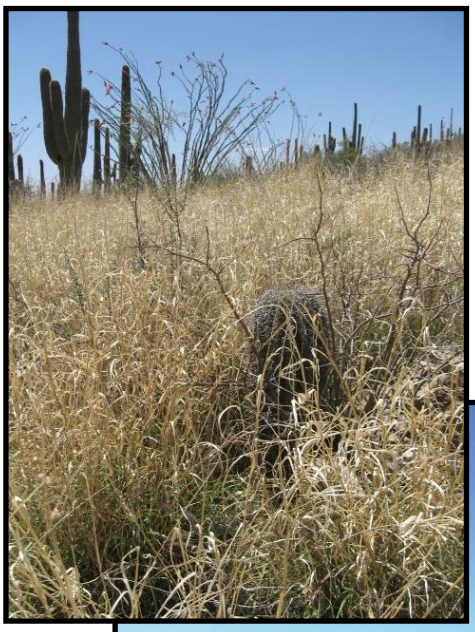
National Park Service
U.S. Department of the Interior

Saguaro National Park

Restoration Management Plan

Environmental Assessment



January 2014

EXECUTIVE SUMMARY

In order to fulfill its mandate of preserving and protecting the natural and cultural resources of Saguaro National Park (SNP), the National Park Service proposes this Restoration Plan and Environmental Assessment (EA). The plan specifically addresses the increase of invasive non-native plant populations and other large-scale or remote disturbances, such as intense wildfires, that cannot be effectively treated with the ground-based techniques currently available to the park.

This EA examines in detail a No Action alternative (NAA) and a Proposed Action alternative (PAA). The NAA describes the restoration techniques that are currently in use, including the use of chemical herbicides, which was analyzed and approved in the park's current Exotic Plant Management Plan and EA (SNP 2004). Since then, concentrated efforts to treat invasive non-native plants and restore impacted sites have had several small-scale successes. However, some species (e.g., buffelgrass) are continuing to spread and threaten native ecosystems. Populations of these plants have become established in remote and inaccessible areas of the park where they simply cannot be treated with ground-based efforts. The PAA, which is also the Environmentally Preferred Alternative, identified as the Preferred Action (PA), introduces the use of aircraft to apply restoration treatments to disturbed areas. Specifically, helicopters may spot-treat patches of invasive non-native plants with herbicides, and helicopters or fixed-wing aircraft may spread seed or mulch over severely burned areas after wildfires. Recent developments in technology have led to precise aerial herbicide application methods, including helicopter boom sprayers, spray balls, and on-board computerized mapping, all of which reduce herbicide impacts to non-target species. With both ground-based and aerial delivery options available to the park, the appropriate restoration strategy and technique(s) can be identified and implemented for each unique disturbance in order to achieve the ultimate goal of restoring and maintaining natural diversity and native ecosystems in the park, reducing the threat of severe wildfire, and protecting human health and property.

This EA has been prepared in compliance with the National Environmental Policy Act of 1969 to provide the decision-making framework to: 1) analyze a reasonable range of alternatives to meet the objectives of the proposal, 2) identify and evaluate potential issues and impacts to the resources and values of SNP, and 3) develop mitigation measures to lessen the degree or extent of these impacts. The following issues/topics were identified as potentially being impacted by the proposed action: human health and safety, soils and surface hydrology, water quality and quantity, vegetation, wildlife, special-status species, cultural resources, cultural landscapes, and Wilderness. Each of these topics is discussed and analyzed in this document, and mitigations to reduce impacts are described.

PUBLIC COMMENT

This document will be available for public review for 32 days (from January 24, through February 24, 2014). If you wish to comment on it, you may post comments online at: http://parkplanning.nps.gov/SNPRPEA or mail comments to Superintendent, Saguaro National Park, 3693 S. Old Spanish Trail, Tucson, AZ 85730. Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. Although you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

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CHAPTER 1: PURPOSE AND NEED

1.0 INTRODUCTION

Saguaro National Park (SNP) is developing a programmatic Restoration Management Plan. Prior to implementation of the plan, the National Park Service (NPS) is required to consider, in the form of this Environmental Assessment (EA), potential environmental impacts that may result. This EA has been prepared in accordance with the National Environmental Policy Act, regulations of the Council on Environmental Quality (40 CFR 1508.9) and the NPS Director's Order 12 (Conservation Planning, Environmental Impact Analysis, and Decision-making).

For the purposes of this assessment, the project area is defined as all current and future federally owned lands within the legislative boundary of SNP, which includes the Rincon Mountain District (RMD) and the Tucson Mountain District (TMD; Figure 1). Both districts of SNP are located in Pima County, Arizona, and are separated by the city of Tucson. The TMD is located on the western edge of the city and is bordered primarily by Pima County's Tucson Mountain Park to the south, and residential development and other private lands to the north, east, and west. The RMD is located on the eastern edge of Tucson, approximately 30 miles east of the TMD. It is bordered by the Santa Catalina Ranger District of the Coronado National Forest for most of its north, all of its east, and about one third of its south boundaries. Private land with low density housing borders much of the south, all of the west, and part of the north boundaries of this district. Any non-federal lands within park boundaries would be excluded from restoration treatments and activities. Permission by the State Land Office would be acquired prior to any restoration treatments on state lands within the legislative park boundary.

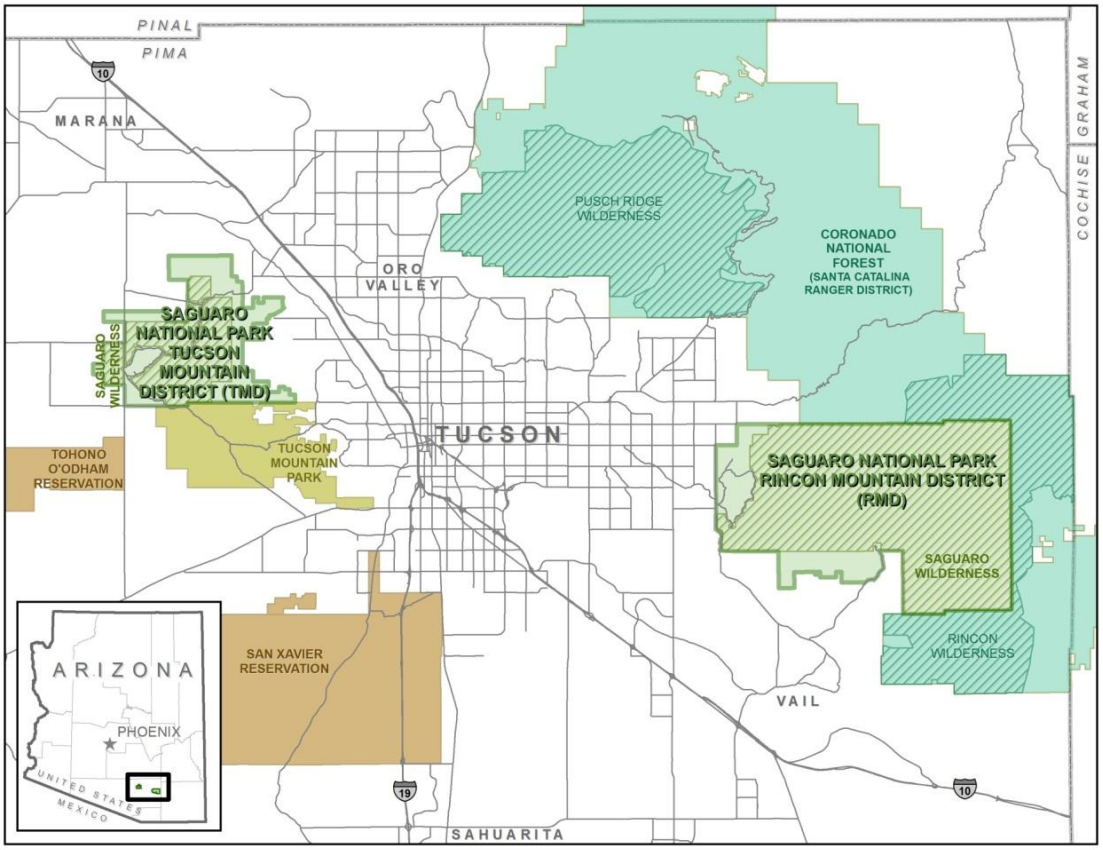

Figure 1. Map showing both districts of Saguaro National Park and wilderness areas in relation to the city of Tucson, AZ, and vicinity.

1.1 BACKGROUND

Saguaro National Park (SNP) protects a superb example of the Sonoran Desert ecosystem featuring exceptional stands of saguaro cacti, important wildlife habitat, and critical riparian areas, as well as associated mountains, or "Sky Islands." SNP also protects significant cultural resources, including national register-listed or national register-eligible archeological resources and historic structures, and places important to American Indian cultural traditions. SNP was established as a National Monument by President Hoover in 1933 (Presidential Proclamation 2032) to preserve and protect these natural and cultural resources and systems. Boundary changes took place in 1961, 1976, 1991, and 1994, and Saguaro changed from a National Monument to a National Park in 1994 (Presidential Proclamation 3439; Public Laws 94-578, 102-61 & 103-364). Preservation of wilderness values was legislatively mandated on October 20, 1976 (PL 94-567), when 71,400 acres were formally designated by Congress as Wilderness in accordance with the provisions of The Wilderness Act. A designated Wilderness Area is "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions…"

Saguaro National Park is currently 91,442 acres, and ranges in elevation from 2,180 feet (TMD) to 8,666 feet (RMD). This elevation gradient translates to very high biodiversity in a relatively small area. These outstanding ecological qualities, which are the very reason the park was established, are increasingly challenging to maintain as conditions within and around the park change. Even before SNP was set aside as a protected area, human habitation and land use practices in the Tucson Basin, such as developing permanent settlements; diverting water; grazing livestock; wood-cutting; hunting and trapping wildlife, particularly predators; introducing exotic species; and either starting or suppressing wildfires caused major impacts to local ecosystems. Such impacts included the dewatering of perennial rivers and streams and loss of desert riparian corridors, and resulted in dramatic changes to vegetation and wildlife abundance and distributions.

The purpose of this Restoration Plan and EA is to enable the park to implement effective and appropriate (i.e., minimal impact to achieve desired results) treatments to restore native ecosystems and processes, and to protect human health and property. For the rest of this document the term "disturbance" refers to an impact causing a functional response in an ecosystem. Generally, it will refer to human-caused disturbances that negatively affect native vegetation and increase erosion, and/or alter fire regimes, which can have profound effects on the structure and function of native plant and animal communities. SNP currently has effective ground-based management strategies and techniques available to restore small-scale, road or trail-accessible impacts or disturbances resulting from off-trail hiking and equestrian use, off-road vehicle intrusions, fires, and invasive non-native species, namely plants (SNP 2004). However, current ground-based treatments are not able to keep pace with the spread of invasive non-native plants into remote areas. Invasive non-native plants not only displace native plants, but also increase the risk of wildfire, and threaten SNP's native ecosystems. Nor can ground-based treatments alone provide the burned area rehabilitation needed to protect life and property and/or restore natural ecosystems after large or remote wildfires. Such large-scale disturbances in remote areas of the park are only expected to increase. To effectively address such disturbances, SNP proposes to include the option of aerial delivery of restoration treatments to the park's Restoration Plan.

Human-Caused Disturbance – Invasive Non-Native Plants

The spread of invasive non-native plants within SNP has become an urgent management issue. Executive Order 1311 defines an invasive non-native plant as "an aggressive non-native plant that is known to displace native plant species. Invasive non-native species are unwanted plants which are harmful or destructive to man or other organisms." It is these invasive non-native plants that threaten the park's natural resources and pose potential irreversible ecological damage (Powell et al. 2006). Invasive non-native grasses, specifically, buffelgrass (*Cenchrus ciliaris* syn. *Pennisetum ciliare*), fountain grass (*Cenchrus setaceus* syn. *Pennisetum setaceum*), Lehmann's lovegrass (*Eragrostis lehmanniana*), African lovegrass (*Eragrostis echinochloidea*), and soft feather pappusgrass (*Enneapogon cenchroides*)] are of particular concern in the park, with buffelgrass currently by far the largest, most serious problem (SNP 2004, AZWIPWG 2005).

The ecological impacts of buffelgrass are well documented, and its establishment and spread is a threat to the integrity of the Sonoran Desert ecosystem (AZWIPWG 2005, Stevens and Falk 2008). Buffelgrass is able to colonize both disturbed and undisturbed sites from sea level to around 5,000 feet elevation, where it forms large continuous monocultures that out-compete and displace Sonoran Desert plant communities, including saguaro cacti (Figure 2). Buffelgrass is spreading rapidly across Arizona's deserts; it was first recorded at SNP in 1989. In 2002, a ground survey of buffelgrass documented approximately 175 acres in the park. Ten years later, aerial mapping efforts estimated approximately 2,000 acres of buffelgrass, primarily large patches in rugged terrain and remote wilderness (Figure 3). Of those 2,000 acres, roughly 500 acres can be reached for ground-based treatment, leaving about 1,500 acres (75%) of the infestation to spread and destroy native vegetation and wildlife habitat.

Manual removal of buffelgrass in SNP began in 1993; and in 2005, efforts to control invasive non-native plants expanded to include ground-based application of herbicides (SNP 2004). Since then, the park has been able to control buffelgrass on approximately 500 acres in several accessible locations.

Figure 2. Buffelgrass infestation near the Freeman Homestead Trail in the Rincon Mountain District of Saguaro National Park.

Figure 3. Aerial photo of a large (about 35 acres) dense buffelgrass patch in a remote area of the Rincon Mountain District of Saguaro National Park.

The other invasive non-native plant that the park has thoroughly mapped and is actively managing is tamarisk, which is most problematic along Rincon Creek on the park's southern boundary. In 2006, when Rincon Creek experienced a 100-year flood event, thousands of tamarisk seedlings sprouted throughout lower Rincon Creek. These seedlings came from a few large trees on private property and were eventually removed by park restoration crews, who continue to survey the area annually. In 2011, there were 72 known tamarisk trees in SNP, all of which were either manually removed or treated with herbicides.

Despite these efforts, the spread of invasive non-native plants in the park is outpacing treatment efforts, and many of the infested areas are inaccessible for ground-based treatments. Thus, this document proposes the addition of aerial delivery of restoration treatments, including herbicides in certain circumstances, to effectively restore native ecosystems in the park, and protect human health and property. This EA also evaluates SNP's need to respond to and treat disturbances from any known, currently undiscovered, and/or future invasive non-native plant infestations.

Surveying for new invasive non-native plants is an ongoing effort. Seven non-native plant species have been added to the park's flora since 2006, five of which are considered invasive. Of the 87 non-native plant species documented in the park about 26 are currently considered invasive (Table 1), though species currently not considered invasive can become problems in the future. Many horticultural plants have become invasive in natural areas, for example fountain grass. Many more, such as tamarisk (*Tamarix* spp.) and buffelgrass, were intentionally introduced by government agencies and other landowners for various reasons.

Other large-scale and/or remote disturbances in the park that require restoration include: impacts from past land management practices, such as grazing; developments, such as roads and mines; and agency responses to accidents, wildfires, or other incidents (Backer et al. 2004).

Table 1. Non-native plants known to be present in Saguaro National Park (emboldened species are invasive non-native plants currently under management).

