to help native vegetation become established during dry periods. However, no surface water depletions or accretions related to irrigation could occur under the preferred alternative. Because much of the SEUG area has been in a drought over the last several years, any projects that involve planting native shrubs or trees should also consider whether there could be adequate water to facilitate vegetation establishment. If drought conditions are forecasted, resource managers should delay the purchase and planting of shrubs to avoid the need for irrigation. Resource managers should also confirm that there is water available for irrigation should the need arise.

b. Manual/Mechanical Treatments

Manual and mechanical treatments involve physical damage to or removal of part or all of the plant. Hand pulling is the primary manual treatment method. Mechanical treatments involve the use of tools to remove or physically damage exotic plants. Examples of mechanical treatments include using hand cutting (shovels and clippers), pulling tools (such as weed wrenches™) and power tools (such as weed whips or chainsaws). Any manual and mechanical methods are highly selective for individual plants. Both manual and mechanical treatments are used to treat individual plants or specific treatment areas. Manual or mechanical treatments may need to be performed several times during a season and are often used in concert with other treatment methods. For example, manual or mechanical treatments

may be followed by application of herbicides or prescribed fire to treat re-sprouts and new seedlings.

Manual treatment can be used in any area. It is most effective for pulling shallow-rooted species. Manual pulling of deep-rooted species may require repeated treatment to effectively deplete the root system. Portions of roots can break off, remain in the soil, and regenerate. Hand pulling is conducted by removing as much of the root as possible while minimizing soil disturbance.

Types of mechanical treatment currently used include using hand cutting tools, pulling tools, and power tools. Hand cutting tools are a treatment option for removing the aboveground portions of annual or biennial plants. Use of hand tools, such as trowels, shovels, and Pulaskis are simple forms of mechanical treatments. These tools are used to remove a larger portion of the root system or to sever the plant's taproot below the point where nutrients are stored. Efforts are made to collect viable seeds from plants that are cut, or to cut plants when seeds are not viable. Pulling tools are a treatment option for removing individual plants that are deep-rooted. Pulling tools are used to control small infestations, such as when an exotic plant is first identified in an area. These tools grip the weed stem and remove the root by providing leverage. Pulling tools are most effective on firm ground rather than soft, sandy, or muddy substrate (Tu et al. 2001).

Power tools, such as chainsaws, are used to treat small to large infestations. Weed whips are used at small sites or sites that are inaccessible or are too rocky to be mowed. Power tools remove aboveground biomass, reduce seed production, and reduce plant growth. Power tools are useful for controlling annual plants before they set seed. Power tools are also used along with other treatments, such as chemicals or prescribed fire, to treat perennial exotic plants.

c. Chemical Treatments

Using chemical treatments consists of applying herbicides as prescribed by their labels, using a variety of application methods. The primary application method use by SEUG parks is hand spraying or direct application using a small paint brush. Herbicides are most effective for treating pure stands of a single exotic plant species in areas where desirable plants are scarce or absent. Herbicides can also be used to treat small patches of exotic plants where hand pulling or cutting is not feasible (Colorado Natural Areas Program [CNAP] 2000:50). Parks are currently using a number of herbicides to treat exotic plants. Examples of application methods include portable sprayers, vehicles equipped with sprayers, and aerial application (helicopter and fixed wing).

If chemicals could be used, the resource manager must confirm that these treatments are justified and compliant with NPS policies using this decision tool. According to the NPS Management Policies (2006:48), a designated IPM specialist must first determine that the use of a chemical is necessary. In addition, all other treatment options considered must be either not acceptable or not feasible. If the use of chemical has not been determined necessary, or if there are other treatment options that are acceptable or feasible, the resource manager returns to the Optimum Tool Analysis to consider these treatments further.

In accordance with NPS-77 (NPS 1991), only those herbicides that are registered by the USEPA can be used. Herbicides must also be used in accordance with product labels. Some herbicides have use restrictions that prohibit their use under certain conditions. Herbicides having use restrictions could only be used for sites that meet the conditions specified on the product label. If the herbicide is registered, and if there are no existing site conditions that could restrict its use, the next step is to submit a herbicide use request to the Regional and/or National IPM Coordinator. In general, herbicide use proposals from parks are submitted to the Regional IPM Coordinator, who is responsible for soliciting input from the National IPM Coordinator for cases where the Regional Coordinator does not have approval authority. Herbicide use requests that involve any of the following actions must be approved by a National IPM Coordinator (NPS 1991):

- Aquatic applications or situations in which the applied herbicide could reasonably be expected to get into waters or wetlands;
- Applications that may affect rare, threatened, or endangered species or associated critical habitat;
- The use of restricted-use herbicides as defined by the USEPA;
- Treatment areas are equal to or larger than four sections of land.

Under the preferred alternative, herbicides could be applied a number of different ways. In most instances brushes or portable sprayers will be used, other possible methods include All-Terrain Vehicles (ATVs) equipped with sprayers, and aerial application (helicopter and fixed wing). Portable spot or wick applicators can be used to apply an herbicide directly onto a target plant. Power sprayers are portable, pressurized sprayers that can be used to treat small application areas. ATVs or helicopters can be equipped with either a boom or boomless applicator to rapidly treat large areas. A boom applicator is a long horizontal tube that is equipped with multiple spray heads. A boomless sprayer is designed to provide a full left to right hand spray pattern from a centrally mounted nozzle. An ATV can be mounted with two nozzles directly behind the ATV that can spray 15 feet in each direction. The boom is carried above the exotic plants, while spraying the herbicide. Spray mechanisms are equipped with flow regulators that control application rates. In the SEUG, a common application method for treating trees and shrubs is the “cut stump method.” The tree or shrub is cut near the base of the trunk, and herbicides are sprayed or painted directly onto the cut stump.

Aerial application of herbicides could only be conducted for sites that meet one of the following criteria:

- The infestation covers a large area and could be most effectively treated from the air. There is no acre limit for using aerial application, however aerial application sites are typically over 20 acres and have fairly dense exotic plant coverage.
- The infestation covers a small area but can be successfully treated using a microfoil boom or similar apparatus that allows for a limited band of spray. A microfoil boom can be used to spray widths as small as 12 feet, effectively treating small infestations. Microfoil booms are designed specifically to minimize herbicide drift.

- The infestation is very remote and treatment using other application methods could require an inordinate amount of time for crews to arrive and apply ground treatment.
- The infestation is located on rough, steep terrain that prevents ground application and is too dangerous for employees on foot.

Under the preferred alternative, the use of herbicides could be considered only after alternative manual/mechanical, cultural, or biological control treatment methods have been ruled out using the Optimum Tool Analysis (Appendix B). Under some circumstances, herbicides may be the only feasible option for treating an exotic plant. Herbicides selected for treatment could be known to be effective on the target exotic plant and known to have a minimal effect on the environment. To minimize potential environmental effects, herbicides could be selected based on the presence of non-target plants (including sensitive, traditional use plants), soil texture, depth and distance to water, and environmental conditions.

Under the preferred alternative, resource managers may use the Relative Aquifer Vulnerability Evaluation (RAVE) system to assess the potential risk for ground water contamination resulting from the use of herbicides. Use of the RAVE model or other appropriate model is encouraged in areas where leaching to ground water is possible. RAVE is a numeric scoring system that is relatively simple to use, and allows resource managers to quantitatively evaluate the potential for an herbicide to contaminate ground water. The RAVE system can also be used for insecticides, fungicides, and rodenticides. However, only herbicides could be used under the preferred alternative.

The RAVE system includes a model that addresses irrigation systems developed by Montana State University (MSU 1990) and one that addresses natural precipitation systems developed by the Forest Service (USFS 1992). The original RAVE system, titled “RAVE: Relative Aquifer Vulnerability Evaluation,” was developed by the MSU Extension Service (MSU 1990). This system was developed for farming situations that use irrigation. Under the EPMP/EA/AEF, the original RAVE system could be used for situations where parks irrigate areas that are also chemically treated. The Forest Service has modified this original RAVE system so it can also be used for non-irrigated areas that only receive natural precipitation. This version of the RAVE system is titled RAVE: Relative Aquifer Vulnerability Evaluation (as adapted from Montana Department of Agriculture and Environmental Management Division) (USFS 1992). This version of RAVE could be used by parks for those areas that only receive natural precipitation and do not receive supplemental irrigation.

To determine the potential for ground water contamination, the RAVE system considers several factors: irrigation practice, depth to ground water, distance to surface water, percent organic matter, herbicide application frequency, herbicide application method, herbicide leachability, and topographic position. Values are assigned to each of these factors and then totaled. The total value is then compared to a “scorecard interpretation scale” to determine the potential for ground water contamination by an individual herbicide. Higher scores indicate a higher vulnerability of ground water to herbicide application. If an herbicide is determined to have a high potential for ground water contamination, an alternative herbicide or alternative application method is selected and results are compared. The alternative that has the lowest

potential for ground water contamination and that has an acceptable score is then selected. Approval by the Regional IPM Coordinator is also required. In some cases, herbicide soil mobility data are available which has enabled the establishment of herbicide-specific buffer zones. In such cases, these data could be used instead of the RAVE model, as it is based on research data rather than modeling.

Only those herbicides that have been registered by the US EPA could be used under the preferred alternative. When considering the use of a chemical treatment, the resource management specialist could confirm that its use is necessary and that all other treatment options are either not acceptable or not feasible. The resource manager should also confirm that use of the selected herbicide is appropriate for the site and that it has the potential to be effective on the target species. Taking these extra steps could help to ensure that the most appropriate and cost-effective herbicide is selected.

Herbicides are classified according to their mode of action, which is determined by the active ingredients. Active ingredients that may be used under the preferred alternative are summarized in Table 2. Common trade names are provided in parentheses after the active ingredient. This is not a comprehensive list of trade names, and under the EPMP/EA/AEF, any registered herbicide trade name that contain the active ingredients listed in Table 2 may be used. Herbicides containing active ingredients that are not listed on Table 2 may also be used under the EPMP/EA/AEF. However, the use of any herbicide must meet all conditions outlined in this document and must also be approved by the Regional or National IPM Coordinator.

An adjuvant is a substance added to an herbicide to aid its action, but has no herbicide action by itself. Some herbicides require the addition of an adjuvant to work effectively. Surfactants are adjuvants used in conjunction with herbicides to increase absorption. A surfactant is a surface active ingredient that lowers surface tension of the solvent in which it is dissolved or the tension between two immiscible liquids. Safety procedures and MSDS's must be kept on site for all adjuvants used under the EPMP/EA/AEF.