Scientific Name[1]	Common Name	Scientific Name	Common Name
Agrostis semiverticillata	beardless rabbitsfoot grass	*Lamarckia aurea*	goldentop grass
Agrostis stolonifera	creeping bentgrass	*Malva parviflora*	little mallow
Asphodelus fistulosus[2]	**onionweed**	***Marrubium vulgare***	**horehound**
Avena fatua	wild oats	***Matthiola longipetala***	**evening stock**
Avena sativa	common oats	*Medicago polymorpha*	bur clover
Bothriochloa ischaemum	**yellow bluestem grass**	*Medicago sativa*	alfalfa
Brassica nigra	black mustard	*Melilotus officinalis*	sweet clover
Brassica tournefortii	**Sahara mustard**	***Melinis repens***	**natal grass**
Bromus catharticus	rescue grass	***Nerium oleander***	**oleander**
Bromus rubens	red brome	***Nicotiana glauca***	**tree tobacco**
Bromus tectorum	**cheat grass**	***Opuntia engelmanii var. linguiformus***	**cow's tongue prickly pear**
Caesalpinia gilliesii	Mexican bird of paradise	***Panicum antidotale***	**blue panic grass**
Capsella bursa-pastoris	shepherd's purse	***Parkinsonia aculeata***	**Mexican palo verde**
Cenchrus ciliaris[3]	**buffelgrass**	*Paspalum dilatatum*	dallis grass
Cenchrus setaceus	**fountain grass**	*Phalaris canariensis*	canary grass
Cenchrus spinifex	coastal sandbur	*Phalaris minor*	littleseed canary grass
Centaurea melitensis	**Malta starthistle**	*Phleum pratense*	timothy grass
Cerastium gracile	slender chickweed	*Physalis peruviana*	Peruvian ground cherry
Chenopodium graveolens var *neomexicanum*	fetid goosefoot	*Poa annua*	annual bluegrass
Chenopodium murale	lambs quarter	*Poa pratensis*	Kentucky bluegrass
Convolvulus arvensis[3]	field bindweed	*Polygonum persicaria*	spotted lady's thumb
Conyza bonariensis	flaxleaved fleabane	*Polypogum aviculare*	prostrate knotweed
Cortaderia selloana	pampus grass	*Polypogon monspeliensis*	annual rabbit's foot grass
Cynodon dactylon	**Bermuda grass**	*Polypogon viridis*	beardless rabbit's foot grass
Cyperus esculentus	yellow nutsedge	***Rhus lancea***	**African sumac**
Dactyloctenium aegyptium	Egyptian grass	*Rumex acetosella*	sheep sorrel
Descurainia sophia	herb sophia	*Rumex crispus*	curly dock
Digitaria ciliaris	southern crab grass	***Salsola spp.***	**Russian thistle**
Digitaria sanguinalis	hairy crab grass	*Schismus arabicus*	Arabian schismus
Dimorphotheca sinuata	**African daisy**	*Schismus barbatus*	Mediterranean grass
Echinochloa colonum	jungle rice grass	*Sisymbrium altissimum*	tumble weed
Echinochloa crus-galli	barnyard grass	*Sisymbrium irio*	London rocket
Enneapogon cenchroides	**soft feathered pappus grass**	*Sonchus asper*	spiny sow thistle
Eragrostis cilianensis	stink grass	*Sonchus oleraceus*	common sow thistle
Eragrostis curvula	weeping lovegrass	***Sorghum halepense***	**Johnson grass**
Eragrostis echinochloidea	**African lovegrass**	***Tamarix aphylla***	**athel**
Eragrostis lehmanniana	**Lehmann's lovegrass**	***Tamarix aralensis***	**Russian saltcedar**
Erodium cicutarium	filaree	***Tamarix ramosissima***	**saltcedar**
Galinsoga parviflora	gallant soldier	*Taraxacum laevigatum*	rock dandelion
Herniaria hirsuta ssp. cinerea	hairy rupturewort	*Taraxacum officinale*	common dandelion
Hordeum murinum	wild barley	*Tribulus terrestris*[3]	puncture vine
Hordeum vulgare	common barley	*Verbascum thapsus*	mullein
Kochia scoparia	mock cypress	*Vulpia myuros*	rat tail fescue
Lactuca serriola	prickly lettuce	∑ =	87

[1] *Nomenclature from Natural Resources Conservation Service PLANTS database (http://plants.usda.gov; accessed September 2013)*
[2] *Federal Noxious Weed List (http://plants.usda.gov/java/noxious; accessed September 2013)*
[3] *Arizona Noxious Weed List (http://plants.usda.gov/java/noxious?rptType=State&statefips=04; accessed September 2013)*

Natural Disturbance – Fire

Despite the common perception that SNP is all desert, more than half (about 47,000 acres) of the park is grassland, woodland, or forest. Fire occurs naturally throughout these higher elevation ecosystems, where it plays a critical role in ecosystem function (Baisan and Swetnam 1990). From the late 17th century to the late 19th century, fires burned on Mica Mountain (the highest peak in the park) regularly, averaging every 6 to 9 years for pine and mixed conifer forests, respectively.

In these high elevation plant communities, allowing natural (lightning-caused) fires to burn improves overall ecosystem health. Benefits of these wildfires include reducing fuel loads, which in turn reduce the intensity of future fires; creating a shifting mosaic of different habitats; recycling nutrients, thereby increasing plant productivity; maintaining fire-adapted plant and animal populations; and reducing invasive non-native plant infestations.

Although fire is a natural disturbance to the park's fire-adapted ecosystems, fire severity has increased over the last several decades in the southwest due to increased fuel loads resulting from fire suppression policies, insect damage to trees, and a warming and drying climate (Brown et al. 2004, Jenkins et al. 2013). SNP was one of the first places in the country to switch from suppressing all fires to attempting to let lightning-caused fires assume more of their natural role (van Wagtendonk 2007). Even so, for a variety of reasons, most natural fires that have started in SNP have been suppressed. This means that fuels such as pine needles, branches, snags, shrubs, and saplings have been accumulating, and the tree and shrub canopy has become more closed, all of which can create a scenario for an intense, potentially catastrophic, wildfire (Covington and Moore 1994, Rollins et al. 2001, Villarreal and Yool 2008). Such wildfires not only destroy forests, but can cause severe soil erosion that can lead to flooding and debris flows after heavy rains.

Unlike the upper elevations of the park, historically, fire was rare in the Sonoran Desert (Humphrey 1974). Sonoran Desert plants are adapted to obtain and store water, not to resist fire. In fact, many are very sensitive to fire damage, notably saguaros and palo verdes (Cable 1967, Rogers and Steele 1980, McLaughlin and Bowers 1982, Thomas 1991, Wilson et al. 1995). This has changed, however, with the invasion of non-native grasses which have introduced fire into the Sonoran Desert. Following wet winters in the 1970's-1990's, red brome and Mediterranean grass (winter annuals) fueled unnatural fires throughout the Sonoran Desert (Schmid and Rogers 1988). Currently, buffelgrass and other non-native warm season perennial grasses are creating unprecedented large patches of continuous fuel in the Sonoran Desert (McDonald and McPherson 2011, Marshall et al. 2012). Buffelgrass, which is very fire-adapted, facilitates the introduction of fire into an ecosystem and increases fire size, intensity, and frequency (Marshall et al. 2012; Figure 4). Mortality of native desert plants from buffelgrass fires is very high due to the hotter temperatures, higher flame lengths, and prolonged residual burning; and plant cover in burned Sonoran Desert areas can take decades to recover to pre-burn levels, if non-native plants do not get established first (Abella 2009). Similarly, many desert wildlife species, particularly reptiles, such as desert tortoise and Gila monsters, are injured or killed by fire in the desert, though the greater impacts to wildlife are from habitat destruction (Esque et al. 2002, 2003).

Since low elevation wildfires have more potential to burn into developed areas, post -burn rehabilitation treatments to mitigate damage from wildfires in the Sonoran Desert are likely to become important for protecting human life and property in the future. Such rehabilitation will also be needed to restore Sonoran Desert vegetation communities, as they are unlikely to recover naturally.

SNP also experiences other natural disturbances (e.g., floods) that could require large-scale restoration treatments in remote areas to protect life and property and/or restore natural ecosystem processes and function.

Figure 4. Prescribed burn in buffelgrass in Avra Valley, Arizona, 2008. Flame lengths of this fire exceeded 15 feet.

1.2 PURPOSE AND NEED

The vegetation communities the park was established to protect are under threat by the spread of invasive non-native plants, such as buffelgrass, that displace native vegetation, increase the potential for wildfire in the desert ,and threaten the native ecosystems that the park was established to protect. SNP has found that the ground-based restoration techniques currently used to treat invasive non-native plants are inadequate to keep pace with their spread and new treatment methods are needed to stop degradation of important park resources (e.g., saguaros and other Sonoran Desert plants). Approximately 2,000 acres of the park are currently infested with buffelgrass, and only about 500 acres are accessible for ground-based restoration treatments. This leaves the majority of the threat unmanaged, and park resources at risk. If these remote infestations are left untreated, research indicates that buffelgrass has the potential to spread throughout most of the park below 5,000 feet elevation, and displace the native Sonoran Desert plant communities (SNP 2012). Additional restoration techniques are needed to treat and restore areas impacted by invasive non-native plants, wildfire, and other large-scale and/or remote disturbances that can destroy native vegetation, cause extensive soil erosion, and degrade water sources and wildlife habitat, including sensitive riparian areas.

This plan will serve as is a decision-making tool that will enable SNP to more effectively:

1. Restore ecosystem processes, structure and function in disturbed areas;
2. Maintain ecosystem processes, structure and function in undisturbed areas;
3. Maintain and restore Wilderness character, reducing negative impacts from human actions;
4. Establish a decision-making process for identifying and implementing effective and appropriate (i.e., the least impact to provide the desired results) restoration strategies and treatments; and
5. Protect human health and property within and outside SNP by implementing best management practices.

1.3 RELATIONSHIP TO OTHER PLANS AND POLICIES

SNP is mandated to manage the park's natural and cultural resources in such a manner as to leave them unimpaired for the enjoyment of future generations, including addressing threats and restoring disturbed areas. The following plans and policies apply to the management of park resources. All restoration strategies and techniques proposed in this plan are consistent with these documents.

The NPS Organic Act of 1916 (Title 16 of U.S. Code, Ch. 1)

The Act that established the National Park Service states, "The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations… by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The Act was reaffirmed by Congress in 1970 in 16 USC 1a-1, the "General Authorities Act," which added more specific guidance, particularly regarding leaving park resources "unimpaired."

Presidential Proclamation, March 1, 1933

President Herbert Hoover created Saguaro National Monument, to protect for "the public interest" its "outstanding scientific interest because of the exceptional growth thereon of various species of cacti, including the so-called giant [saguaro] cactus".

The Wilderness Act of 1964

This Act established a national wilderness preservation system, "administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness." The Wilderness Act gives the land manager responsibility for preserving the wilderness character of the area and devoting the area to the public purpose of recreational, scenic, scientific, educational, conservation, and historical use.

Executive Order 13112: Invasive Species (1999)

Federal agencies are responsible for preventing the introduction of invasive species, detecting and responding rapidly to and controlling their populations in a cost-effective and environmentally sound manner, and providing for restoration of native species and habitat conditions in ecosystems that have been invaded. This order also includes monitoring, conducting research, developing technologies to provide for environmentally sound control of invasive species, and promoting public education about invasive species and treatments.

NPS Management Policies 2006

4.4.1 General Principles for Managing Biological Resources

This regulation requires the NPS to "maintain as parts of the natural ecosystems of parks all plants and animals native to park ecosystems…by preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur; restoring native plant and animal populations in parks when they have been extirpated by past human-caused actions; and minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them."

4.4.4 Management of Exotic Species

This section mandates that non-native plants be managed if control is "prudent and feasible" and if non-native species causes harm, including if a species interferes with natural processes and the perpetuation of natural features, native species or natural habitats, or damages cultural resources, or significantly hampers the management of park or adjacent lands, or creates a hazard to public safety.

4.4.5.2 Integrated Pest Management Program

This section directs the NPS and each park unit to use an integrated pest management (IPM) approach to address pest issues in order to reduce risks to the public, park resources, and the environment from pests and pest-related management concerns. It states that proposed pest management activities must be conducted according to the IPM process prescribed in Director's Order #77-7: *Integrated Pest Management*.

5.3.1 Protection and Preservation of Cultural Resources

This section states that the "National Park Service will employ the most effective concepts, techniques, and equipment to protect cultural resources against theft, fire, vandalism, overuse, deterioration, environmental impacts, and other threats without compromising the integrity of the resources."

Saguaro National Park Planning Documents

SNP Fire Management Plan (2007)

SNP General Management Plan (2008)

SNP Comprehensive Trails Management Plan (2009)

These park planning documents all identify the need for and/or importance of monitoring and controlling non-native species to protect park resources.

Arizona Administrative Code Regulations

AZ R3-4-244 Regulated and Restricted Noxious Weeds

AZ R3-4-245 Prohibited Noxious Weeds

The State of Arizona requires monitoring and eradication/control of non-native plants that are listed in state law as Arizona noxious weeds, several of which occur in SNP, including buffelgrass.

1.4 SCOPING

Scoping is an early and open process to determine the breadth of environmental issues, to identify the issues and resources that may be affected by the plan, and to explore alternative ways of achieving the plan's objectives while minimizing adverse impacts. Internal scoping regarding aerial delivery of herbicides and other restorations treatments has been ongoing since 2008, led by an interdisciplinary team of NPS professionals from SNP, the Intermountain Regional Office, and the Southern Arizona Group Office.

In 2008, when it became clear that ground-based restoration efforts were insufficient to keep up with the spread of buffelgrass in the park, a process was initiated to evaluate the use of helicopters for aerial application of herbicides, specifically for the control of buffelgrass. In early 2009, as part of an effort to introduce this issue to the public, SNP met with representatives of local environmental organizations to identify any concerns they and their constituents might have about aerial delivery of herbicides on parklands. SNP described the impacts and threats of buffelgrass establishment in the park, and the proposed application technologies (helicopter mounted boom and/or spray ball).

In February 2009, the Coronado National Forest hosted a workshop in Tucson on aerial herbicide technology. The workshop included presentations on the equipment and herbicides used, digital aerial sketch mapping, global positioning system (GPS) navigation systems, aircraft sprayer calibration, and

herbicide drift. A demonstration by a helicopter with a spray boom configuration was conducted over a parking lot using water and dye. The purpose of the demonstration was to show stakeholders, including SNP staff, the technology and equipment that were available.

In the summer of 2009, a test application using a helicopter with a spray boom was proposed to be evaluated in Pima County's Tucson Mountain Park. Two public meetings, hosted by the U.S. Forest Service, Pima County, University of Arizona, National Park Service, Bureau of Land Management, and the City of Tucson, were held prior to approval by the Pima County Board of Supervisors. Unfortunately, the project had to be postponed due to lack of precipitation, which prevented the buffelgrass from actively growing; thus the herbicide would not have been effective.

In the summer of 2010, another public meeting was held prior to the aerial test. The actual spraying of twelve, one-acre plots took place in Tucson Mountain Park in August, 2010. Since then three years of post-treatment vegetation monitoring to evaluate the effectiveness of different herbicide application rates and concentrations have taken place. Results are presented in Appendix A. In addition to the spray boom configuration, a helicopter with a suspended spray ball that administers herbicide very precisely was also demonstrated in the Ironwood Forest National Monument. However, only water and dye were used in the spray ball demonstration, which was conducted to examine the safety, maneuverability and accuracy of this alternate equipment.

The positive results of both demonstrations, and additional information gained from local buffelgrass research and other scientific studies, have proven the efficacy of these methods and have prompted SNP to propose aerial spraying of non-native invasive plants, specifically buffelgrass, in the park. In 2012, SNP began an environmental assessment of potential post-disturbance restoration treatments and activities, including the use of helicopters for aerial application of herbicides, seeding, and mulching.

In May, 2012, SNP sent 47 letters to notify and solicit comments from local, state and federal land management agencies, environmental organizations, and other interested parties that had previously expressed interest in SNP's planning activities. During this same time frame, scoping letters were also sent to the U.S. Fish and Wildlife Service, the Arizona State Historic Preservation Office, the Army Corps of Engineers, and eight Native American tribes. The project was initiated in the NPS's web-based Planning, Environmental and Public Comment (PEPC) system, and opened for public comment with a public scoping letter on May 21, 2012.

In November, 2012, representatives from local environmental organizations were invited to attend a pre-scoping meeting to identify issues and concerns their organizations may have with the proposal. Representatives from the Center for Biological Diversity, National Parks and Conservation Association, The Nature Conservancy, Public Employees for Environmental Responsibility, Sierra Club, Southern Arizona Buffelgrass Coordination Center, Tucson Mountains Association and the Wilderness Society participated in the meeting on November 15. At the conclusion of the meeting there was general support for the planning efforts and proposed alternative.

Also in November, 2012, invitations to a public Open House on November 27 regarding this plan and associated EA were mailed to over 500 individuals, organizations, and agencies. Press releases, SNP's website and Facebook page, and radio/newspaper announcements were also used to notify the public. Forty-eight individuals signed in, and 15 comments were received at the Open House on November 27.

A total of 39 comments were received during the entire scoping period (May 21-December 31, 2012). These comments were received at the November Open House, by mail, email or posted directly into PEPC. Additional informal meetings were held after the official scoping period with the conservation

chair of the Arizona Chapter of the Sierra Club (1/3/13), one neighborhood group adjacent to the park (1/11/13), and a chemically sensitive advocacy group (2/13/13). These meetings were held at the request of the constituents to provide information that was prepared for and presented at the public open house and to answer any questions.

1.5 IMPACT TOPICS RETAINED FOR FURTHER ANALYSIS

Impact topics are the resources or issues of concern that could be affected by the range of alternatives. NPS specialists used federal laws, regulations, management policies, and scoping results to identify the impact topics retained for further analysis. Impact topics are organized to facilitate the analysis of environmental consequences and allow for a standard comparison between alternatives based on the most relevant information. Impact topics that are carried forward for further analysis in this EA include:

- Human Health and Safety
- Soils and Surface Hydrology
- Water Quality and Quantity
- Vegetation
- Wildlife
- Special Status Species
- Archaeological and Historic Resources
- Cultural Landscapes
- Wilderness

1.6 IMPACT TOPICS DISMISSED FROM FURTHER ANALYSIS

Some impact topics have been dismissed from further consideration, as discussed below. During internal scoping, SNP's interdisciplinary team conducted a preliminary analysis of resource topics to determine the context, duration, and intensity of effects that the proposal may have on those resource topics. If the magnitude of effects was determined to be at the "negligible to minor" level, there is no potential for significant impact, further impact analysis is unnecessary, and the resource issue is dismissed as an impact topic. If however, during internal scoping and further investigation, effects remain unknown, or are at the "minor to moderate" level of intensity, then the analysis of that issue as an impact topic is carried forward in the Affected Environment and Environmental Consequences, Chapter 3.

For the purposes of this section, an impact of negligible intensity is one that is "at the lowest levels of detection, barely perceptible, and not measurable." An impact of minor intensity is one that is "measurable or perceptible, but is slight, localized, and would result in a limited alteration or area." Rationales for dismissing these topics from further analysis are given below.

Geology

According to its management policies, the NPS will preserve and protect geologic and topographical resources and features from adverse effects of human activity, while allowing natural processes to continue (NPS 2006). No major earthmoving or blasting activities would occur as a result of this project. Because this project would not affect geology, this topic is dismissed from further analysis in this document. Note that soils are discussed and analyzed in Soils and Surface Hydrology, Section 3.3.

Air Quality

The 1963 Clean Air Act (CAA), as amended (42 USC 7401 et seq.), provides that federal land managers have a responsibility to protect values relating to air quality (including visibility, vegetation, wildlife, soils, water quality, cultural and historic resources and objects, and public health) from adverse air pollution impacts. Section 118 of the 1963 CAA requires SNP to meet all federal, state, and local air pollution standards. Section 176(c) of the 1963 CAA requires all federal activities and projects to conform to state air quality implementation plans to attain and maintain national ambient air quality standards. NPS Management Policies also address the need to analyze potential impacts to air quality during park planning.

As a wilderness area, SNP is classified as a Class 1 Area under the CAA. Class 1 Areas are granted special air quality protections under Section 162(a) of the CAA. Maximum allowable increases of sulfur dioxide (SO2), particulate matter (TSP), and nitrogen oxides (NOx) beyond baseline concentrations established for Class 1 Areas cannot be exceeded. The CAA also sets a national goal to restore natural visibility to Class 1 Areas. The City of Tucson is classified as Carbon Monoxide Maintenance Area; however, both districts of SNP fall outside of the city's Maintenance Area boundaries.

There could be some slight impacts to air quality from implementing this plan from the use of gasoline-powered string trimmers, chainsaws, vehicles or aircraft that would cause some exhaust emissions and dust during use of aircraft take-off and landings; and the use of inorganic chemicals and organic plant material could pose negligible impacts to air quality, principally from drift. Drift is the movement of particulates through the air, away from their source or their target location. Generally, the larger the particle, the more directly it falls. SNP proposes to optimize herbicide droplet size (i.e., >600 micrometers, or about the size of medium rain) to minimize herbicide drift and maximize coverage. Thus, impacts to air quality from herbicide drift will be slight and mitigated by limiting herbicide application to days when winds are less than 10mph, controlling droplet size, and flying as low as safely possible when spraying (see Best Management Practices in Section 2.4). During the test applications in the Tucson Mountain Park, there was no substantial (more than 5%) drift 75 feet from the targeted locations, and computer models of the drift indicated that only 1% of the application rate occurred 90 feet downwind (see Appendix A).

Potential air quality impacts from burning of herbicides on vegetation during a wildfire would be insignificant for a number of reasons. A relatively small amount of herbicide is applied on a per acre basis; the chemicals begin to be absorbed and degraded almost immediately after spraying; and a fire would not be likely to spread in treated areas until the vegetation became brown, two or more weeks after spraying. Much of the small amount of herbicide potentially remaining if a fire burned would be degraded by the heat of the fire. Studies have found no detectable herbicide residues in smoke from burning vegetation (McMahon and Bush 1992).

Because impacts to air quality would be insignificant and would not exceed Class I Area baseline concentrations, air quality is not addressed as an impact topic in this document.

Floodplains

Executive Order 11988 (Floodplain Management) requires an examination of impacts to floodplains and potential risk involved in placing facilities within floodplains. A review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map indicates SNP is located in Zone D, defined as an area "in which flood hazards are undetermined, but possible." Impacts on floodplains typically occur when the topography within a floodplain is substantially modified either by placement or removal of materials within the floodplain. This project will not noticeably modify materials within a floodplain or change the ability of a floodplain to convey flood waters or its values and functions. Therefore, floodplains are not addressed as an impact topic in this document. Soil erosion is discussed and analyzed in Soils and Surface Hydrology, Section 3.3.

Sole Source Aquifer

The U.S. Environmental Protection Agency's (EPA) Sole Source Aquifer (SSA) program was established under the authority of Section 1424(e) of the Safe Drinking Water Act. The SSA program allows for EPA environmental review of any project which is federally funded to evaluate and determine whether or

not a project has the potential to contaminate a sole source aquifer (i.e., more than 50% of a community's drinking water is supplied by the aquifer). SNP is located within the Upper Santa Cruz and Avra Basin Sole Source Aquifers, and the park consulted with the EPA for this project, but received no response. This project meets all federal, state, and local groundwater protection standards; therefore, Sole Source Aquifer is not addressed as an impact topic in this document. Water Quality and Quantity is discussed and analyzed in Section 3.4.

Prime and Unique Farmlands

The Farmland Protection Policy Act of 1981, as amended, requires federal agencies to consider the adverse effects to prime and unique farmlands that would result in the conversion of these lands to non-agricultural uses. The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), in cooperation with other interested federal, state, and local government organizations, have inventoried land that can be used for the production of the nation's food supply. According to NRCS, the soils within the project area are not classified as prime or unique farmlands; therefore, prime and unique farmlands are not addressed as an impact topic in this document.

Soundscape Management

Natural sounds are intrinsic elements of the environment that are often associated with parks and park purposes and values. They are inherent components of "the scenery and the natural and historic objects and the wildlife" protected by the NPS Organic Act. Natural sounds are vital to the natural functioning of many parks and may provide indicators of the health of various ecosystems. The NPS is mandated by Director's Order 47: Soundscape Preservation and Noise Management, to protect, maintain or restore the natural soundscape unimpaired by inappropriate or excessive noise, to the fullest extent practicable. Activities proposed in this plan would include use of motorized equipment, including vehicles and aircraft. Noise impacts would be local, short-term, and generally unnoticeable, and, after restoration treatments are complete noise levels would return to the natural condition; therefore, soundscape is not addressed as an impact topic in this document. Much of the project will occur in designated wilderness, however, and noise from motorized equipment is discussed in detail under the Wilderness impact topic (Section 3.10).

Lightscape Management

NPS strives to preserve natural ambient lightscapes, which are natural resources and values that exist in the absence of light created by humans (NPS 2006). The proposed action only occurs during daylight hours and would not increase outdoor lighting. There are no effects on lightscape management; therefore, this topic is dismissed from further analysis in this document.

Climate Change and Sustainability

The impacts of climate change may affect SNP and contribute to ecological disturbances to SNP's resources. Although climatologists are unsure about the long-term effects of global climate change, it is clear that the planet is experiencing a warming trend that affects ocean currents, sea levels, polar sea ice, and global weather patterns. Research is currently being conducted to determine how climate change will affect SNP's natural and cultural resources. While results have not been published at this time, it is widely accepted that changes in the climate would likely have an effect on SNP's ecosystems and would contribute to large and small-scale disturbances, such as altered fire regimes and changes in invasive non-native and native species' habitat ranges. However, it would be speculative to predict

specific effects on SNP's natural resources, in part because there are many variables that are not fully understood and there are undoubtedly variables not currently identified. Conversely, post-disturbance restoration treatments and activities will not produce measurable impacts to the global phenomena of climate change; therefore, this topic is dismissed from further analysis in this document.

Indian Trust Resources

Secretarial Order 3175 (Departmental Responsibilities for Indian Trust Resources) requires that any anticipated impacts to Indian trust resources from a proposed project or action by the Department of Interior agencies be explicitly addressed in environmental documents. The federal Indian trust responsibility is a legally enforceable fiduciary obligation on the part of the U.S. to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal law with respect to American Indian and Alaska Native tribes. No parklands or resources identified in the project area are held in trust by the Secretary of the Interior for the benefit of American Indians; therefore, Indian Trust Resources are not addressed as an impact topic in this document.

Ethnographic Resources

Ethnographic resources are defined by NPS as a "site, substance, object, landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it" (Director's Order 28: Cultural Resource Management). American Indian tribes traditionally associated with SNP, including the Ak-Chin Indian Community Council, Gila River Indian Community Council, Hopi Tribe, Mescalero Apache Tribe, Pascua Yaqui Tribe, San Carlos Apache Tribe, Tohono O'odham Nation, and Zuni Tribe, were apprised of the proposed action by letter on May 18, 2012. On January 23, 2013, park staff met with Tohono O'odham tribal cultural representatives in Sells, Arizona. The NPS will continue to consult with these tribes, and copies of the environmental assessment will be forwarded to each group for review or comment. If subsequent issues or concerns are identified, appropriate consultations will be undertaken; therefore, ethnographic resources are not addressed as an impact topic in this document. Cultural Resources are discussed and analyzed in Section 3.8.

Museum Collections

According to Director's Order 24: NPS Museum Collections Management, the NPS requires the consideration of impacts on museum collections (historic artifacts, natural specimens, and archival and manuscript material), and provides further policy guidance, standards, and requirements for preserving, protecting, documenting, and providing access to, and use of, NPS museum collections. SNP has museum collections stored in two facilities within SNP, as well as at the Western Archaeological and Conservation Center, and the University of Arizona. Since these collections would not be impacted by implementation of this plan, this topic is dismissed from further analysis in this document.

Environmental Justice

Executive Order 12898: General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. The proposed action would not have disproportionate health or environmental effects on any communities, including minorities or low-income populations or communities as defined in the

Environmental Protection Agency's Environmental Justice Guidance of 1998; therefore, environmental justice is not addressed as an impact topic in this document.

Socioeconomics

Socioeconomics refer to local and regional businesses and residents, and local and regional economies. The local economy and most business in neighboring communities are based on construction, recreation, transportation, tourism, services, and educational research; the regional economy is strongly influenced by tourist activity. Activities proposed in this plan would require some closures of certain remote areas of the park for limited periods, but would not deter people from visiting SNP or neighboring communities; therefore, socioeconomics are not addressed as an impact topic in this document.

Visitor Use and Experience and Recreation Resources

Visitor use and experience and recreation resources include park access, scenery, and recreational opportunities. The annual average recreational visitation to SNP over the last five years is approximately 620,000, and activities include scenic driving, picnicking, hiking, wildlife viewing, horse-back riding, cycling, and backpacking. Visitor access, enjoyment of the scenery, and opportunities for solitude may be impacted in areas of SNP for short periods of time during treatment of a disturbed area under this plan. Visitors may encounter park staff, hear motorized equipment, or see areas of restoration treatment. These would be short-term and very limited. There will be long-term benefits as a result of restoring disturbed lands, which will have positive impacts on visitor use, experience and recreational resources. All of these impacts would be negligible to minor to visitor use, experience, and recreation resources; therefore this topic is not addressed as an impact topic in this document. The impacts to visitors' enjoyment of wilderness is discussed and analyzed in the Wilderness impact topic (Section 3.10).

Park Operations

Park operations refer to adequacy of staffing levels and the quality and effectiveness of park infrastructure in protecting and preserving park resources and providing for positive visitor experiences. It also refers to levels of park staff, funding, and time needed to accomplish a project. The cost to prevent disturbances is far less than the cost to mitigate the impacts of the disturbance; however, funding is limited for such activities, and preventing all natural or anthropogenic disturbances is not possible. Activities associated with post-disturbance restoration treatments and operations would involve relatively few park staff for short periods of time; therefore, Park Operations is not addressed as an impact topic in this document.

CHAPTER 2: ALTERNATIVES

2.0 INTRODUCTION

In 2011, an interdisciplinary team of National Park Service (NPS) employees met to identify and discuss the restoration needs of the park and develop alternatives for meeting those needs. The team articulated the objectives of the park's restoration program, and considered seven potential action alternatives, in addition to the No Action Alternative (NAA). Six of these alternatives were subsequently deemed infeasible or inadequate to address the park's needs (see section 2.1). Thus, only one action alternative, the Proposed Action Alternative (PAA), and the NAA, are presented and analyzed in this document.

The two alternatives presented in this EA are very similar; and it is important to note that any current or future restoration treatments applied to disturbed areas in the park, under either alternative, will be beneficial to park resources. As described in Chapter 3, they could also have some minor short-term adverse impacts. The only difference between the alternatives is the additional option of aerial delivery of treatments (i.e., seeds, mulch and/or herbicides) in the PAA. This would allow for the treatment of large scale and/or remote disturbed areas, which has not been previously analyzed and approved in an environmental assessment document.

2.1 ALTERNATIVES CONSIDERED AND DISMISSED

The alternatives listed below were considered, but dismissed for the reasons described, as allowed by the NPS Directors Orders #12: Conservation Planning, Environmental Impact Analysis, and Decision-Making.

Use of Backcountry Crews in Spike Camps to Treat Remote Sites

Deploying crews into the backcountry to apply ground-based herbicide would require them to hike to, or helicopters to drop them off at, remote campsites for four to six days at a time. Crews would have to travel each day from their camp to work sites. Because many areas infested with non-native invasive plants are not adjacent to park trails, additional helicopter flights would be needed to deliver supplies, large quantities of water (for mixing with herbicides, drinking, and washing), food and camping gear, and later backhauling the supplies and equipment out of the area. Camp sites would create environmental impacts and require additional restoration work. Invasive non-native plant infestations on some of the steepest slopes in the park would remain untreated because it is impossible to safely access them and conduct restoration treatments. This alternative was dismissed due to its technical and economic infeasibility, inability to meet the project objectives (i.e., invasive non-native plant infestations on steep slopes), and additional environmental and wilderness impacts.

Use of Aircraft to Apply Seeds and Mulch but not Herbicides

The use of aircraft for seeding, mulching, and delivering soil improvements would address post-fire and other large-scale disturbances that cause erosion in remote areas, but it would not address invasive non-native plant infestations, a critical restoration need of SNP. This alternative was dismissed because it would not meet project objectives.

Use of Prescribed Fire

The use of prescribed fire to control invasive plants is a common practice in some regions; however, the Sonoran Desert, where most of the park's invasive non-native plant infestations occur, is not fire adapted so native species would be harmed. Furthermore, the non-native grasses that infest the Sonoran Desert *are* fire-adapted and usually re-establish quickly after a fire. The use of prescribed fire in the lower elevations of the park would not achieve restoration goals and would be an additional

disturbance that would require restoration. This alternative was dismissed because it would not meet project objectives.

Use of Aircraft Only for Restoration Treatments

Using only aircraft to implement restoration treatments (with no ground-based efforts) would not be feasible, effective or efficient for restoring small, accessible disturbed sites. This alternative was dismissed because of its technical and economic infeasibility, and inability to meet project objectives.

Restricting the Use of Aircraft to Treat Non-wilderness Areas Only

Seventy-eight percent of SNP is designated Wilderness. Restricting aerial treatments to non-wilderness areas would not only ultimately harm the "wilderness character" and "naturalness" of wilderness areas in the park, but would negatively affect the ecological integrity of the entire park. This alternative was dismissed because it would not meet project objectives.

Use of Biological Control

Use of biological control to address invasive non-native plants would be considered; however, there is currently no known or approved biological control agent for use against the non-native grasses in SNP. If a safe and reliable biological control agent is identified in the future, its use would be considered in a separate analysis process. This alternative was dismissed because of its technical infeasibility and inability to meet project objectives.

2.2 NO ACTION ALTERNATIVE (NAA)

This alternative proposes a continuation of management practices described and analyzed in the park's current Exotic Plant Management Plan (SNP 2004), including prevention and outreach, and manual and mechanical treatments (including the use of herbicides) to restore small-scale disturbances. Under this alternative, SNP would continue within the scope of the current planning and compliance documents to treat known infestations of invasive non-native plants in the park (see Figures 5 and 6; locations of non-native plants depicted are based on data from ground-based and aerial surveys of buffelgrass, comprehensive surveys of RMD drainages for tamarisk, and opportunistic sightings of other invasive plants.) Figure 7 depicts a typical roadside restoration site before and several years after treatment.

Restoration Strategies

Overall restoration strategies (i.e., passive, facilitated or active) and the specific techniques used to restore damaged parklands depend on a variety of factors, including the location, type and extent of damage, type and health of surrounding native plant communities, and soil characteristics. Decisions are based on professional experience, input from desert restoration experts, and published literature. Each site is unique, and restoration strategies vary greatly in their resource requirements and intensity. The steps for selecting the most effective and appropriate strategy for a given site are outlined below and in Appendix B.

- Passive restoration is recommended when disturbance is minimal, and/or for sites that are expected to recover naturally, within one to two growing seasons. This is a natural approach to restoration that focuses on monitoring, allowing for natural recovery, and intervening minimally, only when necessary. Sites are monitored to establish that desirable native species are recovering, and for the presence of invasive plants, which are removed as detected. Interventions could include installation of barricades or signs to prevent public access into recovering areas (i.e., prevention and education). There is minimal, if any, use of manual and mechanized treatments. If monitoring indicates that the native plant response is poor after the second growing season, a facilitated or active restoration strategy may be employed.