Table 2. SUMMARY OF ACTIVE INGREDIENTS FOR PROPOSED HERBICIDES

Active Ingredients	Registered Use	Target Plants	Mode of Action	Method of Application
Aminopyralid (Milestone)	General Use	Annual, biennial and perennial broadleaf weeds and woody plants.	Translocates throughout the entire plant and accumulating in meristematic tissues, including the roots. It disrupts plant growth metabolic pathways affecting the growth process of the plant.	Aerial spraying, spraying from a truck, backpack or handheld sprayer, foliar spray, spot treatments.
Clopyralid (Curtail, Transline, Reclaim, Lontrel, Redeem)	General Use	Annual and perennial broadleaf herbs, especially knapweeds, thistles, and other members of the	Absorbed by the leaves and roots of the exotic plant and moves rapidly through the plant. It affects plant cell respiration and growth.	Aerial spraying, spraying from ground equipment.

Active Ingredients	Registered Use	Target Plants	Mode of Action	Method of Application
		sunflower, legume, and knotweed families		
Glyphosate Products (Roundup Pro, Roundup Ultra, Rodeo, GlyPro, Accord, Glyphomax, Touchdown)	General Use	Grasses, herbaceous plants including deep rooted perennial exotic plants, brush, some broadleaf trees and shrubs, and some conifers. Does not control all broadleaf woody plants.	Absorbed by leaves and rapidly moves through the plant. It acts by preventing the plant from producing an essential amino acid. This reduces the production of protein in the plant, and inhibits plant growth.	Aerial spraying, spraying from a truck, backpack or handheld sprayer, wipe application, frill treatment, cut stump treatment.
Imazapic (Plateau, Cadre, Plateau Eco-Paks)	General Use	Annual and perennial broadleaves and grasses	Inhibits the production of some amino acids, which are necessary for protein synthesis and growth.	Aerial spraying, spraying from ground equipment or a handgun sprayer.
Imazapyr (Arsenal, Habitat)	General Use	Annual and perennial grass, broad-leaved weeds, brush, vines, and deciduous trees.	Absorbed by leaves and roots, moves rapidly through plants. Disrupts photosynthesis and interferes with cell growth and DNA synthesis.	Ground or aerial foliage spray, basal bark and stem treatment, cut stump treatment, tree injection.
Picloram (Tordon, Grazon PC, Tordon K, Tordon 22K)	Restricted Use*	Broadleaf herbs, vines, and woody plants (especially leafy spurge).	Absorbed through plant roots, leaves and bark. It moves both up and down within the plant, and accumulates in new growth. It acts by interfering with the plant's ability to make proteins and nucleic acids.	Broadcast or spot treatment as foliar (leaf) or soil spray, basal spot treatment, tree injection, frill treatment, stump treatment, basal bark treatment, low volume dormant stem spray, by air as broadcast or low volume dormant spray.
Triclopyr (Garlon products)	General Use	Woody plants and broadleaf plants.	Disturbs plant growth. It is absorbed by green bark, leaves and roots and moves throughout the plant. Accumulates in the meristem (growth region) of the plant.	Ground or aerial foliage spray, basal bark and stem treatment, cut surface treatment, tree injection.

* All formulations that may be broadcast on soil or foliage are classified as “restricted use” herbicides. Sale and use of these herbicides are limited to licensed herbicide applicators or their employees, and only for uses covered by the applicator's certification. The restricted use classification is due to picloram's mobility in water, combined with the extreme sensitivity of many important crop plants to damage.

Each herbicide varies in terms of its chemical and biological behavior in the environment. Factors that affect herbicide behavior in the environment include herbicide properties, soil characteristics, and climatic conditions. Factors that influence the behavior of herbicides in

the environment are summarized below. This summary is based on information provided by Miller and Westra (1998) in “*Colorado State University Fact Sheet: Herbicide Behavior in Soils*”. Acid or base strength - refers to whether a herbicide has basic, acidic, or non-ionizable properties. This factor determines the ability of a herbicide to exist in soil water or be retained onto soil solids. In general, herbicides whose pH is close to the pH of soil are strongly retained and are not subject to runoff, erosion, and/or leaching. In contrast, herbicides whose pH is not close to that of the soil are less strongly retained and are subject to runoff, erosion, and/or leaching. These herbicides are also more available for plant uptake than those herbicides that are strongly retained onto soil solids.

- Water solubility - refers to how readily an herbicide dissolves in water and determines the extent to which an herbicide is in the solution (water) phase or the solid phase. An herbicide that is water soluble generally is not retained by soil.
- Volatility - refers to the tendency of an herbicide molecule to become a vapor. Herbicides with high vapor pressures are likely to escape from the soil and volatilize in the atmosphere.
- Soil retention - is an index of the binding capacity of the herbicide molecule to soil organic matter and clay. In general, herbicides with high soil retention are strongly bound to soil and are not subject to leaching. Those not exhibiting high soil retention are not strongly bound and are subject to leaching.
- Soil persistence - refers the longevity of an herbicide molecule, typically expressed in terms of a half-life, as determined under normal conditions in the region where the herbicide could be used.

These factors influence the environmental fate and effects of an herbicide, including its residual soil activity, persistence, volatilization, water solubility, and potential for leaching into ground water. Table 3 summarizes potential environmental fate and effects of herbicides that may be used under the preferred alternative.

Once an herbicide has been selected, the resource manager could submit an herbicide use request using the Intranet-based IPM System. In general, the Regional IPM Coordinator could be responsible for reviewing and approving proposed herbicide uses. However, review and approval from a National IPM Coordinator could be required for herbicide uses that involve: aquatic applications or situations in which the applied herbicide could reasonably be expected to get into waters or wetlands; herbicide uses that may affect rare, threatened, or endangered species or associated critical habitat; herbicide use involving aerial application; herbicide use on 400 or more contiguous acres, use of a restricted-use herbicide as defined by the USEPA could be used. The only restricted use herbicide currently being used by parks is picloram. All formulations that contain picloram and that may be broadcast on soil or foliage are classified as “Restricted Use” herbicides. Sale and use of these herbicides are limited to licensed herbicide applicators or their employees, and only for uses covered by the applicator's certification. A National IPM Coordinator must approve the use of picloram prior to its purchase and use.

Table 3. PROPOSED HERBICIDES AND THEIR ENVIRONMENTAL FATE AND EFFECTS.

Active Ingredient	Persistence in Soil	Residual Soil Activity	Volatilization and Potential By-Products from Burning	Solubility	Potential for Leaching	Surface Waters	Toxicity
Aminopyralid (Milestone)	Half-life can range from 32-533 days with a typical time of 103 days.	Soil microorganisms and sunlight break down aminopyralid	No information is available on potential by-products from burning.	Not available	Moderate potential to leach through soils and contaminate groundwater.	Reduced run-off potential because of its low use rate. Surface water breakdown in less than 24 hours.	Soil microorganisms - no information is available. Plants - Contact with non-target plants may injure or kill plants especially leguminous trees. Aquatic animals -Practically non-toxic to slightly toxic to aquatic invertebrates. Practically non-toxic to fish. Terrestrial animals - Practically non-toxic to mammals and birds Human health -EPA toxicity level IV. Classified as “not likely” to be carcinogenic to humans.
Clopyralid (Curtail, Transline, Reclaim, Lontrel, Redeem)	May be present in anaerobic soils or soils with low microorganisms. Half-life is 15-287 days.	Active in soil, is usually absorbed from soil by plants. Soil microorganisms break down Clopyralid.	Does not evaporate easily. No information is available on potential by-products from burning.	Highly soluble in water.	Because clopyralid is highly soluble in water, does not absorb to soil particles, and is not readily decomposed in soils, it may leach into ground water. Ground water may be contaminated if clopyralid is applied to areas where soils are very permeable and water table is shallow.	Because clopyralid is highly soluble in water, there is potential for surface waters to be contaminated if clopyralid is applied directly to bodies of water or wetlands.	Soil microorganisms - no information is available. Plants - contact with non-target plants may injure or kill plants. Aquatic animals - low toxicity to fish and aquatic invertebrate animals. Clopyralid does not bio-accumulate in fat tissues. Terrestrial animals - low toxicity to birds and mammals. Not toxic to bees. Human Health - EPA Toxicity level IV. This herbicide 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, so properly fitted goggles are mandatory for applicators.
Glyphosate Products (Roundup Pro, Roundup Ultra, Rodeo, GlyPro, Accord, Glyphomax, Touchdown)	Half-life can range from 3 to 130 days. Soil microorganisms break down glyphosate. Surfactant in Roundup has a half-life of less than 1 week.	Generally not active in soil. It is not usually absorbed from the soil by plants.	Does not evaporate easily. Major products from burning treated vegetation include phosphorus pentoxide, acetonitrile, carbon dioxide, and water. None of these compounds is known to be a health threat at levels that could be found in a vegetation	Dis-solves easily in water.	The potential for leaching is low. Glyphosate and the surfactant in Roundup are strongly absorbed by soil particles. Half-life for glyphosate in water ranges from 35 to 65 days. The surfactant half-life ranges from 3 to 4 weeks.	Very low concentrations of glyphosate have been observed in surface water following heavy rains, up to 3 weeks after application.	Soil microorganisms - Glyphosate and the surfactant have no known effects on soil microorganisms. Plants - Contact with non-target plants may injure or kill plants. Aquatic animals - Glyphosate is no more than slightly toxic to fish, and practically non-toxic to aquatic invertebrate animals. It does not bio-accumulate in fish. The Accord and Rodeo formulations are practically nontoxic to freshwater fish and aquatic invertebrate animals. The Roundup formulation is moderately to slightly toxic to freshwater fish and aquatic invertebrate animals.