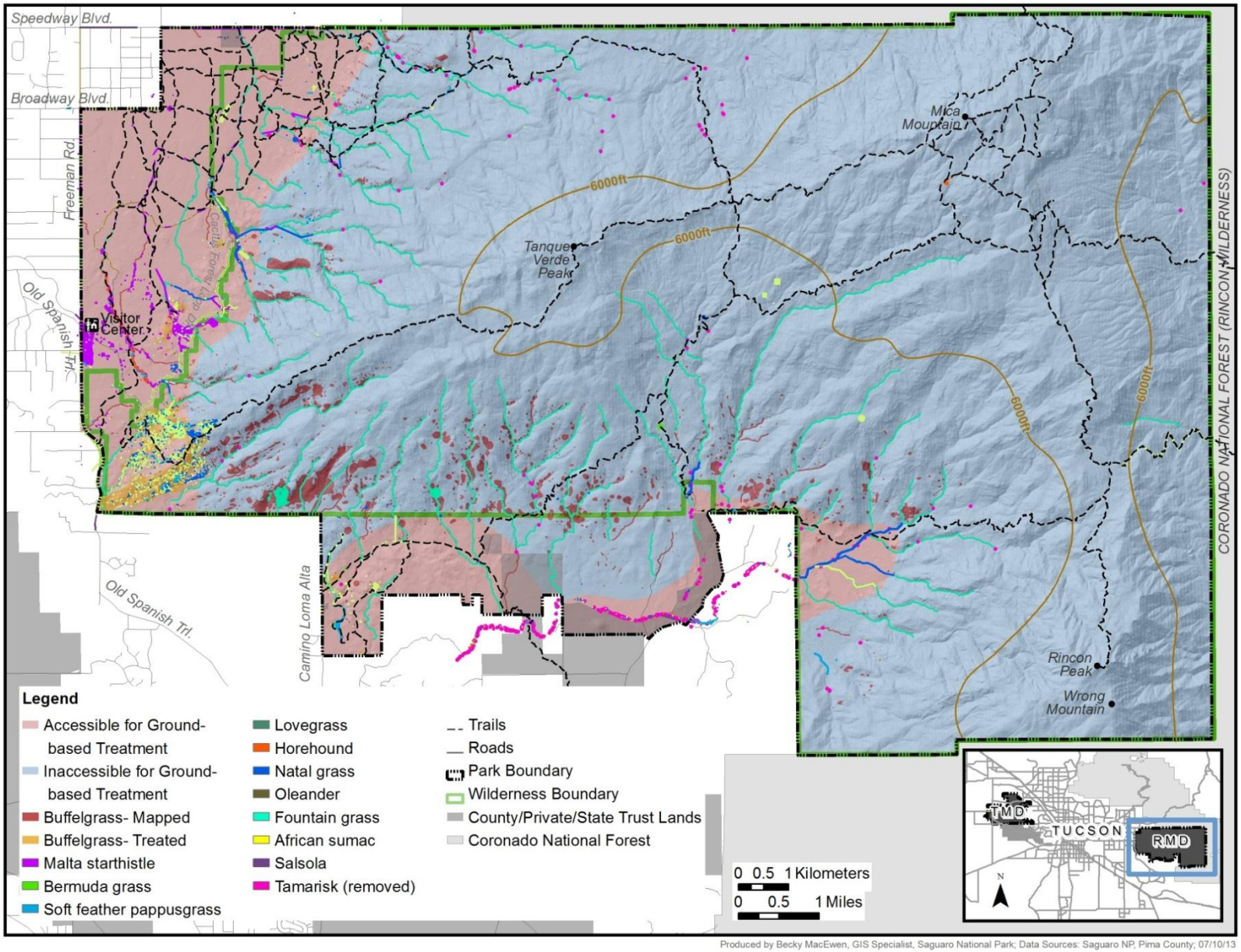

Figure 5. Map of the Rincon Mountain District showing locations of buffelgrass and treatment areas under the No Action Alternative.

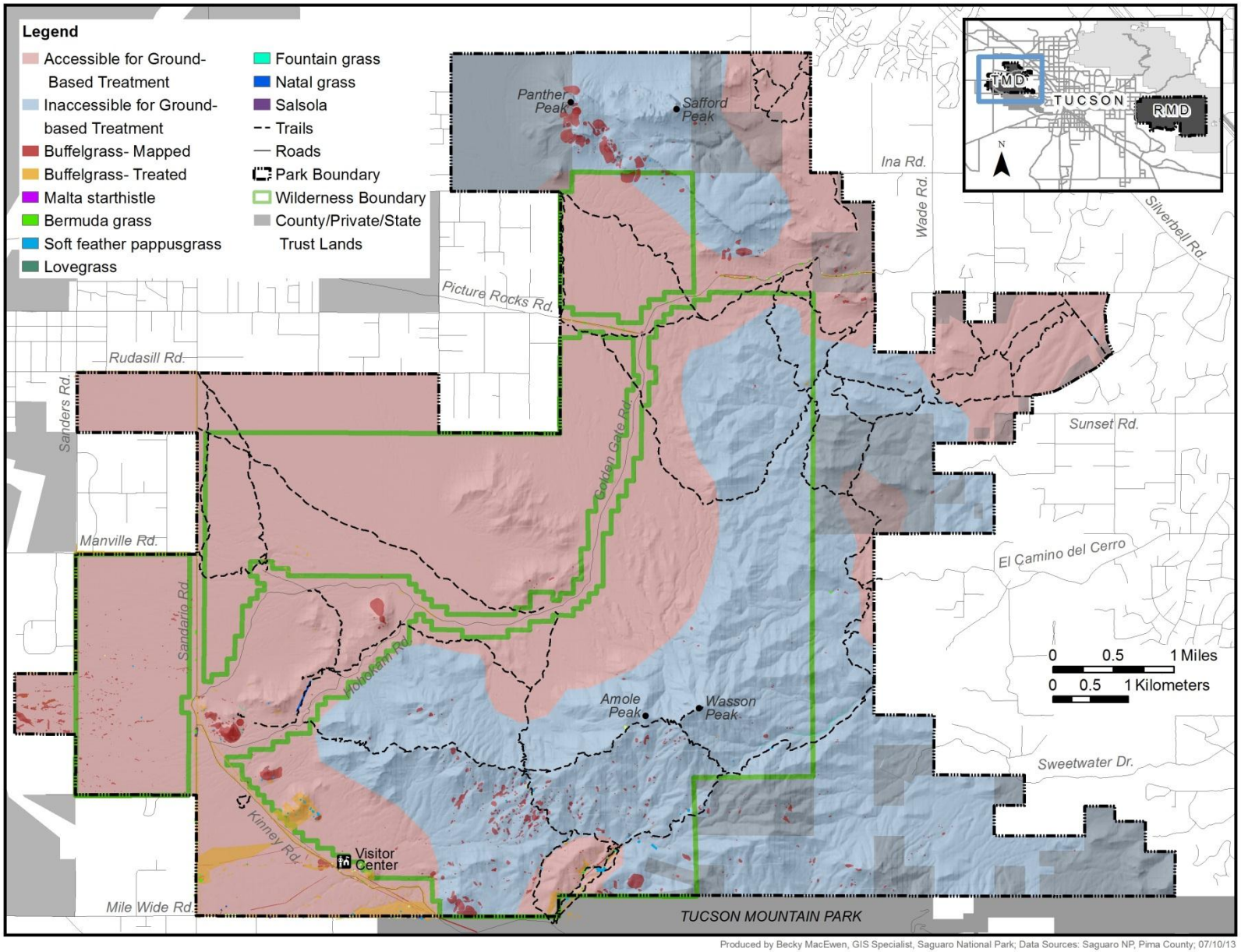

Figure 6. Map of the Tucson Mountain District showing locations of buffelgrass and treatment areas under the No Action Alternative.

- Facilitated restoration is recommended when disturbance at a site is moderate, and native vegetation response is expected to occur in two to three growing seasons. Sites are monitored for native plant recovery, soil erosion, the presence of invasive plants, and treatment effectiveness. Facilitated restoration requires some degree of intervention to assist the native plant community towards a desired condition. Facilitated treatments include prevention and education, use of native seeds and/or live plant material available around the disturbed area to encourage re-vegetation, and ground-based manual and mechanized activities, including herbicide applications. As with passive restoration, if monitoring indicates that the native plant response is poor after the third growing season, a more active restoration strategy may be employed.
- Active restoration is recommended when disturbance at a site is high and the native vegetation response is expected to be moderate to slow, or it may not recover at all without intervention. Active strategies are a more aggressive approach to restoration, and include any or all ground-based treatments identified in Table 2. Local, as well as off-site materials could be used to encourage native re-vegetation. As above, sites are monitored for native plant recovery, soil erosion, the presence of invasive non-native plants, and treatment effectiveness.

Note that the park's restoration program employs an adaptive management approach; that is, sites being restored are monitored and when a chosen strategy or technique proves ineffective, methods are adjusted until they are successful.

Restoration Treatments and Activities

Under the NAA, all park restoration treatments and strategies are implemented from ground-based resources (e.g., humans, vehicles, horses). The most effective treatment depends on the type, location, and extent of the disturbance (see also Appendix B).

A  B 

Figure 7. Before (A) and several years after (B) photographs of a site along a roadside in the park where off-road vehicle use had destroyed native vegetation.

Prevention and Education

Prevention and education treatments are actions that influence human behavior to prevent degradation or further degradation of disturbed sites. These treatments include but are not limited to: public education (displays, brochures, handouts and information on social media), signage, area closures, fencing or other barriers to exclude access or to delineate roads or trails, and cleaning equipment to remove material that might contain seeds or plant propagules before entering the park.

Table 2. Types of ground-based restoration. These activities and treatments would be common to both the No Action and Proposed Action alternatives.

Type	Restoration Activity	Treatment		Comments
		Manual	Mechanized*	
WATERSHED TREATMENTS	Sediment control	x		Primarily removal of sediment from tinajas
SITE PREP	Raking	x	x	
	Tilling/ripping		x	Non-Wilderness only, and only on heavily impacted areas such as old roads
	Soil amendments	x	x	
	Scarification	x	x	
NON-NATIVE PLANT CONTROL	Physical removal	x	x	
	Herbicide application	x	x	
REVEGETATION	Broadcast seeding	x	x	
	Drill seeding		x	Non-Wilderness only
	Transplanting	x		
	Irrigation	x	x	Non-Wilderness only
EROSION CONTROL – CHANNEL TREATMENTS	Sandbags	x		
	Straw bale check dams	x		Weed- and seed-free only
	Straw wattle dams	x	x	Weed- and seed-free only
	One-rock dams	x		
	Gabions	x	x	
	Bank/stream-channel armoring	x	x	
	Grade stabilizers	x	x	
	Check dams	x	x	Relatively flat slopes only
	Channel debris clearing	x	x	
	Geotextile fabric	x		
	Straw mulching	x	x	Weed- and seed-free only

Type	Restoration Activity	Treatment		Comments
		Manual	Mechanized*	
EROSION CONTROL –HILLSOPE TREATMENTS OR SEDIMENT CONTROL	Wood strand mulch	x	x	
	Excelsior straw fabric	x		Wildlife-friendly, monitor for entrapment
	Straw wattles	x		Weed- and seed-free only
	Log erosion barriers	x	x	
	Contour falling	x	x	
	Hydromulch		x	
	Silt fencing	x		
	Rock grade stabilizers	x	x	
	Contour trenching	x	x	Developed areas only
	Geotextile fabric	x		
	Slash spreading	x		
ROAD & TRAIL TREATMENTS	Rolling dips and water bars	x	x	
	Berm removal	x	x	
	Outsloping	x	x	
	Overside drains	x	x	
	Culverts		x	
	Debris structures	x	x	
	Storm inspection and response	x	x	
PUBLIC SAFETY	Install early warning systems	x	x	
	Enact temporary public use closures	x	x	As needed
	Install/re-install warning signs regarding specific hazards	x	x	
	Incorporate post-fire safety messages into interpretive materials	x	x	As appropriate
	Protective fencing and barriers	x	x	
	Hazard removal	x	x	

***** Mechanized equipment would only be used in wilderness after a thorough assessment via the NPS's Minimum Requirements Decision Guide (MRDG) for actions proposed in wilderness.

Prevention and educational activities are important components of, and inherent in, any park restoration program, activity, or alternative. However, these actions do not require NEPA analysis, so will not be discussed or analyzed further in this document.

Manual

Manual treatments consist of using hand tools and other non-mechanized equipment to remove invasive non-native plants and/or restore sites. Manual treatments include, but are not limited to: pulling, raking, digging, picking, shoveling, stabilizing hillsides or channels, removing sediment, and applying herbicides by use of a backpack pump sprayer. Specific restoration activities and treatments are listed in Table 2.

Mechanized

Mechanized treatments employ gas, electric or battery powered equipment to restore sites (e.g., mowing, plowing, drilling, pumping, using motorized vehicles for support, or to spread seeds or till/loosen compacted soil, and motorized pumps for herbicide spraying; Table 2).

In 2008, the park internally assessed the impacts of various methods of water delivery to staging sites, and developed a decision tree to determine the appropriate delivery method (i.e., humans, pack animals, or helicopters; see Appendix C). Although use of helicopters for water delivery was approved for certain remote sites, including wilderness areas, all actual restoration *treatments* continued to be ground-based. Conditions for the use of helicopters in wilderness areas were further analyzed in a Minimum Requirements Decision Guide (MRDG), an analysis guideline for determining the least intrusive method to achieve management goals in wilderness.

Herbicides

Herbicides are currently used during both manual and mechanical treatments in SNP. During manual treatments, herbicides are applied with hand-held spray wands attached to a hand-pressurized backpack spray apparatus (Figure 8). Mechanical herbicide treatments are also delivered by hand-held spray wands, but the herbicide is contained in a larger tank pressurized by an electric motor and transported by a motorized vehicle (Figure 9). All personnel working with herbicides are required to read and adhere to SNP's Herbicide Training and Safety Plan (Appendix C).

Herbicides are classified according to their mode of action, which is determined by their active ingredients. The active ingredients (chemicals) considered for use in the park under both alternatives are summarized in Table 3. (Note the NPS has an internal process for herbicide approval. At SNP, the Intermountain Regional Office Integrated Pest Management Coordinator approves or denies pesticide use per project based on established NPS guidelines. The purpose of this environmental assessment is to evaluate the methods used to deliver herbicides, not their use). Some herbicides proposed for use in Table 3 are listed because they may be needed/used in the park in the future. Herbicides containing active ingredients that are not listed in Table 3 may also be considered for use in the future if their environmental impacts do not exceed the impacts identified under the environmental consequences. Approval would also be obtained prior to using any of the previously approved chemicals in a setting different than originally approved. The park is required to keep accurate records about the amount of chemical used and the total acreage to which it is applied. Computerized records are submitted to the regional office on an annual basis.

Figure 8. Manually treating buffelgrass with herbicide in backpack pump sprayers.

Figure 9. Herbicide tank mounted in the back of a truck, an example of mechanical treatment.

The most commonly used herbicides in SNP are products with glyphosate as the active ingredient. In 2005, glyphosate was selected as the preferred herbicide for buffelgrass control based on the scientific literature (Dixon et al. 2002). Glyphosate is a non-selective herbicide that is effective on most invasive non-native grasses and herbaceous plants. Since glyphosate affects a plant-specific enzyme pathway that inhibits growth, it has minimal impacts to other biological resources, a major factor in herbicide selection in the park. Dixon et al. (2002) experimented with glyphosate, fluazifop, and haloxyfop for buffelgrass control in Australia based on herbicides known to control other Cenchrus species (e.g., Cenchrus echinatus), and which would be suitable for Australian conditions. Their results suggested that glyphosate was the most effective on mature plants, haloxyfop (which is not registered in the U.S., Dow 2011) was effective on seedlings, and fluazifop was not significantly effective. More recently, University of Arizona weed specialist, Dr. William McCloskey compared the effectiveness of grass-specific herbicides (i.e., clethodim, fluazifop-P butyl, and sethoxydim) alone and in combination with glyphosate on buffelgrass. Reducing the amount of non-selective herbicide (glyphosate) used to kill buffelgrass would reduce the impact to non-target plants. Unfortunately, his results indicate that the more selective grass-specific herbicides are generally effective only on annual grasses and seedlings, not on established plants, and they do not kill buffelgrass (McCloskey pers. com.)

Some herbicides are used only on certain species or in specific situations in SNP. For example, triclopyr is applied directly on cut stumps to control tamarisk; imazapic, a pre- and post-emergent, is used along roadways where invasive non-native plants often get established, and aminopyralid is used on Malta starthistle, because glyphosate is not effective on that plant.

Table 3. Active ingredients of herbicides proposed for ground-based and aerial use in Saguaro National Park and their modes of action.

Active Ingredient (trade name examples)	Target Plants	Mode of Action
GROUND-BASED APPLICATION ONLY		
2,4 D acid, salt, esters[1] (Barrage, Weedone)	Broadleaf herb (including leafy spurge, knapweeds, thistles) and woody plants	Plant-growth regulator that stimulates nucleic acid and protein synthesis and affects enzyme activity, respiration, and cell division. Absorbed by plant leaves, stems, and roots, and moves throughout the plant. Accumulates in growing tips.
Aminopyralid (Milestone)	Annual (starthistles), biennial, and perennial broadleaf herbs and woody plants	Moves throughout the entire plant and accumulates in growing tips, including roots. Disrupts metabolic pathways affecting plant growth.
Clopyralid[1] (Curtail, Transline, Reclaim, Redeem)	Annual and perennial broadleaf herbs, especially knapweeds, thistles, and other members of the sunflower, legume, and knotweed families	Absorbed by the leaves and roots of the plant and moves rapidly through the plant. Affects plant cell respiration and growth. Pre- and post-emergent herbicide.
Dicamba[1] (Clarity, Banvel)	Annual and perennial broadleaf herbs and woody plants.	Penetrates plant leaves, roots, and stems. Moves and accumulates at the growing tips. Acidifies the cell wall membrane. Pre-and post-emergent herbicide.
Triclopyr[1] (Garlon, Remedy)	Woody (tamarisk, Russian olive, African sumac) and broadleaf plants	Disturbs plant growth. Absorbed by green bark, leaves, and roots, and moves throughout the plant. Accumulates in the growing tips.
PROPOSED FOR GROUND-BASED AND AERIAL APPLICATION		
Glyphosate[1] (Roundup Pro, KleenupPro, Rodeo, Aquamaster)	Grasses, herbaceous plants including deep rooted perennials, and some broadleaf trees and shrubs	Absorbed by leaves and rapidly moves through the plant. Prevents plant from producing an essential amino acid, reducing the production of proteins and inhibiting growth.
Imazapic[1] (Plateau, Cadre, Plateau Eco-Paks)	Annual and perennial broadleaf herbs and grasses (cheatgrass)	Inhibits the production of amino acids necessary for protein synthesis and growth. Pre- and post-emergent herbicide.
Imazapyr (Arsenal, Habitat)	Annual and perennial grasses, broadleaf herbs, vines, and trees (tamarisk, tree of heaven)	Absorbed by leaves and roots, moves rapidly through plants. Disrupts photosynthesis and interferes with cell growth.