Active Ingredient	Persistence in Soil	Residual Soil Activity	Volatilization and Potential By-Products from Burning	Solubility	Potential for Leaching	Surface Waters	Toxicity
			fire.				Terrestrial animals - Glyphosate is practically nontoxic to birds and mammals. It is practically non-toxic to bees. Human Health - EPA Toxicity level IV. Glyphosate is not classified as a carcinogen, teratogen, mutagen, or reproductive inhibitor. Most reports impacts to humans have involved skin or eye irritation while mixing and loading.
Imazapic (Plateau, Cadre, Plateau Eco-Paks)	Half-life can range from 120- 140 days. It binds weakly to moderately with most soil types. Adsorption increases with decreasing soil pH and increase-ing clay and organic matter.	Moderately persistent.	Does not volatilize from the soil surface and photolytic break down on soils is negligible.	Soluble, but not degraded in water.	Has not been found to move laterally with surface water. Breaks down rapidly in aqueous solution, with a half-life of 1 or 2 days. Has limited horizontal mobility (6 to 12 inches; up to 18 in sandy soils).	Is rapidly degraded by sunlight in aqueous solution, but is not registered for use in aquatic systems.	Soil microorganisms - no information is available. Plants – contact with non-target plants may injure or kill plants. Aquatic animals - moderately toxic to fish. Terrestrial animals – low toxicity to birds and mammals. Does not bio-accumulate in animals, and is rapidly excreted in urine and feces. Human Health - EPA Toxicity level IV. Imazapic is not classified as a carcinogen, teratogen, mutagen, or reproductive inhibitor. If ingested, imazapic is rapidly excreted in the urine and feces and does not bioaccumulate.
Imazapyr (Arsenal, Habitat)	May be broken down by exposure to sun-light. Soil micro-organisms contribute to breakdown of imazapyr.	Imazapyr can remain active in soil for 6 months to 2 years.	Does not evaporate easily.	Soluble in water.	Imazapyr has a low potential for leaching to ground water.	Imazapyr may move from treated areas to streams. Most movement of imazapyr was found in runoff from storms. Use of a stream-side management zone can significantly reduce the amount of off-site movement in stream-flow. Half-life in water is about 4 days.	Soil microorganisms - has very little effect on soil microorganisms. Plants - non-toxic to conifers, but is toxic to many other non-target plants. Aquatic animals - Imazapyr and its formulations are low in toxicity to invertebrates and practically non-toxic to fish. Imazapyr is not expected to build up in aquatic animals. Terrestrial animals - practically non-toxic to mammals and birds. It is of low toxicity to bees. Imazapyr is rapidly excreted by animals. Human Health - EPA Toxicity level III. Triclopyr does not cause birth defects or cancer, and has little or no effect on fertility or reproduction. The exposure levels a person could receive from routine operations are below the levels shown to cause harmful effects in laboratory studies. If ingested, imazapyr is rapidly excreted in the urine and feces and does not bioaccumulate.
Picloram (Tordon, Grazon)	Long-term build up of picloram in	Picloram can stay active in soil for a	Does not evaporate easily. Burning	Dissolves readily in	Picloram can leach into ground water under	Picloram can be carried by surface	Soil microorganisms - Picloram has very low toxicity to soil microorganisms at up to 1,000

Active Ingredient	Persistence in Soil	Residual Soil Activity	Volatilization and Potential By-Products from Burning	Solubility	Potential for Leaching	Surface Waters	Toxicity
PC, Tordon K, Tordon 22K)	soil generally does not occur. Sunlight and microorganisms in the soil break down picloram. Alkaline conditions, fine textured clays, and low densities of plant roots can increase the persistence of picloram.	moderately long time, depending on soil, soil moisture, and temperature. It may exist at levels that are toxic to plants more than a year after application.	destroys more than 95% of picloram residue.	water.	certain conditions. Picloram leaches more easily in soils that have low organic content or are very sandy. Picloram movement is greatest for soils with low organic matter, alkaline soils, and soils that are highly permeable. Where the water table is very low, picloram may leach into ground water. Picloram should not be applied to any surface that could allow for direct pollution of ground water.	run-off water. To prevent water pollution, picloram spray drift or runoff should not be allowed to fall onto banks or bottoms of irrigation ditches, or water intended for drinking or house-hold use. Picloram should not be directly applied to wetlands.	parts per million (ppm). Plants - Picloram is highly toxic to many non-target plants. Most grasses are resistant to picloram. Aquatic animals - Picloram is moderately to slightly toxic to freshwater fish, and slightly toxic to aquatic invertebrate animals. It does not bio-accumulate in fish. The formulated product is generally less toxic than picloram. Terrestrial animals - Picloram is almost non-toxic to birds. It is relatively non-toxic to bees. Picloram is low in toxicity to mammals, and animals excrete picloram in urine unchanged. Human Health - EPA Toxicity level III. Exposure is primarily through inhalation and dermal sensitization. The exposure levels a person could receive from routine operations are below the levels shown to cause harmful effects in laboratory studies.
Triclopyr (Garlon products)	Microorganisms degrade triclopyr rapidly. The average half-life in soil is 46 days.	Triclopyr is active in soil and is absorbed by plant roots.	Very low potential for volatilization. No information is currently available on potential for byproducts from burning of treated vegetation.	Moderate to low.	The potential for leaching depends on soil type, acidity, and rainfall conditions. Triclopyr should not be a leaching problem under normal conditions since it binds to clay and organic matter in soil. Triclopyr may leach from light soils if rainfall is very heavy.	Sunlight rapidly breaks down triclopyr in water. The half-life in water is less than 24 hours. Irrigation ditches or waters used for irrigation or domestic use should not be polluted by triclopyr.	Soil microorganisms - slightly to practically non-toxic to soil microorganisms. Plants - Triclopyr is toxic to many plants. Even very small amounts may injure some plants. Aquatic animals - Triclopyr is low in toxicity to fish. The ester form of triclopyr, found in Garlon 4, is more toxic, but in normal conditions, it rapidly breaks down to a less toxic form. Does not bio-accumulate in fish. Triclopyr is slightly toxic to practically non-toxic to aquatic invertebrates. Terrestrial animals - Triclopyr is slightly toxic to mammals. In mammals, most triclopyr is excreted, unchanged, in urine. Triclopyr and its formulations have very low toxicity to birds. Triclopyr is non-toxic to bees. Human Health - EPA Toxicity level III. Triclopyr does not cause birth defects or cancer, and has little or no effect on fertility or reproduction. The exposure levels a person could receive from routine operations are below the levels shown to cause harmful effects in laboratory studies.

Director's Order-77-7 (DO 77-7) (in preparation) requires herbicide use request approval by a National IPM Coordinator for aerial application of herbicides. DO 77-7 also require approval by a National IPM Coordinator for application of 400 contiguous acres. This differs from current NPS-77 requirements, which requires National IPM Coordinator review of any treatments equal to or larger than four sections of land. Although the size limit of four acres proposed under DO-77 has not been finalized, it is being used by the NPS as the acreage above which approval from the National IPM Coordinator is required.

The Regional IPM Coordinator may approve other herbicide use requests that do not fall into these categories. Once the herbicide use request has been approved, the resource manager may then purchase herbicides. However, according to NPS policy, no herbicides may be purchased unless they could be used within one year from the date of purchase (NPS 2006:48).

d. Biological Treatments

Biological treatments are commonly referred to as biological control, or bio-control. Biological treatments involve the use of "natural enemies" (including insects and microorganisms) to reduce the abundance of an exotic plant. Natural enemies are imported from areas where the target exotic plant occurs as a native plant. They are deliberately released into areas where the plant is exotic.

These natural enemies limit the growth or reproduction of exotic plants. Examples include plant-feeding insects such as flea beetles (*Aphthona lacertosa*) for leafy spurge (*Euphorbia esula*) and the Tamarisk leaf beetle (*Diorhabda elongata deserticola*) for tamarisk (*Tamarix chinensis*).

Flea beetles can kill leafy spurge as a direct or indirect consequence of larvae feeding on leafy spurge roots. Leaf beetle larvae feed on bud, leaf, and stem tissue of tamarisk. Biological control may be a long-term solution for controlling some exotic species that are too widespread for control by other means or for exotic plants that are readily invading a park. Biological control is best suited for infestations of a single, dominant exotic plant species that is not closely related to other native plant species.

Biological control agents are currently not used by the SEUG parks for management of exotic plants. However, the Tamarisk leaf beetle (*Diorhabda elongata deserticola*) has been released by the Grand County Weed Department, even though this beetle has not been approved for release on federal lands in Utah, in areas adjacent to CANY and ARCH and it has expanded into both parks.

If biological control agents could be used, the resource manager must confirm that these treatments are justified and compliant with NPS policies using this decision tool. According to the NPS Management Policies (2006:48), a designated IPM specialist must first determine that the use of a biological control agent is necessary. In addition, all other treatment options considered must be either not acceptable or not feasible. If the use of biological control agents has not been determined necessary, or if there are other treatment options that are acceptable

or feasible, the resource manager returns to the Optimum Tool Analysis (Appendix B) to consider these treatments further.

Only biological control agents that have been approved by APHIS for release on federal lands in Utah and/or Colorado could be used under the preferred alternative. If a biological control agent has not been approved by APHIS, resource managers must consider other treatments using the Optimum Tool Analysis in Appendix B. APHIS undergoes an extensive review process prior to approving any biological control agents for release in the U.S. The next step is to submit a biological control agent use request to the Regional IPM Coordinator. Once the biological control use request has been approved by the National IPM Coordinator, the resource manager can then identify a procurement source for the biological control agents. If biological control agents could be obtained from another state, a permit must be obtained from APHIS. Transportation and handling of biological control agents could comply with any conditions specified in this permit.

Table 4. SUMMARY OF BIOLOGICAL CONTROL AGENTS PROPOSED FOR USE UNDER PREFERRED ALTERNATIVE

Targeted Plants	Biological Control Agent		Habitat	Mode of Action	Impact on Host
	Common Name	Scientific Name			
Tamarisk	Tamarisk Leaf Beetle	<i>Diorhabda elongata deserticola</i>	This beetle may not be able to establish where floods or permanent above-ground water do not permit pupation or over wintering.	Both adults and larvae feed on the foliage of tamarisk.	Beetle causes death of more plant tissue than it consumes. Damages tamarisk foliage by scraping tissue off leaves, causing twigs beyond this damage to turn yellow and eventually fall off.
Goathead/ Puncturevine	Puncturevine Seed Weevil	<i>Microlarinus lareynii</i>	Hot and dry conditions and only on puncturevine plants	Adults over winter in plant debris. Adults lay eggs in the immature burr or flower bud and the larvae feed on and destroy the seeds before they pupate and emerge as adults	This feeding prevents many seeds from germinating and severely impacts the plants.
	Puncturevine Stem Weevil	<i>Microlarinus lypriformis</i>	Hot and dry conditions and only on puncturevine plants	Adults over winter in plant debris and lay eggs in the undersides of stems, branches, and the root crown. The larvae tunnel in the pith where they feed and pupate.	Damage to the stems from both external adult feeding and internal larval activity shortens stem lengthening and ultimately delays or prevents the development of flowers and, subsequently, seeds.
Field Bindweed	Bindweed Gall Mite	<i>Aceria malherba</i>	Cultivated fields, roadsides, waste places. Grows best on moist fertile soils. Tolerates poor, dry, gravelly soils, but seldom grows in wet soils.	Mites cause galls to form on the leaves and stems of bindweed; During the winter these mites feed on root buds.	Feeding results in stunting of the plant, reduced flowering, and some reduction in the amount of bindweed.
	Field Bindweed Moth	<i>Tyta luctuos</i>	Cultivated fields, roadsides, waste places. Grows best on moist fertile soils. Tolerates poor, dry, gravelly soils, but seldom grows in wet soils.	Larvae feed on both leaves and flower buds.	Heavily defoliated plants may die or produce fewer shoots the following year.
Purple Loosestrife	Loosestrife Beetle	<i>Hylobius transversovittatus</i>	Sites without prolonged flooding are favored for weevil development.	Larvae live in the roots while adults feed on foliage.	Small roots can be destroyed within two years if infested by several larvae. Larger roots may die after several consecutive years of infestation.

Targeted Plants	Biological Control Agent		Habitat	Mode of Action	Impact on Host
	Common Name	Scientific Name			
	Golden loosestrife beetle	<i>Galerucella pusilla</i>	Readily establishes in infested areas that do not remain flooded.	Adults and larvae feed on buds and foliage.	Defoliates purple loosestrife so completely that plants are often killed.
	Black-margined loosestrife beetle	<i>Galerucella californiensis</i>	Continuously flooded habitats are not suitable for beetle survival.	Adults and larvae feed on buds and foliage.	Stunts plants and reduces seed production. Heavily defoliated plants may die or produce fewer shoots the following year.
Canada Thistle	Canada thistle stem-boring weevil	<i>Ceutorhynchus litura</i>	Favorable conditions include disturbed areas where Canada thistle is dense, and where plant is not stressed by grazing, flooding, mowing, or herbicides.	Adults feed on leaf and stem tissue. Larvae feed on stem and crown of the plant.	Departing larvae create an emergence hole below the soil surface, which provides access for small insects, other arthropods, nematodes, and pathogens.
Spotted Knapweed, diffuse knapweed	Blunt knapweed flower weevil	<i>Larinus obtusus</i>	More moist areas than <i>L. minutus</i> (see below)	One or two larvae destroy most of the developing seeds in the head.	Seed production is reduced.
	Lesser knapweed flower weevil	<i>Larinus minutus</i>	Hot and dry areas	Larvae feed on seeds, adults feed on rosette leaves.	Reduces seed production. Single larva can destroy an entire knapweed seedhead.
	Knapweed root weevil	<i>Cyphocleonus achates</i>	Prefers well-drained soils that lack dense vegetation other than knapweed.	Larvae mine and gall the central vascular tissue of the roots.	Newly hatched larvae mine into the root cortex. Feeding by older larvae causes damage to roots.
	Sulfer knapweed moth, yellow knapweed root moth	<i>Agapeta zoegana</i>	Favorable habitats are moderately humid and temperate and have an arid subcontinental climate.	Larvae damage their host plant by mining the roots.	Small plants are often killed by the feeding of the young larvae, larger plants will not flower.

e. Prescribed Fire Treatments

Using prescribed fire treatments consists of applying fire to a predetermined area to reduce the growth of exotic plants and to increase the growth of desirable plants. Prescribed fires are most effective when the exotic plant is more susceptible to the effects of fire when compared with intermingled native plants (CNAP 2000). Prescribed fire may also be used to control exotic cool-season plants.

The SEUG Fire Management Plan 2005 does not include the use of prescribed fire per se as an exotic plant management tool. It does allow individual burns to be used for disposal of vegetative debris that is infeasible to dispose of by other means. This includes brush piles that accumulate from cutting and piling of exotic plants such as tamarisk (*Tamarix chinensis*) or Russian thistle (*Salsola tragus*).

Another treatment that is currently being used to control exotics is using a weed burner. This heat treatment technique uses a propane torch to burn individual or small populations of emerging plants, particularly puncturevine (*Tribulus terrestris*) and Russian thistle (*Salsola tragus*). This treatment is used around buildings and parking areas.

Individual treatments or combinations of those treatments could be implemented as appropriate to control exotic plants in SEUG park units. Parks could cooperate with state, county, private, tribal, and federal officials.

V. Species Considered and Their Status

In accordance with the ESA, Section 7 consultation with the FWS concerning impacts to threatened and endangered species was initiated during the initial drafting of this EPMP/EA/AEF. Letters initiating informal consultation and requesting a list of federal threatened and endangered species were sent to Colorado and Utah Service Offices on June 25, 2008. Response to the informal consultation letters was received from the Utah FWS office on July 30 and the Colorado FWS office on September 17 respectively. The US Fish and Wildlife Mountain Prairie Region was consulted and in their response letter requested SEUG to access their website (USFWS 2008b) for the list of threatened, endangered and candidate species for Grand and San Juan Counties in Utah. The Colorado FWS submitted a list of threatened, endangered and candidate species for Montezuma County.

The following list includes threatened, endangered, and candidate species located in Grand County, UT, San Juan County, UT and Montezuma County, CO. A pre-field review was conducted of available information to assemble occurrence records, describe habitat needs and ecological requirements, and determine whether field reconnaissance is needed to complete the BA. The NPS Inventory and Monitoring Program undertook inventories over the last few years designed to improve park species lists of vascular plants and vertebrate animals to at least a 90 percent completion level for all Northern Colorado Plateau Network parks, including those of SEUG. These inventories provide park managers in the network with scientifically sound information on the nature and status of selected biological resources in a readily accessible form to assist field resource managers. Current species lists, resulting from

older list reviews and recent inventories, on the SEUG parks plants and vertebrates is available on-line on the NPS Inventory and Monitoring (I & M) Program website at:

<http://science.nature.nps.gov/im/units/ncpn/SpeciesSelect.cfm>

Additional sources of information included the State Natural Heritage Program database, State wildlife agency information, and published research (Schelz et al. 2004, Sloan 2008, Johnson et al. 1999, Halterman 1991, Johnson 2002, Brown et al. 2003, Haymond et al. 2003, NPS 2008, USFWS 2008, and Albee et al. 1988).

Although the following threatened, endangered and candidate species of plants on the county lists of Grand and San Juan County, Utah and Montezuma County, Colorado they do not occur within the Southeast Utah Parks: Navajo Sedge (*Carex speculicola*), Mancos milk-vetch (*Astragalus humillimus*), Mesa Verde cactus (*Sclerocactus mesae-verde*) and Sleeping Ute milk-vetch (*Astragalus toripes*). Recent extensive plant surveys (NPS 2008) and personal observations from field resource managers (Moran 2008b) give us confidence that these plants do not extend into the SEUG parks.

Table 5. FEDERALLY LISTED AND CANDIDATE SPECIES POTENTIALLY FOUND IN SEUG AND VICINITY

Common Name	Scientific Name	Status	Habitat	Notes	Determination of Effect for Preferred Alternative
Mexican spotted owl	<i>Strix occidentalis lucida</i>	Threatened	Steep walled canyons or closed canopy forests. Elev. 5,000-7,000 ft.	Potential habitat in all four park units but has only been found in CANY.	May effect-not likely to adversely effect
Southwestern willow flycatcher	<i>Empidonax traillii extimus</i>	Endangered	Dense riparian, cottonwood-willow habitat. Elev. 4,500-6,000 ft.	Potential habitat in CANY and ARCH and found in both.	May effect-not likely to adversely effect
California condor	<i>Gymnogyps californianus</i>	Endangered	Pacific coastline. Mountains, rocky cliffs, hillsides, gorges.	Potential habitat found in SEUG. One rare sighting in ARCH	May effect-not likely to adversely effect
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	Candidate	Old-growth riparian cottonwood-willow galleries with dense understories. Elev. 4,000-6,000 ft.	Potential habitat in CANY and ARCH and found in both park units.	Will not contribute to listing
Black-footed ferret	<i>Mustela nigripe</i>	Endangered	Grasslands, shrublands with prairie dog towns. Elev. 3,000-10,000 ft.	Obligate species to prairie dog; rare prey or habitat and not known in SEUG.	May effect-not likely to adversely effect
Colorado pikeminnow	<i>Ptychocheilus lucius</i>	Endangered	The Colorado and Green river system	Potential habitat in CANY and ARCH and found in or near both park units.	May effect-not likely to adversely effect
Razorback sucker	<i>Xyrauchen texanus</i>	Endangered	The Colorado and Green river system	Potential habitat in CANY and ARCH and found in or near both park units.	May effect-not likely to adversely effect
Humpback chub	<i>Gila cypha</i>	Endangered	The Colorado and Green river system	Potential habitat in CANY and ARCH and found in or near both park units.	May effect-not likely to adversely effect
Bonytail chub	<i>Gila elegans</i>	Endangered	The Colorado and Green river system	Potential habitat in CANY and ARCH and found in or near both park units.	May effect-not likely to adversely effect
Mancos milkvetch	<i>Astragalus humillimus</i>	Endangered	Sandstone ledges or mesa tops within the Mesa Verde series, 5560 ft. approx.	Not found in SEUG	No effect
Jones cycladenia	<i>Cycladenia humillis var. jonesii</i>	Threatened	Eriogonum-ephedra, mixed desert shrub, and scattered pinyon-juniper communities, Elev. 4000-6800 ft.	Potential habitat in CANY and ARCH. Unconfirmed report in ARCH. Not found in CANY.	May effect-not likely to adversely effect
Navajo sedge	<i>Carex specuicola</i>	Threatened	Moist, sandy soils of shady seep pockets/alcoves. Elev. 5700-6000 ft.	Not found in SEUG	No effect
Mesa Verde cactus	<i>Sclerocactus mesae-verde</i>	Threatened	Dry low exposed hills and mesas of Mancos or Fruitland clays, 3940-6560 ft.	Not found in SEUG	No effect
Sleeping Ute milkvetch	<i>Astragalus tortipes</i>	Candidate	Scattered colonies on the lower slopes of Cretaceous Mancos Shale, 5570-5700 ft.	Not found in SEUG	No effect

Committed Conservation Measures for Threatened, Endangered, and Species of Concern

A number of conservation measures have been developed to mitigate potential impacts to threatened and endangered species. Although candidate species are not afforded any protection under the ESA, efforts could be made to avoid or minimize potential impacts to these species as well.