[1] *Herbicides approved for use under the Exotic Plant Management Plan and EA (SNP 2004).*

2.3 PROPOSED ACTION ALTERNATIVE (PAA)

The Proposed Action Alternative (PAA) includes all of the activities and treatments listed under the NAA (Table 2) *and* also allows for aerial application of restoration treatments. Aerial treatments under the PAA include use of a helicopter for aerial application of herbicides, and use of a helicopter or fixed-wing aircraft for aerial seeding and aerial mulch treatments. Thus, it will enable the park to restore disturbed areas of any scale (small or large), and sites that are currently inaccessible due to their remote or unsafe locations (i.e., too far from a trail to be accessed in a single work day, or too steep to have crews work safely in the area).

This alternative is the most comprehensive for implementing restoration treatments and activities to manage invasive plants, stabilize soils, and re-establish native vegetation; and for mitigating the impacts from disturbances, such as fire and invasive non-native plants.-

This alternative would allow for all of the restoration strategies and treatments that achieve maximum effectiveness in restoring the health of ecological communities, while minimizing risks to humans, natural and cultural resources, and other park values, such as wilderness. Restoration treatments could be implemented throughout SNP, although aerial treatments would be carefully managed to minimize impacts to other values of concern. For example, aerial application of herbicides would not occur within ¼ mile of any road or occupied structure; within ¼ mile of trails, campgrounds, picnic areas within the park; within 1/8 mile of any private land (occupied or unoccupied); within 165 feet of any surface water; or above 6,000 feet elevation (Figures 10 and 11). Furthermore, aerial application of herbicides, primarily for buffelgrass control, would be restricted to dense patches of buffelgrass (i.e., where over 50% of plant cover is buffelgrass). These patches range in size from less than one acre, which would be treated with a precision ball sprayer (Figure 12), to 1 to 50 acres (currently the size of the largest patch at SNP), which would be treated with a boom sprayer (Figure 13). Of the 1,500 inaccessible acres of the park currently infested with buffelgrass, approximately 600 acres are proposed for aerial treatment in any given year during the summer growing season, or potentially in winter if growing conditions indicate that it would be successful. Treatments would be conducted four to eight hours per day, and about two weeks per year. The size of aerial restoration treatments (seeding and mulching; Figure 14) following a fire, would depend on the location, size and severity of the fire.

Conditions for the aerial application of herbicides in wilderness areas were analyzed and determined using a Minimum Requirements Decision Guide (MRDG; see Appendix D).

2.4 BEST MANAGEMENT PRACTICES

All restoration treatments conducted in the park adhere to Saguaro National Park's standard mitigations to ensure incidental impacts to natural and cultural resources are minimized (see Appendix E). Additional mitigations, described in SNP's Herbicide Training and Safety Plan (Appendix C), are implemented when working with herbicides.

Best management practices for aerial application of herbicides under the Proposed Action Alternative (PAA), to minimize potential impacts to non-target plants and animals and to protect human health and safety, are listed below:

- Aerial applications of herbicides will be used to treat steep and/or otherwise inaccessible sites. Sites greater than one acre in size would employ a helicopter with a boom sprayer; sites less than one acre would entail spot precision application (such as with a "ball sprayer").

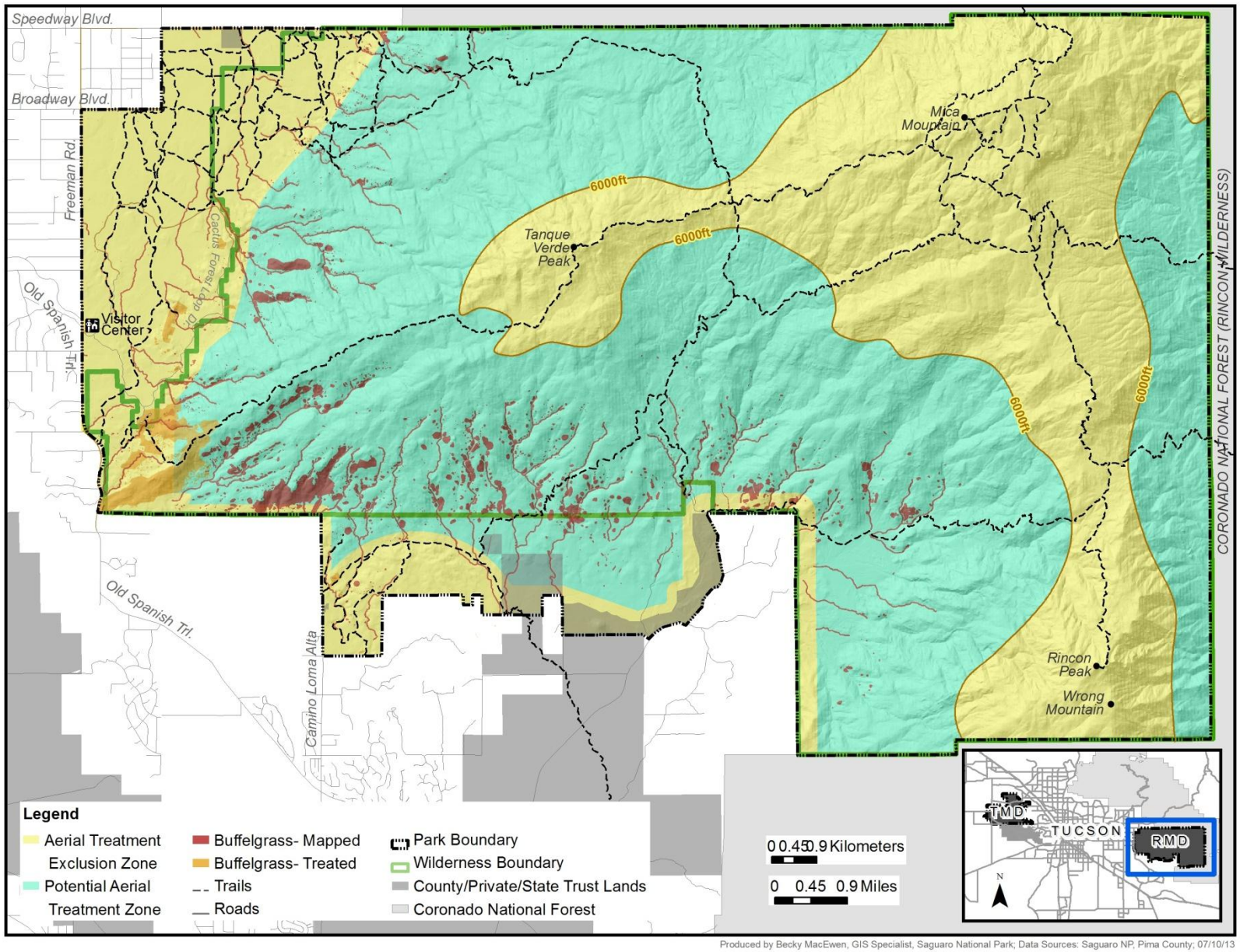

Figure 10. Map of the Rincon Mountain District showing locations of buffelgrass and potential treatment areas under the Proposed Action Alternative.

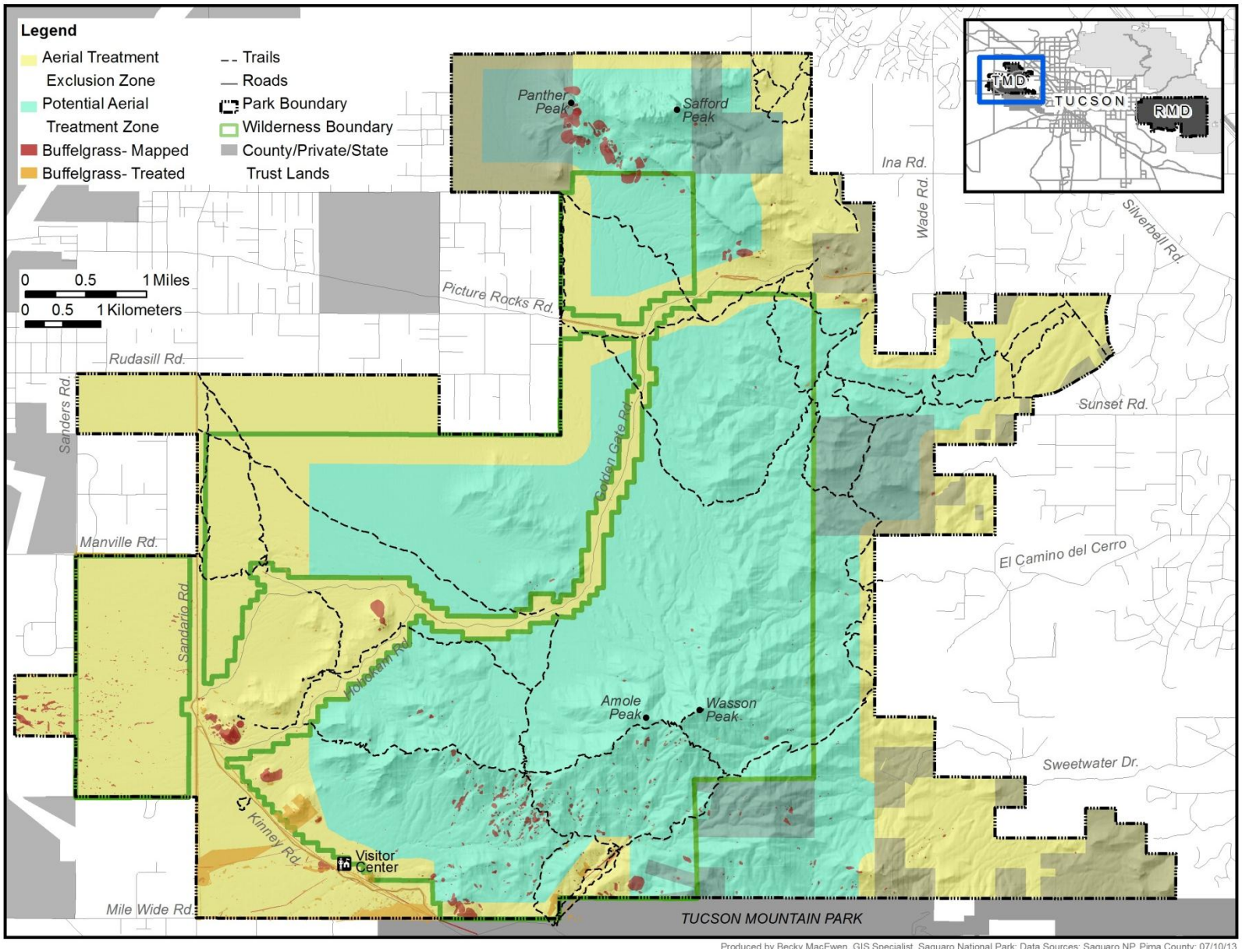

Figure 11. Map of the Tucson Mountain District showing locations of buffelgrass and potential treatment areas under the Proposed Action Alternative.

Figure 12. Ball sprayer suspended from helicopter applying spot treatment.

Figure 13. Helicopter with boom sprayer.

Figure 14. Helicopter delivering mulch to mitigate soil erosion after an intense fire in the western United States.

- Aerial applications of herbicide will **not** take place when invasive non-native infestations are:
  - Less than 50% plant cover of the disturbed area
  - Above 6,000 feet (1,830 meters) elevation
  - Within the designated exclusion zone for each district (see figures 10 and 11)
  - Within 165 feet (50 meters) of a spring, perennial channel, or any other surface water at the time of treatment
  - Within ¼ mile (0.4 kilometers) of an occupied structure
  - Within ¼ mile (0.4 kilometers) of a trail, campground or picnic area
  - Within 1/8 mile (0.2 kilometers) of private land, even if unoccupied
- To minimize herbicide drift:
  - The lowest pressure, largest droplet size [volume median diameter (VMD) would be > 600 µm (micrometer)], and largest volume of water permitted by the label to obtain adequate treatment success will be used.
  - The lowest spray release height safely possible will be used.
  - Windspeeds will not exceed 10mph during treatments.
- Herbicide delivery aircraft will be equipped with a differential global positioning system (DGPS) that records both the position of the aircraft and the status ('on' or 'off') of the spray boom.
- Herbicide delivery aircraft will be equipped with a spatially registered flow controller that compensates for variation in aircraft speed (as the plane flies up and down over rugged terrain) to ensure even delivery of herbicides.
- Aircraft mounted sprayers will use Accu-flow or similar nozzles to regulate the amount of herbicide delivered and minimize drift.
- All herbicide label instructions will be followed.

2.5 ALTERNATIVE SUMMARIES

Table 4 summarizes the major components of the NAA and PAA, and compares the ability of these alternatives to meet the project objectives (identified in the Purpose and Need, Section 1).

2.6 ENVIRONMENTALLY PREFERABLE ALTERNATIVE

According to the Council on Environmental Quality's (CEQ) regulations implementing NEPA (43 CFR 46.30), the environmentally preferable alternative is the alternative "that causes the least damage to the biological and physical environment and best protects, preserves, and enhances historical, cultural, and natural resources. The environmentally preferable alternative is identified upon consideration and weighing by the Responsible Official of long-term environmental impacts against short-term impacts in evaluating what is the best protection of these resources. In some situations, such as when different alternatives impact different resources to different degrees, there may be more than one environmentally preferable alternative."

NPS (2006) policy also requires that an EA identify the environmentally preferred alternative, or "the alternative that causes the least damage to the biological and physical environment"; or "the alternative which best protects, preserves, and enhances historic, cultural, and natural resources."

The Proposed Action Alternative (PAA) is the environmentally preferable alternative because under the NAA, ground-based restoration efforts, although successful, are inherently limited to treating small (up to several acres in size), accessible (within two miles of roads or trails) disturbed sites only. Buffelgrass is spreading faster than ground-based control efforts can keep pace with, and to areas inaccessible to ground crews. The continued spread of buffelgrass is resulting in the displacement and loss of native

plant and animal species, alteration of the soil nutrient cycle, and an increased threat of wildfire and subsequent ecosystem conversion.

In addition, ground-based treatments would be insufficient to treat post-fire disturbances in remote areas of the park that could result in threats to human health and safety and the degradation of park resources.

The PAA allows for aerial delivery of restoration treatments (i.e., herbicides, seeds and mulch) that will ultimately cause the least damage to the biological and physical environment, and best protect, preserve, and enhance natural and cultural resources, and park values, making it the environmentally preferable alternative.

2.7 PREFERRED ALTERNATIVE

The proposed action alternative (PAA) is the agency's preferred alternative (PA). Only the PA meets the park's restoration needs and objectives, and is consistent with other park plans, NPS guidelines and policies, and all other applicable laws and regulations.

No new information came forward from public scoping or consultation with other agencies to necessitate the development of any new alternatives, other than those described and evaluated in this document. The proposed action is the environmentally preferable alternative and better meets the project objectives; therefore it is also considered the NPS preferred alternative. For the remainder of the document, the proposed action alternative will be referred to as the "Preferred Alternative (PA)."

Table 4. Comparison of the ability of the No Action and the Proposed Action alternatives to meet project objectives.

Project Objectives	No Action Alternative	Proposed Action Alternative
1. Restore ecosystem processes, structure and function in disturbed areas	The park would only be able to restore about 25% of known disturbed areas throughout the park since treatments would be limited to small and easily accessible disturbed areas.	The park could conduct appropriate restoration treatments to disturbed areas throughout the park in order to restore ecosystem processes, structure and function.
2. Maintain ecosystem processes, structure and function in undisturbed areas	This alternative would only partially meet this objective since restoring only 25% of known invasive non-native plant infestations would enable the other 75% to expand and continue to adversely impact native plants and animals and ecosystem processes.	The park could use both ground-based and aerial restoration treatments to address known disturbances throughout the park. Aerial delivery of restoration treatments would facilitate rapid response to existing large remote infestations of invasive non-native plants, and prevent their expansion.
3. Maintain and restore Wilderness character, reducing negative impacts from human actions	Under this alternative, the park's ability to restore "naturalness" in wilderness would be limited to small and easily accessible disturbed areas (see Section 3.10).	Under this alternative, the park could restore "naturalness" in wilderness areas throughout the park (see Section 3.10).
4. Establish a decision-making process for identifying and implementing effective and appropriate restoration strategies and treatments	This alternative restricts the park to using ground-based restoration techniques. This alternative is neither cost effective due to the high cost and labor intensive manual treatments, nor ultimately effective as larger disturbed areas in remote locations of the park would not be restored.	The use of both ground-based and aerial restoration techniques allow for the implementation of the most environmentally sound and cost effective strategies. Disturbances throughout the park would be addressed per a comprehensive decision-making process that would consider all viable options.
5. Protect human health and property within and outside SNP	This alternative would provide for visitor and staff safety through education and prevention techniques, such as appropriate training and protocols for field crews, and notifications and signage for visitors when herbicides are being used. Current practices would require large restoration crews in the field for long periods of time.	This alternative would also provide for visitor and staff safety through education and prevention techniques, such as appropriate training and protocols for field crews, and notifications and signage for visitors when herbicides are being used. The ability to use aerial treatments would require fewer restoration crews would be in remote areas of the park. Aerial post-fire restoration treatments would mitigate soil erosion, and the potential for flooding and debris flows that could affect human health, safety and property both within and outside of the park after large fires.