- Field personnel will be trained to recognize and avoid threatened, endangered, and candidate species in their travel routes.
- Prior to implementation of treatment controls, areas that are potential habitat for listed wildlife species will be surveyed. If listed species are found in the vicinity of the treatment area, treatments will be limited to ones that are unobtrusive or to times of year when the listed species are not present or will be less affected by disturbance.
- Selection of restoration species will be limited to native species that exist naturally in the region, or non-native species that are known to not spread, to prevent the accidental introduction of new exotic plants that could endanger listed plant or wildlife values.
- Restoration activities will be timed so that negligible disturbance to listed wildlife occurs.
- All restrictions outlined on herbicide labels will be followed.
- Chemical controls will only be used in the vicinity of listed wildlife or their habitat when other weed management techniques might cause undue disturbance to listed wildlife or their habitat or are deemed infeasible.
- Herbicides that are of low toxicity to wildlife and/or that will degrade before wildlife are likely to encounter them will be used and will be applied in a manner that uses the least amount, but still remains effective and that best protects habitat for listed species.
- Ground-based equipment, including backpack sprayers and spray units on trucks will be used only in low-wind conditions.
- In the event that an area infested by one of the target species provides habitat for a listed species (such as tamarisk for the southwestern willow flycatcher), weed management activities will be implemented in such a way that any potential adverse impacts to that species are negligible. For example, if certain times of the year are less likely to cause disturbance than others, then for all treatments this will be implemented. If a critical feature (such as a snag or den) is within the treatment area, then the area will not be disturbed and a buffer around the critical feature will be maintained.
- If a target species provides critical habitat for a listed species, such as nesting sites or a food source, then for all treatments it will be small and site specific and in controlled in phases. This will allow native vegetation to continually become reestablished and will provide the equivalent requirements of maintaining the listed species habitat.
- Burning of brush piles will not be conducted in T&E species' habitat during active periods. Project specific brush piles could be designed to prioritize the protection of habitat for T&E species.
- Treatments will be chosen as selectively as possible to minimize impacts to native species. "Broad brush" treatments (such as indiscriminately using ATVs or aerial

sprayers for chemical treatments, or mechanical treatments such as mowing) will mostly be used for large, dense infestations of exotic plants if and when feasible. In contrast, individual exotic plants or smaller infestations interspersed with native plants will be treated using precise methods such as using a backpack sprayer. These methods will allow for treatments of smaller areas or individual plants, while limiting the potential impact on non-target native species.

- If boom treatments are used on ATVs or aircraft to apply herbicides, a 100 foot no-spray zone around T&E will be established. GPS units within aircraft can guarantee this precision when additional BMPs are followed regarding herbicide treatments (low wind conditions, etc.).
- Vehicle traffic, including ATV's, will be limited to existing paved and four wheeled drive roads.

Threatened, Endangered, and Sensitive Plants

- If portable spraying is used to apply herbicides, establish a 5- foot no- spray zone around threatened or endangered plants for treatments involving application of herbicides. Portable spraying allows for treatment of individual plants and the spray can be directed within an inch of the target plant.
- If boom treatments are used on ATVs or aircraft to apply herbicides, establish a 100-foot no- spray zone around threatened and endangered plants.
- Tilling will not be used in areas where threatened, endangered, and sensitive plants are known to occur or have the potential to occur.
- ATVs and vehicle traffic will remain in established paved and 4 wheeled drive roads and will not be used in areas where threatened, endangered, and sensitive plants are known to occur. No off-road driving is permitted.
- Herbicide applicators will receive training on identification of threatened, endangered, and sensitive plants. If these plants are identified in the field, treatments will be halted until the aforementioned buffer areas are established.
- Larger equipment associated with restoration, such as seed drills, seedbed preparation equipment or harrowing equipment will not be used in the vicinity of listed plant species unless there is a direct benefit to the listed species.

Species of Concern

- Parks will identify state species of concern based on lists developed by each state and federal agency. State species of concern include state endangered, state threatened, state candidate, or state species of concern, or species of special concern and are not part of a federal designation of threatened or endangered species made by the FWS.
- NPS staff will receive training on identification of state species of concern and will avoid treating these species to the extent feasible.
- Mechanical methods such as tilling will not be used in areas where state species of concern are known to occur or have the potential to occur.
- Only bio-controls that are deemed host-specific by APHIS and other associated federal agencies using the best available science and monitoring techniques will be approved for release in the parks, should they match the park's need for management of a particular species.

- When possible, all tamarisk treatments will occur outside breeding bird periods to protect migratory bird species.

VI. Analysis of Effects-Federally Listed and Candidate Species

a. Mexican spotted owl

Strix occidentalis mexicana

Affected habitat description and status within planning area

The federally threatened Mexican spotted owl, nests in steep canyons with dense stands of large ponderosa pine or pinyon-juniper with Douglas-fir, and in mature to old-growth mixed-conifer forest with high canopy closure. Favored stands generally are multi-storied, with snags and downed logs. The owls nest in tree cavities or on cliff ledges. Extensive inventories have been conducted and a number of breeding Mexican spotted owls were found in Canyonlands National Park. Most of the existing twenty-two Protected Activity Centers in CANY were surveyed sometime during 2002 and 2003. A total of 47 Mexican spotted owls were confirmed within CANY in 2002-2003. This total includes 10 pairs and 27 individuals (Schelz et al. 2004). Two pairs and 5 individuals were confirmed in the Maze District, 3 pairs and 7 individuals were in the Island-in-the-Sky District, and 5 pairs plus the remaining 15 individuals were in the Needles District (Schelz et al. 2004).

Arches National Park has potential habitat for Mexican spotted owls as determined by several polygons from the 1997 and 2000 Spotskey and Willey models for Mexican spotted owl's habitat. The majority of potential habitat is along the Colorado River, mainly beyond park boundaries. Although no formal Mexican spotted owl survey has been documented, park resource management staff has surveyed much of the park for many years and none of this staff has detected the presence of Mexican spotted owls (Sloan 2008).

Mexican spotted owl is known to occur in similar habitats near NABR, but surveys have not revealed their presence in the monument. There is also a possibility that the Mexican spotted owl could be found in HOVE once surveys are initiated.

Analysis of effects

Under the preferred alternative, there could be adverse, site specific, short-term minor impacts to Mexican spotted owls. The owls that were heard in CANY occupy relatively inaccessible areas like canyon cliff walls. Personnel and vehicle intrusion could therefore be negligible and site specific. Cultural treatments could have negligible impacts as well. However, removal of tamarisk via mechanical or chemical treatments could have an indirect adverse, site-specific, short-term, and minor impact on the owls by decreasing the habitat, like tamarisk, of the Mexican spotted owl's prey.

It is unlikely that Mexican spotted owls could receive direct exposure to herbicides during application, and it is also unlikely that they could be overexposed to herbicides over time when herbicides are applied under label specification. The impacts of chemical treatments on the Mexican spotted owls could therefore be direct and indirect adverse, site-specific, short-term, and minor. It is also unlikely that pile burning could directly affect Mexican spotted owls since piles could not be constructed in areas where Mexican spotted owls are likely to

occupy. The impacts of pile burning on the Mexican spotted owls could therefore be indirectly adverse, site specific, short-term, and negligible.

Because biological control agents are specific to a target exotic plant, there could be no known direct impacts to Mexican spotted owls. The additional biomass created by the introduction of biological control agents may indirectly benefit T&E species that prey on terrestrial insects. However, Mexican spotted owls prey on rodents and the impacts of biological treatments to Mexican spotted owls could therefore be negligible.

Conservation Measures

In addition to the general conservation measures on page 26, the following species specific conservation measures are incorporated into the EPMP:

- Treatment areas could be evaluated for Mexican spotted owl nesting and roosting habitats prior to conducting exotic plant management activities. Suitable nesting or roosting habitat is any forested mountain, shady or steep canyon with mature trees that create high closed canopies.
- A disturbance-free buffer area of 100 feet could be maintained around any active Mexican spotted owl nests. If a disturbance-free buffer zone is not feasible, then activity should be conducted outside of the period from April through October to protect nesting and fledgling birds.
- Clearing of live or dead trees greater than 12 inches in diameter at breast height (DBH) along canyons could be avoided to the extent possible to help preserve potential Mexican spotted owl roosting or nesting habitat.

Determination of Effect and Rationale

It is anticipated that the Mexican spotted owl will benefit overall from the implementation of the EPMP as exotic species spread and introduction is expected to decrease when the full range of IPM is used. Therefore, it is the determination that the proposed implementation of the EPMP *may affect but is not likely to adversely affect the Mexican spotted owl.*

b. Southwestern willow flycatcher

Empidonax traillii extimus

Affected habitat description and status within treatment areas

This endangered migratory bird requires dense riparian, cottonwood-willow habitat (although it has adapted to tamarisk) that is associated with rivers, streams and wetlands for nesting and breeding. The SEUG area, especially in Canyonlands and Arches National Park has this potential habitat. In 1999, a survey of the Southwestern willow flycatcher by the USGS was conducted along the Colorado and Green Rivers in CANY. The survey from CANY's boundary to the Colorado/Green River confluence determined that although many flycatchers were detected, they appeared to use these portions of rivers as a migratory stopover rather than as a breeding area (Johnson et. al.1999).

The USGS conducted a study on the southwestern willow flycatcher from 1999 to 2001. They surveyed the segment of river adjacent to ARCH from the CANY boundary to Dewey Bridge

(30 miles upstream from ARCH). The same results were found as in CANY. Although some southwestern willow flycatchers were detected, the flycatcher appears to use this portion of the river as a migratory stopover as well (Johnson et al. 1999).

There is no potential habitat for southwestern willow flycatcher in NABR or HOVE, nor is it known there.

Analysis of effects

Southwestern willow flycatchers are not known to nest within SEUG boundaries, though suitable habitat may be present along small, scattered portions of the Colorado and Green River and their vegetated tributaries. Southwestern willow flycatchers have only been known to use the rivers along ARCH and in CANY as a migratory stopover.

There is the possibility that exotic plant management treatments in close proximity to riparian areas could have short and long-term indirect impacts to the southwestern willow flycatcher. The presence of staff and volunteers performing exotic control activities and use of some types of mechanized equipment, such as chainsaws, in close proximity to occupied habitats (should occupation ever occur) could disrupt normal behavior of nesting flycatchers, possibly resulting in nest abandonment or failure. Mechanical or manual removal of tamarisk will have an adverse impact by temporarily reducing the size of this habitat for the southwestern willow flycatcher who has adapted to using the tamarisk thickets for escape and nesting. The impacts of manual or mechanical treatments on the southwestern willow flycatcher could therefore be direct and adverse, site-specific, short to long-term, and minor to moderate.

Removing exotics like tamarisk could also open up areas and enable native vegetation like the cottonwoods and willows to become reestablished thus providing a natural ecosystem for preserving this species. The impacts of manual or mechanical and cultural treatments could also be directly beneficial, site-specific, long-term and moderate.

Misuse or accidental spills/drift of certain herbicides for exotic control that can kill or damage established beneficial riparian vegetation (cottonwoods-willows) that flycatchers prefer for nest sites and foraging can have long term indirect impacts for flycatcher nesting success. It is unlikely that the southwestern willow flycatcher could receive direct exposure to herbicides during application, and it is also unlikely that they could be overexposed to herbicides over time when herbicides are applied under label specification. The impacts of chemical treatments on the flycatcher could therefore be direct and indirect adverse, site-specific, short-term, and minor.

Pile burning will not directly affect the southwestern willow flycatcher because brush piles will not be burned in areas that could affect these species during their nesting and migration periods. The impacts of pile burning on the flycatcher could therefore be indirectly adverse, site specific, short-term, and negligible.

Though flycatchers are documented most frequently nesting in dense willow thickets they have been known to occupy tamarisk thickets. Biological control agents released for tamarisk control may cause the temporary loss of nesting habitat available to this and other migratory

bird species. The impacts of biological treatments on the southwestern willow flycatcher could therefore be direct and adverse, site-specific, short-term to long-term, and minor to moderate.

The additional biomass created by the introduction of biological control agents may indirectly benefit the southwestern willow flycatcher that preys on terrestrial insects. The impacts of biological treatments on the flycatcher could therefore be indirectly beneficial, short-term and minor.

Conservation Measures

In addition to the general conservation measures on page 26, the following species specific conservation measures are incorporated into the EPMP:

- Treatment areas could be evaluated for southwestern willow flycatcher nesting and roosting habitats prior to conducting any exotic plant management activities. Southwest willow flycatcher surveys according to the FWS approved protocol will be completed in any suitable habitats prior to habitat treatments. Suitable nesting/roosting habitat is any dense stand of cottonwood, willows, tamarisk or Russian olive in association with rivers, streams, or any significant body of water, or areas of saturated soils. (See page 11 of the Final Recovery Plan for Southwestern Willow Flycatcher for a detailed list of tree and shrub species used by nesting southwestern willow flycatcher (USFWS 2002).)
- A disturbance-free buffer area of a minimum 300 feet could be maintained around any active southwestern willow flycatcher nests year round and no treatments will occur during the nesting season. Instead the NPS will coordinate with the FWS and UDWR to develop a revegetation and restoration plan for the areas within 300 feet of identified nests. Larger buffers will be considered if the activity includes high noise levels or long-term disturbances.
- Removal of tamarisk on a broad scale (10-200 acres) will only be conducted after a wildfire. Wildfires, which are infrequent within the parks, have the potential to naturally destroy southwestern willow flycatcher habitat. Typically, treatment (cut stump and chemical application to stump or basal spray to new sprouts) of tamarisk is conducted on a smaller scale (less than 2 acres) and is site-specific.
- There will be no clear cutting of large areas (i.e. greater than 2 acres) of exotic species.
- Release of the tamarisk leaf beetle, will not be permitted in the parks until it is approved by APHIS in Utah. If and when the leaf beetle will be approved, formal Section 7 consultation will have to be reinitiated.
- Only willows, cottonwoods and other native vegetation species will be used to reseed and/or replant treated areas.

Determination of Effect and Rationale

There is the potential for direct and indirect impacts. Potential loss of southwestern willow flycatcher nesting habitat caused by leaf beetle defoliation is a high concern for FWS with regard to the proposed tamarisk biocontrol program because it is known to nest in tamarisk below the 37th parallel. Temporary loss of nesting habitat due to beetle predation on tamarisk is expected to impact resident or migratory bird populations in/adjacent to treatment areas.

However, tamarisk leaf beetles (*Diorhabda elongata deserticola*) will not be released in the parks until approved by APHIS in Utah.

Misuse of herbicides or accidental spills may kill or damage cottonwoods southwestern willow flycatchers use for nesting. Vegetation treatments in close proximity to nesting southwestern willow flycatchers may alter normal behavior, resulting in missed foraging opportunities or failed/abandoned nests.

Nevertheless, implementation of the EPMP is expected overall to improve southwestern willow flycatcher habitat over the long term primarily by removing exotic species and allowing native cottonwoods and willow to re-colonize riparian corridors and allow greater diversity and perhaps abundance of insects eaten by flycatchers.

Adhering to the conservation measures will reduce any adverse impacts to southwestern willow flycatchers. Broad-scale treatments will only be conducted after a wildfire has destroyed potential southwestern willow flycatcher habitat. Although the southwestern willow flycatcher is typically known as a migratory species through the parks, if nests are found within and near park boundaries the NPS will coordinate with the FWS and UDWR to develop revegetation and restoration plans for the areas within 300 feet of identified nests. Therefore, implementation of the EPMP is *not likely to adversely affect* the southwest willow flycatcher.

c. California condor

Gymnogypus californianus

Affected habitat description and status within treatment areas

Historically the federally endangered, *Gymnogypus californianus*, habitat is along the Pacific Coast line from Baja to British Columbia but there is potential habitat within the SEUG. There have been two sightings; 1) one sighting in ARCH in 1997 of one condor was reported by Damon Fagan, a park ranger and avid birder and 2) visitors in NABR reported seeing a tagged condor in the summer of 2007 (Sloan 2008). It was considered that both condors were experimental non-essential and probably came from the Grand Canyon National Park in Arizona reintroduction population and the Hurricane Cliff population near Zion National Park in southwest Utah (Sloan 2008).

Analysis of effects

Although there is potential habitat for the condor, there is no real abundance of large prey to maintain a California condor population. Also there are no known nesting sites or observations of this endangered bird. Any exotic plant management impacting the condor could be unlikely. The impact to the California condor could be direct, site-specific, short-term and negligible.

Because biological control agents are specific to a target exotic plant, there could be no known direct impacts to the California condor. The additional biomass created by the introduction of biological control agents may indirectly benefit T&E species that prey on terrestrial insects. However, the condor preys on large mammals and the impacts of biological treatments to the California condor could therefore be negligible.

Conservation Measures

In addition to the general conservation measures on page 26, the following species specific conservation measures are incorporated into the EPMP:

- Treatment areas could be evaluated for California condor nesting and roosting habitats prior to conducting exotic plant management activities. Suitable nesting/roosting habitat is rocky and brushy areas with cliffs or standing snags available for nest sites near important foraging grounds. A disturbance-free buffer area could be maintained around any active California condor nests. If a disturbance-free buffer zone is not feasible, then activity should be conducted outside of the period from early February through early May to protect nesting and fledgling birds.

Determination of Effect and Rationale

There are no direct or indirect impacts to the California condor. No birds are known to nest within the SEUG. It is anticipated that the condor will benefit overall from the implementation of the EPMP as exotic species spread and introduction is expected to decrease when the full range of IPM is used. Therefore, it is the determination that the proposed implementation of the EPMP *may affect but is not likely to adversely affect the California condor*.

d. Yellow-billed cuckoo

Coccyzus americanus occidentalis

Affected habitat description and status within treatment areas

Coccyzus americanus occidentalis habitat consists of old-growth riparian cottonwood-willow galleries with dense understories. The riparian zone along the Colorado and particularly the Green River include many areas that appear, based on vegetation characteristics, to be potential yellow-billed cuckoo breeding habitat (e.g., overstory of cottonwood spp. and/or old growth tamarisk with dense understory (Haltermann 1991). During 1999, 2000 and 2001 surveys in CANY by the USGS, only 3 yellow-billed cuckoo were documented. It was determined that all three cuckoos were migrant or unpaired non-breeding birds since all of which were not detected on subsequent surveys (Johnson 2002).

In ARCH, Sonya Daw, avian biologist for SEUG, observed a yellow-billed cuckoo on June 3, 2006, during the annual riparian bird survey. This was the first sighting of this species in Arches National Park.

There is no potential habitat for yellow-billed cuckoo in NABR or HOVE. Nor is it known there.

Analysis of effects

Although the yellow-billed cuckoo does not require as dense habitat as the southwestern willow flycatcher, the potential impacts for the cuckoo are the same as the flycatcher.

Yellow-billed cuckoos are not known to nest within SEUG boundaries, though suitable habitat may be present along small, scattered portions of the Colorado and Green River and their vegetated tributaries.

There is the possibility that exotic plant management treatments in close proximity to riparian areas could have short and long-term indirect impacts to the yellow-billed cuckoo. The presence of staff and volunteers performing exotic control activities and use of some types of mechanized equipment, such as chainsaws, in close proximity to occupied habitats (should occupation ever occur) could disrupt normal behavior of nesting cuckoos, possibly resulting in nest abandonment or failure. Mechanical or manual removal of tamarisk will have an adverse impact by temporarily reducing this habitat for the cuckoo which has adapted to using the tamarisk thickets for escape and nesting. The impacts of manual or mechanical treatments on the yellow-billed cuckoo could therefore be direct and adverse, site-specific, short-term, and minor to moderate.

Removing exotics like tamarisk could also open up areas and enable native vegetation like the cottonwoods and willows to become reestablished thus providing a natural ecosystem for preserving this species. Reseeding these areas could also have long-term beneficial impacts. The impacts of manual or mechanical and cultural treatments could also be directly beneficial, site-specific, long-term and moderate.

Misuse or accidental spills/drift of certain herbicides for exotic control that can kill or damage established beneficial riparian vegetation (cottonwoods-willows) that cuckoos prefer for nest sites and foraging can have long term indirect impacts for yellow-billed cuckoo nesting success. It is unlikely that the yellow-billed cuckoo could receive direct exposure to herbicides during application, and it is also unlikely that they could be overexposed to herbicides over time when herbicides are applied under label specification. The impacts of chemical treatments on the cuckoo could therefore be direct and indirect adverse, site-specific, short-term, and minor.

Pile burning will not directly affect the yellow-billed cuckoo because brush piles will not be burned in areas that could affect these species during their nesting and migration periods. The impacts of pile burning on the cuckoo could therefore be indirectly adverse, site specific, short-term, and negligible.

Though yellow-billed cuckoo are documented most frequently nesting in cottonwood woodlands they have been known to occupy tamarisk thickets. Biological control agents released for tamarisk control may cause the temporary loss of nesting habitat available to this and other migratory bird species. The impacts of biological treatments on the cuckoo could therefore be direct and adverse, site-specific, short-term, and minor to moderate.

The additional biomass created by the introduction of biological control agents may indirectly benefit the yellow-billed cuckoo that preys on terrestrial insects. The impacts of biological treatments on the cuckoo could therefore be indirectly beneficial, short-term and minor.