CHAPTER 3: AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.0 INTRODUCTION

This chapter describes the existing, or baseline, conditions of the environment affected by the proposed action (all of SNP), and analyzes the potential direct, indirect and cumulative effects or impacts to the environment that would occur as a result of implementing each of the alternatives. These potential impacts are described in terms of type, intensity, duration and spatial context. General definitions for each of these impact types are provided below; more specific impact definitions are given for each topic analyzed.

The two alternatives analyzed in this EA are largely the same. The only difference between them is the option of aerial delivery of treatments (i.e., seeds, mulch and/or herbicides) in the Preferred Alternative (PA) which would allow for the treatment of large scale and/or remote disturbed areas, and which is not possible under the No Action Alternative (NAA). As noted earlier, any restoration treatments applied to disturbed areas in the park, under either alternative, will be beneficial. The PA, which is also the Environmentally Preferred Alternative, better addresses the serious issue of large, remote disturbances, particularly bufflegrass infestations. It provides much greater long-term benefits to park resources, both directly and indirectly. These benefits, the restoration and maintenance of native ecosystem components and natural processes, have been identified and described in the first two chapters of this EA. They will not be elaborated on in this chapter, other than when specifically relevant, but they will be acknowledged as direct and/or indirect, short- and/or long-term beneficial impacts, to some degree, for every topic analyzed. This chapter also identifies and assesses the generally short-term, low intensity, adverse impacts that proposed restoration treatments could have on park resources.

- **Type** describes the classification of the impact as either *direct* or *indirect,* and *beneficial* or *adverse*:
  - *Direct*: An effect that is caused by an action and occurs in the same place and time.
  - *Indirect*: An effect that ultimately results from an action, but at a later time, or secondarily, from another effect.
  - *Beneficial*: A change that improves the condition of the impact topic, and/or moves it toward a desired condition.
  - *Adverse*: A change that detracts or degrades the condition of the impact topic, and/or moves it away from a desired condition.
- **Intensity** describes the degree, level, or strength of an adverse impact. For this analysis, intensity has been categorized into *negligible, minor*, *moderate*, and *major*. Because definitions of intensity vary, intensity definitions are provided separately for each impact topic analyzed in this EA.
- **Duration** describes the length of time an impact would occur, either *short-term* or *long-term*, as defined for each impact topic.
- **Context** describes the site, area or location in which the impact would occur. Effects may be *site specific* (i.e., directly where restoration treatments and activities occur), *local* (i.e., within about ¼ mile of restoration treatments and activities), or *regional* (i.e., occurring in both park districts).

3.1 CUMULATIVE IMPACT SCENARIO

The CEQ regulations, which implement the National Environmental Policy Act (NEPA), require that environmental compliance documents include assessments of cumulative impacts for all federal projects. Cumulative impacts are defined as the impact on the environment resulting from the incremental impact of each alternative, when added to other past, present, and reasonably foreseeable

future actions, regardless of what entity undertakes such other actions (40 CFR 1508.7). Cumulative impacts provide a broader context for evaluating and comparing the potential impacts of each alternative for each impact topic.

As mentioned earlier, managing SNP to benefit the native biodiversity and natural ecosystem processes is a challenge due to impacts occurring from past and present land use practices within and outside the park. It is largely impacts from these actions that cause the disturbances that require restoration in the park. Provided below is an overview of relevant past, present, or reasonably foreseeable future human activities and developments in close proximity to the park; these have been used to assess cumulative impacts for each of the topics analyzed.

Past Actions Within and Around Saguaro National Park

Within the Park

Prior to SNP being set aside as a protected area in 1933, human habitation and land use practices (i.e., cattle grazing, woodcutting, fire suppression, hunting, mining, farming, and other developments) in the region caused major ecosystem changes, including drastic decreases in flow in perennial rivers and streams, formation of deep arroyos, loss of riparian corridors in the desert, non-native plant invasions, and other dramatic changes in the abundance and distributions of plants and animals (Bahre 1995).

Livestock overgrazing and woodcutting, exacerbated by drought, contributed to the decline in saguaro populations in the RMD. Livestock grazing occurred within the current park boundaries from the late 1870's through the 1980's, and despite attempts to try different stocking strategies, the combination of grazing and intermittent droughts caused these lands to be overgrazed. In order to increase cattle forage and control erosion, non-native plants, such as buffelgrass and Lehmann's lovegrass, were introduced in southern Arizona starting in the late 1800s. Around the same time, woodcutting of native trees to fuel lime kilns used to make lime for the mortar and plaster used to build adobe structures was widespread around Tucson. This activity removed many of the "nurse" trees needed to provide the micro-habitats that saguaro seeds need to germinate and grow, thus negatively impacting saguaro recruitment (Clemensen 1987).

Fire historically played an important role in pre-settlement forests of the west, including Arizona. Forest ecology was shaped by, and ecosystem health depended on, wildfire; and pre-settlement fires in the region frequently spread over large areas. Especially after the railroads arrived, which created easy access to cattle markets, overgrazing removed the light fuels that carried these large, but low intensity fires. Furthermore, as early settlers built homes and began working in forest environments, they found fire to be a threat to their livelihoods and homes, and they began suppressing fires (Bahre 1995, Swetnam and Baisan 1996). Within what is now Saguaro National Park, fire has largely been suppressed since the 1920s. Consequently, in some places fuel has accumulated and tree density has increased to abnormally high levels. Natural plant community succession, species composition, and forest structure have been altered. Grasslands have been lost as small trees and shrubs encroached into large grasslands and small meadows that once would have been maintained by frequent fires. In woodland and forest communities, the canopy has become increasingly closed, and openings have become smaller. Shade-tolerant species have grown up in dense thickets, while fewer grasses, forbs, and shrubs grow on the forest floor. In addition, subtle but important hydrological changes may have occurred because of increased forest growth and resulting wildfires.

All of these changes have deteriorated habitats, indirectly impacting many forms of wildlife. In addition, many species were actively hunted. The last grizzly bear, Mexican gray wolf, and jaguar were shot in the Rincon Mountains in the early 1900's, and bighorn sheep were extirpated in SNP in the 1950s (Swann 2009a).

Outside of the Park

The postwar population boom in the west was especially rapid in Arizona. Extensive urban and rural development occurred throughout the state on private lands. Despite economic downturns in agriculture and mining industries in the region since the 1930s, population growth has remained steady and continuous (Bahre 1995). Between 1950 and 2000, Arizona's population grew almost 600%; and by 2012, its population was estimated at just over 6.5 million (U.S. Census Bureau website http://quickfacts.census.gov/qfd/states/04000.html; accessed Jan 2014). At the same time, Pima County grew almost 500%, and now about 1 million people live in Pima County, mainly in the greater Tucson metropolitan area (PAG 2013a).

Development of large housing tracts and businesses, and associated infrastructure, particularly linear structures such as roads, railroads, canals and utility corridors, has led to the isolation of park lands, which have become islands of natural habitat in a sea of urbanization (Shaw et al. 1992). These and the associated effects of this development (road-killed wildlife, introduction of non-native flora and fauna, increases in human-caused fire, wildlife killed by domestic animals, etc.) cause major changes to the natural systems in this region.

Current Actions, Projects and Plans Within and Around Saguaro National Park

Within the Park

The park is still addressing the legacy of many of the past activities described above by rehabilitating old road beds, filling in abandoned mines, controlling invasive non-native plants, and actively managing wildfires, as evidenced by the plans and projects listed below. Some of these issues are made more complex by the potential historic value of the past activities and structures.

Saguaro National Park has an active resource management program that, along with other NPS programs (e.g., the Sonoran Desert Network Inventory and Monitoring Program; SODN) and private researchers, is monitoring the conditions of its natural and cultural resources. Park studies have shown that with the cessation of grazing and woodcutting in the park, saguaro seedling recruitment has rebounded and saguaro populations in both districts of the park are healthy (Turner and Funicelli 2004, Pierson et al. 2013). Of the wildlife species that were locally extirpated by hunting and trapping in the early 1900s, black bear and mountain lions eventually re-established themselves in the park (Swann 2009a, 2009b). Unfortunately, several other species (i.e., Arizona gray squirrel, porcupine) have recently become rare. Federally listed threatened or endangered species or candidate species that reside in the park (i.e., Mexican spotted owl, lesser long-nosed bat, yellow-billed cuckoo, and desert tortoise) are monitored and protected.

Saguaro National Park's invasive non-native plant management program has made significant progress since adding herbicide treatments in 2005, and has successfully controlled non-native plants in many accessible areas (see Figures 5 and 6). However, ground-based crews cannot address remote or large-scale non-native plant infestations, which continue to grow and spread in the park. Extensive surveys, including aerial surveys, show an increase in buffelgrass and other non-native invasive grasses in the

park, and new non-native and invasive plants continue to be found in the park. Recently, SNP was identified as one of twenty-five "Parks in Peril" due to climate change and predicted increases of flammable non-native grasses such as buffelgrass (Saunders et. al 2009).

Park staff and volunteers survey for non-native plants, pull them out or spray them with appropriate herbicides, and present talks and create handouts and information for the park website to reach and educate the public. In addition to these efforts, research on non-native invasive plants and their impacts on park ecosystems is also being conducted by scientists (e.g., impacts on desert tortoise, alterations of soil properties, seed bank assays, and fuel loads and fire effects of buffelgrass).

In the last two decades, the NPS has restored fire to higher elevation areas in the park by allowing naturally ignited fires that met management objectives to burn, and by using prescribed fire and non-fire treatments, most recently in 2010. Although significant progress has been made, our goal of restoring natural fire regimes throughout the park is far from being achieved. Furthermore, depending on the location and conditions of a wildfire, the resulting disturbances from both fire and suppression activities could increase erosion, sedimentation, and non-native plant invasions (Backer et al. 2004). Currently, to mitigate or restore such post-fire impacts in remote or inaccessible areas, the park must write an environmental assessment for each fire.

In contrast to grasslands, woodlands and forests above 5,000 feet elevation, the Sonoran Desert has not historically experienced much natural wildfire, which can be very destructive to its plant communities (McLaughlin and Bowers 1982, Schmid and Rogers 1988). However, since 1937, fires have burned about 4,100 acres below 4,500 feet in SNP, fueled largely by invasive non-native grasses. Buffelgrass, in particular has been expanding its range exponentially below 5,000 feet. With this spread also comes the threat of wildlife from this very flammable, fire-adapted grass. Fire, especially intense wildfires typical of non-native grasses, reduces vegetation cover and increase runoff (Robichaud et al. 2010). Federal Fire Policy now specifically mandates public land management agencies to reduce the amount of vegetation that fuel wildfires, especially around areas with homes and buildings. In addition, policy directs managers to restore ecosystems to a more natural, resilient, fire-tolerant condition. This means reducing fuels near homes and developed areas as well as in the remote backcountry of the park.

Related Plans and Projects

Saguaro National Park Comprehensive Trails Management Plan (NPS 2009)

The park's Trails Management Plan establishes a trail system for the park that provides for recreational use and enjoyment, and resource protection, including restoration. It identifies specific trails in both districts of the park that meet the management goals of the park's General Management Plan.

Saguaro National Park General Management Plan (GMP; NPS 2008a)

The GMP establishes the park's management direction for the next 10 to 15 years. Tiering off the foundation and direction established in the GMP, implementation plans (such as this restoration plan) provide more site-specific direction and detailed actions needed to achieve resource protection and visitor experiences described in the GMP.

Saguaro National Park Exotic Plant Management Plan (SNP 2004)

Saguaro National Park prepared an exotic plant management plan to identify and analyze alternatives for managing and controlling exotic plant species within the park. Under this plan and accompanying EA,

the park began using herbicides to manage invasive non-native plants. This Restoration Plan will update the 2004 plan.

Saguaro National Park Fire Management Plan (FMP; NPS 2007)

The park's FMP considers the use of treatments to restore areas that have suffered the worst from vegetation encroachment, increasing forest density, and fire suppression. The plan identifies activities for restoring these conditions and reducing the threats from unwanted wildland fires. The FMP recognizes that non-native grasses have changed the fire regime, especially in desert areas and calls for suppressing all fires below 4,500 feet in elevation. The FMP mandates that the least intrusive burned area restoration actions to mitigate actual or potential damage caused by wildland fire will be used. Compliance for such restoration was not addressed at the time, and each wildfire requiring restoration currently needs a separate environmental assessment. The Preferred Alternative in this Restoration Plan would address this need.

Outside of the Park

Current activities occurring near SNP generally fall under the umbrella of urban growth and development, which increasingly encroach on both districts of the park, and practically surround the TMD. As Tucson's population grows, so does urban growth and associated infrastructure. That, along with agriculture and industrialization, creates a landscape matrix that increasingly fragments and isolates the remaining protected natural areas serving as refuge for native plants and animals. Development surrounding the park also facilitates unauthorized human access to the park and detrimental impacts on other park resources (e.g., plant poaching, shooting or otherwise defacing saguaros, collecting or damaging cultural artifacts, littering, starting fires, vandalizing structures or facilities, off-trail hiking, riding or driving causing damage to plants and subsequent soil erosion) that may require restoration or rehabilitation.

Development and growth is expected to continue in the region (e.g., roads, transmission lines, Twin Peaks Quarry, Central Avra Valley Storage and Recovery Project, Houghton Road Master Plan), and will destroy, degrade and fragment wildlife habitat; facilitate the invasion of non-native plants into natural areas like the park; and adversely affect visitor experience (e.g., scenic vistas and drives). Human activities in urban areas, including the use of pesticides in agricultural areas, golf courses, resorts, road and utility right-of-ways, will continue to affect air and groundwater quality, and the plants, wildlife and humans, that depend on them. Some individuals have expressed concerns about the use of pesticides and their sensitivities to them. Demand for water has resulted in declining groundwater levels and sinking of the ground surface (subsidence) in areas around Tucson.

Regional conservation efforts, such as Pima County's Sonoran Desert Conservation Plan, and those of other conservation groups, such as the Southern Arizona Buffelgrass Coordination Center, Water Conservation Alliance of Southern Arizona; and the Arizona Wilderness Coalition will help to mitigate the adverse environmental impacts of urbanization and development in the Tucson Basin.

Related Plans and Projects

Southern Arizona Buffelgrass Strategic Plan (BWG 2008)

Developed by the Buffelgrass Working Group (BWG), a large group of local collaborators (including SNP), this plan called for the formation of the Southern Arizona Buffelgrass Coordination Center (SABCC) and a memorandum of understanding (with SNP as a signatory) to facilitate buffelgrass management

throughout the region. The plan provided a starting point for on-the-ground implementation of a regional strategy, and SABCC provides resources and information for buffelgrass management.

Pima County Sonoran Desert Conservation Plan (PC 2013)

This regional plan was developed to address the long-term conservation needs of the full range of Pima County's natural and cultural resources. It includes a Comprehensive Land Use Plan, which serves as the cornerstone of conservation, as well as economic, expansion; and a Multi-Species Conservation Plan.

Central Avra Valley Storage and Recovery Project (CAVSARP; City of Tucson 2013a)

CAVSARP allows Tucson Water, which supplies water to about 750,000 customers in and around Tucson, to use Colorado River water as a drinking water supply through a process known as recharge and recovery. Groundwater overuse in the latter half of the 20th century led to severely declining groundwater levels and the beginnings of subsidence (land sinking) in and around Tucson. In addition, Arizona law requires Tucson and other groundwater dependent communities to reduce reliance on this limited resource and switch to renewable supplies. To eliminate over-pumping, Tucson Water has been switching from groundwater to Colorado River water delivered via the Central Arizona Project.

Future Actions, Projects and Plans Within and Around Saguaro National Park

Within the Park

As projects outlined in the park plans listed above are funded and implemented additional developments and restoration will occur. For example, the Comprehensive Trails Management Plan proposes the development of several trailheads and trails in the foreseeable future, as well as the closure and restoration of some trails, and conversion of one road to a trail. Overall, 23.2 miles of trails, and four new trailheads (approximately 20 acres) will be added; and four miles of roads and four miles of trails will be decommissioned and restored. In addition, the GMP proposes some facilities at the Madrona Ranger Station in the RMD will be removed, and impacted areas restored; as well as traffic calming structures on certain TMD roads.

Related Plans and Projects

Potential Land Additions to the Park

Proposed legislation would add land to both districts of the park.

Wilderness Plan

This plan is proposed to be written to guide management and recreational activities in wilderness areas within the park in compliance with the Wilderness Act.

Outside of the Park

The greater Tucson metropolitan area is projected to continue growing (PAG 2013), and urban and suburban development could continue to bring a greater number of residents closer to park boundaries. These developments adjacent to the park, in turn, put more stress on park resources, as described above, including increases in invasive non-native plants. They also potentially increase the number of wildfires that will start from human causes. In addition, spreading of development increases the number of homes and other buildings at risk from wildfire in the wildland-urban interface (Radeloff et al. 2005).

Related Plans and Projects

Catalina-Rincon FireScape Plan

Numerous partners are currently working on a framework that promotes managing fire across large areas of the Santa Catalina and Rincon Mountains to achieve sustainable, resilient ecosystems. The main land holders involved in this effort are the Coronado National Forest and Saguaro National Park, but other stakeholders, including the University of Arizona, State of Arizona, and The Nature Conservancy also participate. The purpose of the plan is to allow for wildfire to burn where it is appropriate, and preventing or suppressing fire where it is not; applying science to establish management goals; measuring progress and making adjustments; seeking out and working with partners; sharing resources and increasing funding; and streamlining compliance and other paperwork. (http://www.azfirescape.org/catalina/home)

Coronado National Forest Land and Resource Management Plan Revision (USFS 2013)

The current Coronado National Forest Plan was originally developed in 1986. The purpose of the revision was to incorporate social and resource changes and new information. Some changes have been addressed in amendments to the original Forest Plan; others have not been formally recognized and incorporated.

SunZia Southwest Transmission Project (Sunzia 2013)

The SunZia Project consists of two bi-directional extra-high voltage electric transmission lines and substations that will transport energy from Arizona and New Mexico across the Desert Southwest. The current identified preferred route would be approximately three miles east of the RMD of the park and parallel the park's boundary. This could result in increased habitat fragmentation for terrestrial animals, higher wildlife mortality from bird strikes and electrocutions, and negative impacts on scenic vistas.

Rocking K Ranch Development

This development proposes about 2,000 to 3,000 homes, one golf course and one resort, plus a 50- to 75-acre commercial center, and smaller areas of commercial development on 5,000 to 6,000 acres adjacent to the south boundary of the RMD (Arizona Daily Star 2013). More than 50 percent of the development will be natural and "functional" open space, including parks and golf course land (Arizona Daily Star 2013).

Tucson Mountains Sub-regional Plan (City of Tucson 2013b)

As part of the City of Tucson's General Plan, this sub-regional plan establishes future land use and development policies for the areas on the east, south, and west sides of SNP's TMD that have the potential for future annexation to Tucson. This plan covers about 280 square miles. The current zoning ranges from medium density urban residential to rural. The plan goes into effect when one of the six areas within the plan is annexed by Tucson. Most of the area is designed as residential, ranging in density from medium high intensity urban (24 residences/acre) to low intensity urban (0.5 residences/acre). The remaining area is zoned as industrial.

Rincon/Southeast Sub-regional Plan (City of Tucson 2013b)

As part of the City of Tucson's General Plan, this sub-regional plan establishes future land use and development policies for the area on the south side of SNP's RMD that has the potential for future annexation to Tucson. This plan covers about 400 square miles, which is mostly rural and sparsely populated, although this demographic is rapidly changing. The plan goes into effect when an area is

annexed by the city of Tucson. This sub-region is broken into 15 areas. Most of the areas are zoned residential, ranging from low intensity rural (less than 0.3 residences/acre) to medium intensity urban (5 residences/acre). The remaining areas are either industrial or are resource transition areas.

Pima Association of Governments 2030 Transportation Plan (PAG 2013b)

This plan outlines transportation projects and goals for the county, including the Twin Peaks Interchange north of the TMD, and the Houghton Area Master Plan (HAMP) just west of the RMD. The Twin Peaks interchange, which provides an alternate route from Avra Valley east to I10 and Tucson has been completed. The HAMP is currently being implemented. It encompasses approximately 10,800 acres about one to three miles west of the southwest corner of SNP's Rincon Mountain District (RMD) along Houghton Road. Seventy-six percent of the land covered by the plan is managed by the Arizona State Land Department and is undeveloped. The plan includes a mix of current and proposed high- and low-density commercial and residential development.

Interstate 11 (NDOT and ADOT 2013)

I-11 is a proposed Interstate Highway, officially designated by the U.S. Congress in the 2012 Surface Transportation Act. The highway route as currently proposed runs from Casa Grande, Arizona northwest through Kingman, Arizona, and terminates in Las Vegas, Nevada. A proposed extension from Casa Grande would run south-west of the Tucson Mountains before connecting with Interstate 19 in Sahuarita, south of Tucson, and continuing east to Interstate 10. This project could further fragment habitat and isolate the TMD from other protected areas and would degrade the park's viewshed.

Summary

To fulfill the mandate of the NPS and the purposes of SNP, restoration treatments and activities will be conducted in the park. Restoration actions inherently provide long-term benefits to park resources. Conducting the actions in the No Action Alternative or the Preferred Action Alternative, including the use of herbicides, will also potentially cause some incidental short-term adverse impacts on some park resources. These short-term impacts must be evaluated in the context of the cumulative environmental impacts occurring around both districts of the park, and the long-term benefits provided by the restoration actions.

3.2 HUMAN HEALTH & SAFETY

Affected Environment

The health and safety of park staff, visitors, partners, contractors, and park neighbors is of the utmost importance to SNP and the NPS. NPS Management Policies (NPS 2006; Section 8.2.5.1) state that the NPS "will strive to identify and prevent injuries from recognizable threats to the safety and health of persons and to the protection of property by applying nationally accepted codes, standards, engineering principles." NPS safety policy (2010; Director's Order #50C) strives to manage visitor safety to provide an injury-free park experience, but recognizes there are "inherent risks that cannot be managed or transferred away." Indeed, entering an environment where natural hazards exist is part of the allure of the experience for many park visitors.

Known hazards within SNP are numerous, and include the rugged, rocky terrain; scarcity of water; extremes in weather— from searing heat to winter blizzards; lightning; dangerous or venomous wildlife (e.g., mountain lions, black bears, rattlesnakes); and plants with spines or thorns (e.g., agave and cactus). To ensure visitor safety, SNP provides visitors with information about safety issues and their

potential risks via safety bulletins, updates on the park website and in social media, and press releases. To ensure employee safety, the park has many official safety policies and procedures, including Job Hazard Analyses (JHA), Standard Operating Procedures (SOP), and Best Management Practices for all activities. The purpose of a JHA is to protect employees by defining the technique and tools required for a specific activity, identifying the potential hazards for each step or phase of the technique, and mitigating problems and issues before they occur. The JHA is completed prior to initial activity, and updated as necessary to inform staff of additional hazards as they are identified. SOPs include orientation and training for all activities, safety briefings and debriefings, and risk assessments prior to and following projects. SNP Safety Policy reiterates national guidance, and stresses identification and analysis of potential safety issues, and prompt reporting of unsafe acts or conditions. There are a variety of hazards associated with restoration work at SNP, including those associated with vehicle transportation; walking or hiking to a work site; performing tasks off trail in rugged and remote terrain; carrying and using equipment; and environmental hazards, from weather to dangerous wildlife.

For restoration projects that include use of herbicides, all restoration personnel are required to read the Herbicide Safety and Training Manual (Appendix C) and adhere to the guidelines. This manual is updated annually and includes a JHA for herbicide application, personal protective equipment (PPE) requirements, pertinent herbicide labels and Material Safety Data Sheets; it also provides information on herbicide handling and application. All herbicide applications are conducted under the direction of an Arizona Certified Pesticide Applicator. Contractors are held to industry standards.

When herbicides are applied near public facilities (e.g., visitor centers, roads, trails, picnic areas), area closed signs are posted at relevant access points for the duration of the restricted entry period (the time specified on the herbicide label for a human to wait before entering a treated area without wearing personal protective equipment), and informational materials are provided on the park website and at relevant trail heads. For the herbicides proposed for use in the park, the restricted entry period varies from about 1 hour to 48 hours.

NPS Management Policies (NPS 2006, Section 1.6) also acknowledge that NPS activities may have impacts beyond park boundaries, and state that, “the Service will work cooperatively with others to anticipate, avoid, and resolve potential conflicts; protect park resources and values; provide for visitor enjoyment; and address mutual interests in the quality of life of community residents, including matters such as compatible economic development and resource and environmental protection.” The public, particularly individuals who are sensitive to chemicals, may be affected by herbicide, dust, or other particulates that may be generated by restoration treatments and activities, and SNP provides advance notice of restoration activities and their locations through press releases, website and social media postings, and trail head notifications to reduce potential health threats.

The Tohono O’odham Nation has a special use permit to collect saguaro fruit in the park’s TMD prior to the summer monsoon season. During that period, restoration treatments that include herbicide application would not occur in or around the Tohono O’odham’s fruit harvest site.

Methodology and Intensity Thresholds

Analyses of the potential impacts to human health and safety from each of the alternatives were derived from the sources cited above, park staff’s professional experience and knowledge, and research of the existing literature, herbicide labels, and material safety data sheets. In addition, Park staff met with chemically sensitive individuals from a local advocacy group to provide information on the PA, and on

how to access information on the dates and locations of restoration activities in the park that might include applying herbicides.

Intensity Levels

Intensity Level	Definitions
Negligible	There would be no impacts to human health and safety, or impacts would not be measurable or perceptible, and would not have consequential effects.
Minor	The impacts to human health and safety may be measurable or perceptible, but would not have consequential effects.
Moderate	The impacts to human health and safety are readily apparent, and may be measurable or perceptible and may have consequential effects.
Major	The impacts to human health and safety are measurable and perceptible and may have severe and/or permanent consequences.

Duration

Short-term	Impacts to human health and safety can be immediate (i.e., during restoration treatments and activities), but will generally be imperceptible within one week.
Long-term	Impacts to human health and safety last beyond the restoration treatments and activities period, and may continue beyond one week.

Herbicide formulations (active and inert ingredients) are evaluated by the Environmental Protection Agency (EPA) at the time of registration, and are assigned a signal word that indicates their toxicity (the degree to which a substance or mixture of substances can harm living things). Signal words, listed in order of decreasing toxicity, are: Poison, Danger, Warning, Caution, or None Required, though "Caution" is often used instead of "None Required." The signal word is determined by the most severe toxicity category assigned. Appendix F provides additional information on acute and chronic toxicity, and levels of toxicity of herbicides proposed for use. The herbicides proposed for use under either alternative have signal words that range from Caution to Warning (Table 5).

No Action Alternative (NAA)

Under the NAA, SNP would continue to implement post-disturbance restoration treatments and activities using ground-based treatments and techniques at small and accessible disturbed sites.

Manual

Manual restoration treatments and activities would be ground-based manual labor performed with non-mechanized equipment (e.g., picks, shovels and back-pack herbicide sprayers). With ground-based herbicide application, drift to non-target areas is minimized by the close proximity (within 12 to 24 inches) of the spray wand to targeted plants, and strict adherence to herbicide labels regarding the weather restrictions. Possible impacts to individuals conducting manual restoration treatments and

activities, could include muscle strains, heat stress, dehydration, cuts, sunburns, allergies, and skin/eye irritation. Due to the uneven terrain in the park, injuries or falls may also occur. Restoration crews would follow all park and program safety protocols. Potential impacts to restoration personnel would be direct, site-specific, negligible to minor, short-term, and adverse.

Park visitors or neighbors would be excluded from treatment sites for the restricted entry interval, and would have no contact with restoration tools or materials; therefore, there would be no potential impacts to the public.

Overall, impacts from manual restoration techniques, including herbicides, on SNP staff and volunteers and the public (i.e., visitors and neighbors), would be direct, site-specific, negligible to minor, short-term, and adverse.

Table 5. Toxicity information for the active ingredients of chemical herbicides proposed for use in Saguaro National Park.

Active Ingredient (Brand Names)	Restricted Entry Interval	EPA Toxicity Level	Signal Word
HERBICIDES FOR GROUND-BASED APPLICATION ONLY			
2,4 D acid, salt, esters[1, 2] (Barrage, Weedone)	12-48 hours	III-IV (depending on formulation)	Warning Caution
Aminopyralid (Milestone)	Once dry	IV	Caution
Clopyralid[1, 2] (Curtail, Transline, Reclaim, Redeem)	12 hours	III	Caution
Dicamba[1,2] Acid and salt formulations (Banvel, Vanquish)	12-24 hours	III	Caution
Triclopyr[1] (Garlon4, Remedy); formulations bButoxyenthyl ester (BEE) and triethylamine salt (TEA)	4 hours	III	Caution
HERBICIDES FOR GROUND-BASED AND AERIAL APPLICATION			
Glyphosate[1] (terrestrial formulations: Roundup Pro Kleenup Pro; aquatic formulations: Rodeo, Aquamaster)	4 hours	IV	Caution
Imazapic[1] (Plateau, Cadre, Plateau Eco-Paks)	12 hours	III	Caution
Imazapyr[2] (Arsenal, Chopper)	12-48 hours	III	Caution

[1] *Herbicides approved for use under the Exotic Plant Management Plan and EA (SNP 2004).*

[2] *Not currently being used in the park; but considered for future uses.*

Mechanized

Mechanized restoration treatments and activities require gas, electric or battery powered equipment (e.g., trucks, chainsaws) to treat invasive plants, seed, mulch, scarify, or till, and are used primarily in developed areas of the park. Mechanized equipment used for herbicide application includes a battery-powered motor to pressurize a truck mounted tank mixture of herbicide, which is pumped through a hose to be applied to target plants via a hand-held wand. Like manual treatments, herbicide drift is minimized due to the close proximity of the spray wand to target plants. For some remote treatment

sites, water for mixing with herbicide formulations would be transported by a helicopter to pre-determined staging areas.

Possible hazards to restoration crew members include all of those listed under manual methods, plus risks of cuts, abrasions, and impact from chains, pulleys, and other moving parts of mechanical equipment. Risk of eye injury from flying debris would be higher, and hearing damage could also occur, though the proper use of PPE would mitigate such potential impacts. The use of mechanized equipment has inherent safety concerns, and only certified and trained personnel may operate the equipment per industry standards and other relevant safety protocols. Potential impacts to restoration crews employing ground-based mechanized restoration techniques would be direct and indirect, site-specific, negligible to minor, short-term, and adverse.

Since visitor access would be prevented during restoration activities and the restricted entry interval, and drift would not occur beyond 24 inches from targeted plants, there would be no potential impacts to the public.

Summary of No Action Alternative

Overall, the potential impacts to health and human safety from the NAA ground-based restoration treatments and activities would be direct and indirect, site-specific, negligible to minor, short-term, and adverse.

Restoration treatments that stabilize disturbed lands would also be expected to provide indirect, site-specific to local, negligible, short- and long-term benefits to human health and safety by reducing dust from wind erosion, and the potential of smoke from wildfires.

Cumulative Impacts of No Action Alternative

Activities cited in the cumulative impacts scenario (section 3.1) that have, are, or will expose humans to pesticides or harmful chemicals, particularly activities that could affect air or water quality, are most likely to affect human health or safety (e.g., industrialization, agriculture, mining, vehicle use, suppression of natural wildfires in woodlands and forests and/or facilitating fires in desert areas).

Population growth and associated increases in urbanization and development, including the use of pesticides, and other chemical pollutants, as well as airborne dust, smoke, and other particulate matter are expected to continue with increasing development around both districts of the park. The proposed Rocking K development adjacent to the RMD, and areas covered by the Houghton Area Master Plan, and the Tucson Mountains Sub-regional Plan and Rincon/Southeast Sub-regional Plan would allow low intensity rural to high intensity urban housing developments adjacent to or near the park. The additional roads and vehicle use, and disturbance associated with land clearing could affect the air quality humans breathe; and the use of pesticides on public or private property (e.g., homes, commercial properties, roadsides, and golf courses), particularly near Rincon Creek, could potentially reach groundwater that humans use for drinking water.

Under the NAA of this Restoration Plan park staff would continue to use ground-based restoration methods, including herbicides, to treat invasive non-native plants and restore native vegetation in accessible areas of the park. However large patches of buffelgrass in inaccessible areas would not be treated and buffelgrass would continue to expand, and facilitate wildfire at lower elevations along with the accompanying potential for smoke. Likewise, large, remote areas impacted by intense wildfires may not be adequately restored, and could increase the potential for flooding and sedimentation that could

affect downstream resources and potentially harm human life and/or property. When combined with other past, present, and reasonably foreseeable future actions, the NAA would provide a negligible incremental decrease to these overall negative impacts.

Preferred Alternative (PA)

The Preferred Alternative (PA) includes all of the activities and impacts to human health and safety described under the NAA, and adds the potential for aerial delivery of restoration treatments (e.g., seeds, mulch and herbicides).

Aerial Delivery of Restoration Treatments

The potential impacts to human health and safety from aerial restoration operations fall broadly into two categories: safety of staff and contractors associated with the operation of the aircraft, and safety of the individuals who might come in contact with the materials delivered on the ground. As with ground-based mechanized equipment operation, all personnel involved with aircraft operations would be specifically trained and certified to do so, and federal, NPS, and park laws, regulations, policies, SOPs, and other applicable safety protocols would be adhered to.

There are inherent risks associated with helicopters and aircraft in general, therefore the Department of Interior (DOI) has strict policies regarding the operation of aircraft on parklands. Potential impacts to individuals conducting aerial restoration treatments would be direct and indirect, site-specific, negligible to minor, short- term, and adverse.

Sites to be treated with aerially delivered seeds, mulch or herbicides are primarily remote areas that are rarely visited by the public, and would be temporarily closed to ensure no humans would access these areas until after the restoration operation was completed. Such closures would be well publicized and posted. Aircraft landing zones would be off limits to the public for the duration of the project, and all equipment and herbicides would be secured at all times.

Relative to ground-based herbicide application, aerial herbicide application has an increased potential to "drift." Herbicide drift was measured as part of the 2010 evaluation of aerial application of herbicides to control buffelgrass, and results showed that less than 1% of the herbicide was detected 90 feet from the targets (Appendix A). Herbicide drift would be minimized by following the weather limitations on the herbicide label, using large droplets of herbicide, and delivering the herbicide as low to the ground as safely possible. In addition, no aerial herbicide application would occur within 1/8 mile from unoccupied private land, 1/4 mile from occupied private land, ¼ mile from trails, campgrounds or picnic areas, or 165 feet from any surface water.

Spreading mulch by helicopter can result in mulch particulates and seeds, often mixed with an adhesive natural material, being subject to some drift, and the same constraints as for aerial herbicide application would apply.