Conservation Measures

In addition to the general conservation measures on page 26, the following species specific conservation measures are incorporated into the EPMP:

- Treatment areas could be evaluated for yellow billed cuckoo nesting and roosting habitats prior to conducting exotic plant management activities. Suitable nesting/roosting habitat is any dense stand of cottonwood, willows, tamarisk or Russian olive in association with rivers, streams, or any significant body of water.
- A disturbance-free buffer area of a minimum 100 foot buffer area would be maintained around any active yellow billed cuckoo nests. If a disturbance-free buffer zone is not feasible, then activity will be conducted outside of the period from early May through mid September to protect nesting and fledgling birds.
- When possible, all tamarisk treatments will occur outside the breeding period to protect this migratory species.
- Removal of tamarisk on a broad scale (10 to 200 acres) will only be conducted after a wildfire. Wildfires are usually infrequent. Typically, treatment (cut stump and apply chemical to stump or basal treatment to new sprouts) of tamarisk is on a smaller scale (less than 2 acres) and site-specific.
- There will be no clear cutting of large areas (i.e. greater than 2 acres) of exotic species.
- Release of the tamarisk leaf beetle, will not be permitted in the parks until it is approved by APHIS in Utah. If and when the leaf beetle will be approved, formal Section 7 consultation will have to be reinitiated.
- Only willows, cottonwoods and other native vegetation species will be used to reseed and/or replant treated areas.

Determination of Effect and Rationale

There is the potential for direct and indirect impacts. Misuse of herbicides or accidental spills may kill or damage cottonwoods cuckoos use for nesting. Vegetation treatments in close proximity to nesting yellow-billed cuckoos may alter normal behavior, resulting in missed foraging opportunities or failed/abandoned nests. The conservation measures could adequately reduce any adverse impacts to yellow-billed cuckoos and their potential habitat. No birds are known to nest within the SEUG. Implementation of the EPMP is expected overall to improve yellow-billed cuckoo habitat over the long term primarily by removing exotic species and allowing native cottonwoods and willow to re-colonize riparian corridors and allow greater diversity and perhaps abundance of insects eaten by cuckoos. Therefore, implementation of the EPMP with the conservation measures *will not contribute to listing the yellow-billed cuckoo*.

e. Black-footed ferret

Mustela nigripes

Affected habitat description and status within treatment areas

The *Mustela nigripes* natural habitat coincides with most species of prairie dogs (Brown et al. 2003). Prairie dog towns provide the primary source of food and needed cover. Prairie dogs prefer areas of short vegetation and bare ground. Sagebrush shrubs are the largest plants found near preferred habitat. Suitable habitat for prairie dogs and black-footed ferrets in Utah is found in the eastern portion of the state which includes the SEUG. Gunnison prairie dogs are found southeast of the Colorado River. However within the four SEUG park units, there was

only a historic report of one in CANY and an unconfirmed report in HOVE (Haymond et.al 2003). White-tailed prairie dogs have been found in ARCH and were monitored for several years by Gary Salamacha, a park ranger, as part of a burrowing owl monitoring program. However, there are no reports of black-footed ferrets in the SEUG parks.

Analysis of effects

The impacts of current exotic plant treatment on the black-footed ferret could be site-specific, short-term and negligible. No direct impacts are anticipated to black-footed ferrets, primarily because of their nocturnal nature and their ability to avoid any direct contact with people, equipment, or other animals by escaping into prairie dog burrows. Although there is potential habitat for the ferret, there is no real abundance of prairie dog prey to maintain a black-footed ferret population and no black-footed ferrets have been found in the parks. Any exotic plant management impacting the ferret could be unlikely.

Should exotic plant management activities occur in ferret-occupied habitat, ferret's primary prey species in this area (prairie dogs) may be reduced if desirable vegetation that is used as food by prairie dogs is temporarily reduced or eliminated if herbicide control treatments are improperly performed. Also, use of vehicles in the area for treatments could compact or destroy burrow entrances.

Biological control treatments could not have any measurable or perceptible effect on the black-footed ferret. The impacts of biological treatments on the ferret could therefore be negligible.

Conservation Measures

In addition to the general conservation measures on page 26, the following species specific conservation measures are incorporated into the EPMP:

- Black-footed ferrets are not known to occur within any of the four park units of the SEUG. In the unlikely event that black-footed ferrets are located, the FWS could be consulted and no disturbance could be allowed within prairie dog colonies inhabited by black-footed ferrets.
- Because some white-tailed prairie dog colonies may provide habitat for future black-footed ferret reintroduction, a number of management practices could be implemented to minimize potential impacts to white-tailed prairie dogs. These practices include:
 - *Physical disturbance to prairie dog towns or complexes could be avoided wherever possible.
 - *The use of mechanical treatments such as tilling could not be used in prairie dog colonies.
 - *The use of herbicides in prairie dog colonies could only be considered if no other alternatives are feasible.
 - *Only those herbicides that have a low potential toxicity, such as glyphosate could be used within prairie dog colonies. Glyphosate is strongly adsorbed into soil, with little potential for leaching to ground water. Microbes in the soil readily and completely degrade it even in low

temperatures. It tends to adhere to sediments when released to water and does not accumulate in aquatic life (USFS 2004).

- *Herbicides that do not readily break down in soil could not be used in prairie dog colonies.
- * To avoid physically disturbing prairie dog towns, no mechanical vehicles or maintenance equipment could be used.

Determination of Effect and Rationale

No direct effects are anticipated to black-footed ferrets. There is the potential for short-term damage to burrow entrances by vehicles used in weed control or for a short-term reduction in their primary food source if desirable vegetation (for white-tailed or Gunnison prairie dogs) is damaged or eliminated by misuse of chemical weed treatments. The conservation measures should adequately reduce any adverse impacts to black-footed ferrets and their potential habitat should weed control become necessary in occupied habitat. No ferrets are known to be present within SEUG at this time. It is anticipated that the black-footed ferret will benefit overall from the implementation of the EPMP due to overall improvement of native vegetation composition, diversity, abundance, and health that supports active and healthy white-tailed or Gunnison prairie dog communities. Therefore, it is the determination that the proposed implementation of the EPMP with the conservation measures *may affect but is not likely to adversely affect the black-footed ferret*.

f. Bonytail chub (*Gila elegans*), Humpback chub (*Gila cypha*), Colorado pikeminnow (*Ptychocheilus lucius*) and Razorback sucker (*Xyrauchen texanus*)

Affected habitat description and status within treatment areas

These four federally endangered fish species historically occur in the Upper Colorado River Basin, including the Green and Colorado Rivers. These fish require a diversity of habitats within the Colorado River, particularly during certain life stages. Low velocity side channels, backwaters, oxbows, sloughs, and flooded bottom lands are all important habitats for both young and adult fish.

The Green and Colorado Rivers flow through CANY. The entire segments of both rivers that flow through CANY have been designated as critical habitats by the FWS for the Colorado pikeminnow and razorback sucker (USFWS 2008). The humpback chub and bonytail chub prefer eddies, pools, and backwaters near swift current in larger rivers and are found near the confluence of the Green and Colorado Rivers in Cataract Canyon (USFWS 2008).

The USFWS has designated the Colorado River and its floodplain, for the segment adjacent to ARCH as critical habitat for Colorado pikeminnow and razorback sucker (USFWS 2008). This includes the Colorado River and its confluence with Courthouse Wash to the point where the spring floods of the Colorado back up into these tributaries. The humpback chub and bonytail prefer shallow, backwater sections of river. The sections of river adjacent to ARCH do not have this type of habitat and there is no critical habitat within 60 miles upstream or downstream of the park (USFWS 2008).

There is no fish habitat in NABR or HOVE.

Analysis of effects

Overall, these fish species should benefit from the implementation of the Exotic Plant Management Plan. Removal of riparian exotic plant species, especially tamarisk, will assist in improving habitat for these species by preserving cobble bars and maintaining naturally occurring alluvial sediment deposit dynamics and features that create slower moving water. Erosion within the Green and Colorado River basin has always played a factor in the maintenance of habitats important to these fishes.

There is the potential for erosion due to the manual or mechanical removal of soil stabilizing vegetation on banks, bars, and islands associated with the Green and Colorado Rivers. Loss of vegetation could result in temporary increases in surface water runoff. However, these fish are well adapted to the high silt load conditions of the Green and Colorado Rivers. Potential increases in sediment resulting from the implementation of the EPMP could have negligible effects to these fishes or designated critical habitats, and could be beneficial by limiting productivity of non-native fishes that are not adapted to high silt conditions and by maintaining or restoring un-vegetated spawning and nursery habitat. Impacts could be detectable, site-specific, and short or long-term. The impacts of manual and mechanical disturbance on fish species could therefore be directly or indirectly adverse, site-specific, short-term to long-term, and minor.

It is unlikely that these fish species could receive direct exposure to herbicides during application, and it is also unlikely that they could be overexposed if the herbicides are used according to label specifications. Use of herbicides registered for use in or near water (such as glyphosate) could not pose a risk to these fish and could not be detectable. Impacts resulting from the use of herbicides could not be expected to have any long-term adverse impacts on native endangered fish, their habitats, or natural processes sustaining them. The impacts of chemical treatments on these fish species could therefore be direct, site-specific, short-term, and negligible.

Direct mortality from fire from brush burning is unlikely for fish. These fish may be indirectly affected by temporary loss of vegetation, which could cause minor increases in erosion and sedimentation. Increases in sedimentation could be site-specific and short-term and may be detectable, but could not be outside the range of natural variability. The impacts of pile burning on the fish could therefore be indirectly adverse, site-specific, short-term, and negligible.

The additional biomass created by the introduction of biological control agents may indirectly benefit these fish that prey on terrestrial insects. The impacts of biological treatments on the fish could therefore be indirectly beneficial, site-specific, short-term, and minor.

Conservation Measures

In addition to the general conservation measures on page 26, the following species specific conservation measures are incorporated into the EPMP:

- Treatment areas could be evaluated for these endangered fish prior to conducting exotic plant management activities along the rivers.
- A fifty foot disturbance-free buffer area from the water could be maintained. The Rodeo herbicide (glyphosate) may be applied to exotic vegetation as it is not known to be toxic to fish.

Determination of Effect and Rationale

There is the potential for direct and indirect short-term, site-specific impacts. Herbicides can be toxic to fish in general and may affect populations. The conservation measures should adequately reduce likelihood of negative impacts. It is anticipated that these native Colorado and Green River fish will benefit overall from the implementation of the EPMP, as there are situations in the SEUG where particular riparian exotic species (namely tamarisk and Russian olive) grow up to the water's edge and within channel and indirectly threaten critical habitat for riparian and aquatic T&E species. Research has demonstrated that tamarisk contributes to channel narrowing and alters fluvial sediment deposition processes, which in turn degrades reproductive habitat for these fish by converting cobble bars used for spawning into unusable sandbars. Removal of these exotic species is expected to contribute towards the overall restoration of stream geomorphology and channel characteristics, which may promote and contribute to recovery efforts of these fish species.

Therefore, it is the determination that the proposed implementation of the EPMP with the conservation measures *may affect but is not likely to adversely affect these four endangered fish or their habitat.*

g. Jones cycladenia

Cycladenia humillis

Affected habitat description and status within treatment areas

Cycladenia humillis var. jonesii is a federally threatened plant and has been found in Eriogonum-ephedra, mixed desert shrub, and scattered pinyon-juniper communities, at elevations ranging from 4,000 to 6,800 feet. However, the only report of the plant within the SEUG area is an unconfirmed report in ARCH (Albee et al. 1988). The unconfirmed category indicates this species is included in the park species list based on weak (unconfirmed record) or no evidence, giving minimal indication of the species' occurrence in the park. This category is used as a means of maintaining a "watch list," that is, species that could possibly occur in the park and that should not, at this point, be totally removed or absent from the park's species list. A designation of Unconfirmed implies that there is no evidence that a species was ever in the park. There have been no current reports of the Jones Cycladenia within SEUG.

Analysis of effects

Prior to implementation of mechanical controls, areas that are potential habitat for *Cycladenia humillis var. jonesii* will be surveyed. If they are found in the vicinity of the treatment area, treatments will be limited to ones that are unobtrusive or to times of year when the listed species are not present or less affected by disturbance. The impacts of manual/mechanical treatments will be direct adverse, site-specific, short-term and negligible.

Herbicide use will be avoided in the vicinity of *Cycladenia humillis* var. *jonseii*. Potential impacts of chemical treatments will be direct, adverse, site specific, short-term and negligible.

Burning of brush piles could not be conducted in or near *Cycladenia humillis* var. *jonseii* habitat. Therefore impacts will be negligible.

Any biological agent released in the parks could be approved by APHIS and could have no demonstrated affinity for native plant species. Because biological control agents are specific to individual species of exotic plant, there could be negligible impacts to non-target plant species. Impacts to target plants could be direct and beneficial. No specific measures could be implemented to contain biological control agents. However, any biological control agent used could be host specific so each biological control agent could only attack one plant species (the host, or the target exotic plant). The National IPM Specialist could also further review and approve the release of any proposed biological control agents, which could help to confirm that the use of these agents could be appropriate. The impacts of biological treatments on the Jones cycladenia could therefore be direct beneficial effects, site specific, short- to long-term, and minor.

Conservation Measures

In addition to the general conservation measures on page 26, the following species specific conservation measures are incorporated into the EPMP:

- Prior to implementation of mechanical controls, areas that are potential habitat for *Cycladenia humillis* will be surveyed. If they are found in the vicinity of the treatment area, treatments will be limited to ones that are unobtrusive or to times of year when the listed species are not present or less affected by disturbance.
- NPS staff responsible for exotic plant management at ARCH will receive training on how to identify the Jones cycladenia plant and its potential habitat. If populations of the Jones cycladenia plant are identified, conservation measures developed for threatened and endangered plants will be implemented.

Determination of Effect and Rationale

Therefore, it is the determination that the proposed implementation of the EPMP with the conservation measures *may affect but is not likely to adversely affect the Jones cycladenia or its habitat.*

VII. Responsibility for a Revised Biological Evaluation

This BA was prepared based on presently available information. If the action is modified in a manner that causes effects not considered, or if new information becomes available that reveals that the action may impact endangered, threatened, proposed, or sensitive species in a manner or to an extent not previously considered, a new or revised BA will be required.

The release of tamarisk leaf beetles (*Diorhabda elongata deserticola*) is not currently permitted by APHIS in Utah. Therefore, if future activities include use of this biological control methodology, formal Section 7 consultation will need to be reinitiated.

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Appendix A

EXOTIC PLANT LIST OF SEUG AND THOSE PROPOSED FOR TREATMENT

Common Name	Scientific Name	Present in SEUG units	Proposed for Treatment
African mustard	<i>Malcolmia africana</i>	A,C,H,N	
Alfalfa	<i>Medicago sativa</i>	A,C,H	
Alyssum	<i>Alyssum alyssoides</i>	C	
Annual wheatgrass	<i>Eremopyrum triticeum</i>	A, C	
Asparagus	<i>Asparagus officinalis</i>	A,C,H	
Barbwire tumbleweed	<i>Salsola paulsenii</i>	C	
Black locust	<i>Robinia pseudoacacia</i>	A	
Blue mustard	<i>Chorispora tenella</i>	A,C	
Broadleaf plantain	<i>Plantago major</i>	A,C	
Buffalobur	<i>Solanum rostratum</i>	C	
Bulbous bluegrass	<i>Poa bulbosa</i>	C,N	
Bull thistle	<i>Cirsium vulgare</i>	A,C	
Bur buttercup	<i>Ranunculus testiculatus</i>	A,C,H,N	
Burdock	<i>Arctium minus</i>	A,C,H	
Canada bluegrass	<i>Poa compressa</i>	N	
Canada thistle	<i>Cirsium arvense</i>	C,H,N	
Carolina poplar	<i>Populus x canadensis</i>	A,C	
Cheatgrass	<i>Bromus tectorum</i>	A,C,H,N	
Chicory	<i>Cichorium intybus</i>	H	
Chufa flat-sedge	<i>Cyperus esculentus</i>	A	
Clasping pepperweed	<i>Lepidium perfoliatum</i>	A, C, H	
Common catalpa	<i>Catalpa bignonioides</i>	A	
Common dandelion	<i>Taraxacum officinale</i>	A, C, H, N	
Common horehound	<i>Marrubium vulgare</i>	A,C,H,N	X
Crested wheatgrass	<i>Agropyron cristatum</i>	A,C,H,N	X
Cultivated rye	<i>Secale cereale</i>	A	
Curly dock	<i>Rumex crispus</i>	A, H	
Dalmatian toadflax, broad-leaved	<i>Linaria dalmatica</i>	A, H	
Desert wheatgrass	<i>Agropyron desertorum</i>	A	
Diffuse knapweed	<i>Centaurea diffusa</i>	C	X
English plantain	<i>Plantago lanceolata</i>	A	
European wintercress	<i>Barbarea vulgaris</i>	C	
Field bindweed	<i>Convolvulus arvensis</i>	A,C,H,N	X
Falseflax	<i>Camelina microcarpa</i>	H	
Five-hook smotherweed	<i>Bassia hyssopifolia</i>	A,C,N	
Flixweed	<i>Descurainia sophia</i>	A,C,H	
Garden orach	<i>Atriplex hortensis</i>	H	
Giant ragweed	<i>Ambrosia trifida</i>	H	
Halogeton	<i>Halogeton glomeratus</i>	A,C,H	
Houndstongue	<i>Cynoglossum officinale</i>	A	
Intermediate wheatgrass	<i>Elymus hispidus</i>	C	
Japanese brome	<i>Bromus japonica</i>	C,H,N	
Johnson grass	<i>Sorghum halepense</i>	C	
Kentucky bluegrass	<i>Poa pratensis</i>	A	
Knotweed	<i>Polygonum aviculare</i>	N	
Lambsquarter	<i>Chenopodium album</i> var. <i>album</i>	A,C,N	
Licorice	<i>Glycyrrhiza glabra</i>	C	

Common Name	Scientific Name	Present in SEUG units	Proposed for Treatment
London mustard	<i>Sisymbrium irio</i>	N	
Musk mustard	<i>Chorispura tenella</i>	A,H	
Musk thistle	<i>Carduus nutans</i>	C	
Oats	<i>Avena fatua</i>	H,N	
Orchard grass	<i>Dactylis glomerata</i>	A,N	
Peach	<i>Prunus persica</i>	C	
Perennial pepperweed	<i>Lepidium latifolium</i>	A, C	X
Pitseed goosefoot	<i>Chenopodium album</i> <i>var.berlandieri</i>	A, H	
Prickly Lettuce	<i>Lactuca serriola</i>	A,C,H,N	
Puncturevine/Goathead	<i>Tribulus terrestris</i>	A,C,H,N	X
Purple amaranth	<i>Amaranthus cruentus</i>	H	
Purple loosestrife	<i>Lythrum salicaria</i> L.	A	X
Purslane	<i>Portulaca oleracea</i>	A,C	
Rabbit barley	<i>Hordeum murinum</i>	A,C	
Rabbitfoot grass	<i>Polypogon monspeliensis</i>	A,C,N	
Red brome	<i>Bromus rubens</i>	C,H,N	
Red mulberry	<i>Morus rubra</i>	A	
Redroot pigweed	<i>Amaranthus retroflexus</i>	N	
Redtop	<i>Agrostis stolonifera</i>	A,C,H,N	
Ripgut brome	<i>Bromus diandrus</i>	A,C	X
Russian knapweed	<i>Centaurea repens</i>	A,C,H	X
Russian olive	<i>Elaeagnus angustifolia</i>	A,C	X
Russian thistle	<i>Salsola tragus</i>	A,C,H,N	X
Saltcedar/Tamarisk	<i>Tamarix chinensis</i>	A,C,H,N	X
Siberian elm	<i>Ulmus pumila</i>	A, C	X
Smooth brome	<i>Bromus inermis</i>	C,H,N	
Spiny sow-thistle	<i>Sonchus asper</i>	A,C,H,N	
Spotted knapweed	<i>Centaurea maculosa</i>	A	
Storksbill	<i>Erodium cicutarium</i>	A,C,H,N	
Summer-kochia	<i>Bassia scoparia</i>	A,C	
Tall wheatgrass	<i>Elymus elongates</i>	C	
Timothy	<i>Phleum pratense</i>	A,C,N	
Tumble pigweed	<i>Amaranthus albus</i>	A,C,H,N	
Tumbling mustard	<i>Sisymbrium altissimum</i>	A,C,H,N	
Tumbling orach	<i>Atriplex rosea</i>	C	
Umbrella mallow	<i>Malva neglecta</i>	C,H	
Water bent	<i>Polypogon semiverticillatus</i>	C,N	
Water speedwell	<i>Veronica anagallis-aquatica</i>	A,N	
Watercress	<i>Nasturtium officinale</i>	A, N	
Wheat	<i>Triticum aestivum</i>	A	
White mulberry	<i>Morus alba</i>	A,C	
White poplar	<i>Populus alba</i>	A,C,N	
White sweet clover	<i>Melilotus albus</i>	A,C,H,N	X
Willowweed	<i>Polygonum lapathifolium</i>	A	
Winged pigweed	<i>Cycloloma atriplicifolia</i>	A, C	
Woolly mullein	<i>Verbascum thapsus</i>	A, C, H	
Yellow salsify	<i>Tragopogon dubius</i>	A,C,H,N	X
Yellow sweet clover	<i>Melilotus officinalis</i>	A,C,H,N	X

Appendix B Optimum Tool Analysis for Treatment