Use of aerial treatments may decrease the need for ground-based treatment, and therefore reduce potential injuries from manual and other mechanized treatments.

Potential impacts to human health and safety on the ground from aerial restoration treatments proposed in the PA would be indirect, site-specific to local, negligible to minor, short-term, and adverse.

Summary of Preferred Alternative

Overall, restoration treatments proposed in the PA would potentially have direct and indirect, site-specific to local, negligible to minor, short-term, adverse impacts to human health and safety.

Restoration treatments that stabilize disturbed lands would also be expected to provide direct and indirect, site-specific to local, negligible to minor, short- and long-term benefits to human health and safety by reducing dust from wind erosion, and the potential for smoke from, and/or floods after, wildfires.

Cumulative Impacts of the Preferred Alternative

This alternative would have all of the same adverse impacts on human health and safety as the NAA, and increase the potential impacts by adding aerial restoration treatments (herbicides, seeding and mulching). These additional impacts would be minimized by the herbicides selected, mitigations implemented to limit herbicide drift (see Best Management Practices in section 2.4), and excluding the public from treatment areas.

Under the PA the park would be better able to reverse the loss of native vegetation in desert areas, and restore large and/or remote sites impacted by disturbances, such as unnaturally intense wildfires. Restoration activities that stabilize disturbed lands would reduce the potential for desert wildfires and smoke, dust from wind erosion, and flooding and soil erosion, all of which could affect human health and safety. When combined with other past, present, and reasonably foreseeable future actions, the PA would provide a minor incremental decrease to these overall negative impacts.

Conclusion

To fulfill the mandate of the NPS and the purposes of SNP, restoration treatments and activities will be conducted in the park. Actions proposed under either alternative pose some potential direct and indirect, site-specific, minor, short-term health and human safety issues, particularly for the personnel implementing these actions. The results of restoration activities under both alternatives also offer potential long-term benefits to human health and safety, mainly by decreasing the potential for wildfire in lower elevation areas and associated risks (e.g., smoke and fire-fighting activity). To the extent that the PA offers more benefits from the results of restoration activities, it has less adverse impact on human health and safety.

3.3 SOILS AND SURFACE HYDROLOGY

Affected Environment

Soil is the loose covering of fine rock particles that covers the surface of the earth. It is formed in layers (soil horizons) created from parent materials (bedrock and other minerals), and it is influenced by climate, slope, organic materials and local micro-organisms, and time. The term 'soil' is usually thought of as the surface layer of land that contains organic material that influences and has been influenced by plant roots, and may range in depth from inches to many feet. Surface hydrology includes water that occurs above land, including the oceans, lakes, rivers and streams, springs, and the overland flow of water after rainfall or snow melt. Although physically related, it does not include subsurface water (groundwater) which is addressed in Water Quality and Quantity, Section 3.4.

Due to the region's semi-arid climate, soils are not well developed in southern Arizona. The ground surface of most of the Rincon Mountains consists of bedrock or regolith, loose material covering solid rock. A thin veneer of loose material eroded by water (alluvium) covers sloping bedrock along the edges

of the Rincons. This alluvial fill thickens to tens of feet along larger drainages, such as Rincon Creek. Aridisol soils with calcium carbonate concentrations (caliche), have very little organic matter, and have developed on this deeper alluvium. At the highest elevations of the Rincon Mountains in coniferous forests, there is more organic material and precipitation is greater, and the thin soils have distinctive soil horizons.

The Tucson Mountains are composed of volcanic and sedimentary rocks. The lower slopes of the mountains are covered by alluvium, up to 400 feet thick. The soils of the Tucson Mountains are shallow, coarsely textured, and well-drained, and the soils of the bajadas are alluvial (NPS 1995). Soils become progressively finer with more sand and clay with decreasing elevation. Granite weathers rapidly into granulated rock, known as "gruss," which further degrades into soils favorable to plants.

In both districts of the park, soils located on fan terraces (areas about 2,000 to 3,500 feet in elevation) are highly erodible by wind and water. Wind erosion is a continuous, year-round force. Erosion from water typically occurs during summer thunderstorms, which create sheet erosion instead of a slow percolation of water into the soil that occurs during gentler winter precipitation. Healthy vegetation holds the soil in place during rain and high winds, and slows and reduces soil movement, or erosion.

In arid areas of the park, biological soil crusts composed of blue-green algae (cyanobacteria), lichens, and mosses, are also critical in inhibiting erosion (NRCS 1989). In addition to stabilizing soil and slowing erosion, soil crusts contribute to a number of functions in the environment occurring at the land-surface or soil-air interface, including fixation of atmospheric nitrogen, water infiltration, seedling germination, and plant growth. Soil crusts can be easily damaged or destroyed by disturbances such as fire, livestock grazing, or human activities (e.g., hiking, biking, off road vehicle use) causing a decrease in micro-biotic diversity, soil nutrients and organic matter, and increased erosion potential. Though visual recovery of impacted areas may seem to occur in as little as one to five years, depending on climatic conditions, full recovery of disrupted biological soil crusts is a slow process, often taking decades (NRCS 1989).

Impacts to soil can begin with simple disruption of surface organic matter or biological soil crusts from disturbances such as wind, rain, trampling or off-road vehicle use. Such disruption can lead to a loss of soil crusts and structure, a change in soil chemistry, and facilitate erosion, compaction, and subsequent reduced water infiltration.

Restoration, particularly after a fire, is of particular importance in the lower elevations of the park due to the highly erodible soils. Restoration to stabilize slopes helps to slow erosion and sedimentation, which can degrade or destroy aquatic, wetlands, and/or sensitive riparian habitat.

No perennial water or wetlands are present in the TMD, although a few small intermittent seeps occur near Kings Canyon. The TMD receives about 11.8 inches of precipitation annually, fairly equally divided between winter and summer. Summer rains come in the form of intense local thunderstorms associated with the monsoon, and often lead to flash flooding and surface runoff. Winter precipitation generally comes in western fronts, and tends to be gentler and longer in duration. Winter rainfall better infiltrates the soil to recharge groundwater.

The RMD has several springs and seeps throughout its upper elevations. Annual rainfall near Mica Mountain can exceed 30 inches, while the lower elevations average 11 inches. The snow pack can be heavy in the winter months, and in most years, snowmelt in the winter and spring leads to the majority of the annual surface flow in major drainages in the Rincons. These streams drain sufficient watershed areas that they can flow for weeks or sometimes months. Summer conditions in the RMD are similar to

the TMD, where surface flow occurs only after large storm events. Streams in the RMD are intermittent, but some large, often spring-fed pools of water in bedrock (tinajas), contain water year-round.

Methodology and Intensity Thresholds

Analyses of the potential impacts to soils and surface hydrology from each of the alternatives below were derived from the literature and sources cited above and park staff's professional experience and knowledge of the effects of human impacts, wildfires and restoration treatments and activities on soils, including studies and research conducted on soils in the park (Mott 1997, Graham 2010). Appendix G summarizes the proposed herbicide physical properties and how they act in the environment.

Intensity Levels

Impact Intensity	Definitions
Negligible	There would be no observable or measurable impacts to soils and/or surface hydrology. No herbicides would reach the ground.
Minor	Impacts to soils may be discernible and measurable, but minimal soil loss would occur. There would be minimal disturbance or interruption to surface hydrology. Only non-persistent herbicides (i.e., their half-life* in soil is <30 days; Kerle et al. 2007) would reach the ground.
Moderate	Impacts to soils and surface hydrology would be discernible and measurable. Changes to surface hydrology and soil character, productivity, integrity, stability, or fertility may occur. Only moderately persistent herbicides (i.e., their half-life* in soil is 30-100 days; Kerle et al. 2007) would reach the ground.
Major	Impacts to soils and surface hydrology would be obvious and measurable. Changes to surface hydrology and soil character, productivity, integrity, stability, or fertility would occur. Persistent herbicides (i.e., their half-life* in soil >100 days; Kerle et al. 2007) could reach the ground.

** Herbicide persistence in the environment is measured in half-life, or how long it takes for half of the chemical to degrade.*

Duration

Short-term	Impacts to soils and surface hydrology can be immediate (i.e., during restoration treatments and activities), but would not exceed five years.
Long-term	Impacts to soils and surface hydrology would likely persist beyond five years

No Action Alternative (NAA)

Under the NAA, SNP would continue to implement post-disturbance restoration treatments and activities using ground-based treatments and techniques at small and accessible disturbed sites.

Manual

Field crews conducting manual restoration treatments in the park could cause short-term impacts to soils from hiking to and walking around disturbed sites, removing invasive non-native plants (digging), and raking and scarification prior to seeding and mulching. These actions would disturb and change soil profiles, and compact soils and affect surface hydrology at sites being restored. However, such adverse impacts would be minimized by best management practices (e.g., minimizing crew size, identifying and

using routes that would cause the least disturbance to sensitive soils and vegetation, re-contouring impacted areas, avoiding water sources, and other protocols; see Section 2.4). These activities could cause direct, site-specific, negligible to minor, short-term and adverse impacts to soils and surface hydrology. Ultimately, however, these treatments would reduce compaction and erosion and re-establish the native vegetation and natural surface water flow, providing indirect, local, minor, long-term benefits to soils and surface hydrology.

Importation of non-native soil or other fill material can bury native soils, introduce soil that does not support the local native plant community, and introduce seeds of non-native plants. These actions could result in direct and indirect, site-specific to local, negligible to minor, short- and long-term adverse impacts to soils and surface hydrology.

Herbicides

Herbicide application under the NAA is conducted by well-trained restoration crews that follow federal, agency, state, park and manufacturer laws, regulations, policies, guidelines and procedures, many of which specifically address (prevent and/or mitigate) potential impacts of herbicides to water resources or aquatic environments. It would be very unusual for chemicals from ground-based herbicide treatments to have the potential to contact surface water. However, if there were any potential for herbicides to contact or affect surface water, aquatic approved herbicide formulations would be used.

Manual ground-based application of selected herbicides on targeted individual plants could directly affect soil chemistry if herbicides are spilled on and absorbed into the soil during application. With the exception of pre-emergent herbicides, which are applied to bare ground only at known infestation sites with a high potential for plants to re-establish (e.g., roadsides), the fate of any herbicide reaching the soil depends on many factors, such as herbicide chemistry and its ability to attach to soil molecules or organic matter in the soil (sorption), and soil characteristics, such as texture, moisture, pH, and temperature. Herbicides in soil can undergo transformation by different types of degradation including by light (photo-degradation) or by biological and/or chemical processes (Senseman 2007). Warm temperatures and moist soil usually accelerate herbicide degradation. Water is a significant factor in the movement of herbicides into and on soils through runoff potential and leaching. This is discussed further under Water Quality and Quantity, Section 3.4.

Manual application of herbicides during restoration treatments would have direct, site-specific to local, negligible to minor, short-term, adverse impacts on soils and surface hydrology. The resulting restoration of a native plant community and ecosystem function would have direct and indirect, site-specific to local, minor to moderate, long-term benefits to soils and surface hydrology.

Ground-based invasive non-native plant herbicide treatments in remote areas require staging areas (about 400 square feet) for mixing chemicals, storing equipment, and personnel breaks. When possible, large, flat rock outcrops are used, otherwise a relatively flat area devoid of vegetation is selected. The potential for herbicide spills onto soils is low. Herbicides are transported and stored in leak-proof containers within a secondary container, and are handled according to label specifications. In the unlikely event of a spill, resource managers would immediately implement standard operating procedures for containment and clean-up (see Herbicide Training and Safety Plan; Appendix C). After a staging area is decommissioned, it is re-vegetated with native plant material available near the site. Effects on staging areas include compaction of soil and disturbance to biological soil crusts and upper

soil profiles and would have direct, site-specific, minor, short-term, adverse impacts to soils and surface hydrology.

Mechanized

Mechanized ground-based equipment (e.g., tractors, chainsaws, drill seeders, tanks mounted on trailers or vehicles) that would be used to remove invasive non-native plants, apply herbicides, seed, mulch, scarify, or till would be used only in road-accessible, developed areas of the park. Use of mechanized equipment could result in soil disturbances and compaction and interruptions in natural surface flow, which could affect run-off and surface water quality. These activities could cause direct, site-specific, negligible to minor, short-term, adverse impacts to soils and surface hydrology. Treatment impacts would be mitigated by the seeding, mulching, erosion control structures, and de-compaction of soils that would also occur. Ultimately, restoration treatments would reduce compaction and erosion, and re-establish the native vegetation and natural surface water flow, thereby having indirect, site-specific to local, minor, long-term benefits to soils and surface hydrology.

Summary of No Action Alternative

Overall, restoration treatments and activities under the NAA would have direct, site-specific to local, negligible to minor, short-term, adverse impacts, and indirect, site-specific to local, minor, short- and long-term beneficial impacts on soils and surface hydrology.

Cumulative Impacts of No Action Alternative

The past, present, and reasonably foreseeable future actions with potential to affect soils and surface hydrology are those that cause disturbance to the soil surface and facilitate erosion, or that potentially contaminate soil (e.g., urbanization and development, cattle grazing, agriculture, non-native plant introductions, mining, groundwater pumping, suppression of natural wildfires in woodlands and forests and/or facilitating fires in desert areas, on- and off-road or -trail use by park staff and visitors, and other activities that remove native vegetation).

Population growth and associated increases in urbanization and development, including the use of pesticides, and other chemical pollutants, are expected to continue with increasing development around both districts of the park. The proposed Rocking K development adjacent to the RMD, and areas covered by the Houghton Area Master Plan, and the Tucson Mountains Sub-regional Plan and Rincon/Southeast Sub-regional Plan would allow low intensity rural to high intensity urban housing developments adjacent to or near the park. Soil erosion would be expected to increase with the disturbances associated with land clearing. Use of pesticides on public and private property (e.g., homes, roadsides, commercial properties, and golf courses) could contaminate soils.

The Catalina-Rincon FireScape planning process and Coronado National Forest Land and Resource Management Plan may improve management of wildfires in higher elevations, and help restore native plant communities and their resilience, which would improve soil conditions.

Under the NAA of this Restoration Plan park staff would continue to use ground-based restoration methods, including herbicides, to treat invasive non-native plants, rehabilitate disturbed areas, and restore native vegetation in accessible areas of the park. However large patches of buffelgrass in inaccessible areas would not be treated and buffelgrass would continue to expand, increasing the likelihood of wildfires and subsequent soil erosion. Likewise, large, remote areas impacted by intense wildfires may not be adequately restored, and could increase the potential for flooding, sedimentation, and soil erosion.

When combined with other past, present, and reasonably foreseeable future actions, the NAA would be expected to provide a negligible to minor decrease to the overall negative cumulative impacts on soils and surface hydrology.

Preferred Alternative (PA)

The Preferred Alternative (PA) includes all of the activities and impacts to soils and surface hydrology described under the NAA, and adds the potential for aerial delivery of restoration treatments (e.g., seeds, mulch and herbicides).

Aerial Delivery of Restoration Treatments

Under the PA, helicopters and fixed-wing aircraft could deliver seed to speed recovery of disturbed areas, and apply erosion control material (mulch). Treated sites could include severely burned areas, at both low and high elevations, and other remote sites needing restoration treatments, such as large buffelgrass patches after they have been treated with herbicide. Aerial applications of seeds and mulch would facilitate restoration by quickly treating larger areas. Treatments would provide soil cover, and reduce raindrop impact, erosion, sedimentation, nutrient loss, and improve infiltration and re-vegetation (Napper 2006, Robichaud 2009), and would have direct and indirect, site-specific to local, minor to moderate, short- and long-term benefits to soils and surface hydrology.

The PA would also enable treatments of much larger and more remote non-native plant infestations than can be treated by ground-based efforts, and would not cause direct physical impacts to soils. However, aerial treatments could potentially allow more herbicide to come into contact with soil. Depending on the size and location of the site, either a boom or spot sprayer, would be used to minimize the potential for herbicides to reach non-target resources, including soils. In addition, aerial treatment would be considered only for invasive non-native plant patches with greater than 50% buffelgrass cover, and herbicides would not be used within 165 feet of any surface water (see Best Management Practices, Section 2.4).

Aerial application of herbicides would have direct, local, negligible to minor, short-term, adverse impacts to soils and surface hydrology. The benefits from eradicating invasive non-native plants from these areas would be direct and indirect, local, moderate, and long-term.

Summary of Preferred Alternative

Overall, the Preferred Alternative would have direct, site-specific to local, negligible to minor, short-term, adverse impacts, and direct and indirect, local to regional, moderate, short- and long-term, beneficial impacts to soils and surface hydrology.

Cumulative Impacts of the Preferred Alternative

This alternative would have all of the same adverse impacts on soil and surface hydrology as the NAA, but would allow for the restoration of larger and remote disturbed areas, including infestations of non-native, invasive plants, and large scale post-fire rehabilitation. Soils would be stabilized or enhanced, and surface hydrology restored, aiding in the recovery of native vegetation communities. Under this alternative, the cover and extent of buffelgrass and other flammable non-native grasses would be decreased, and the probability, size, and severity of potential wildfires would be lowered, lessening the occurrence of post-fire soil erosion.

When combined with other past, present, and reasonably foreseeable future actions, the PA would provide a minor to moderate incremental decrease to these overall negative impacts.

Conclusion

Restoration, particularly after a fire, is of particular importance in the lower elevations of the park, due to the highly erodible soils. Restoration to stabilize slopes especially, helps to reduce erosion and sedimentation, which can degrade or eliminate aquatic, wetland and/or sensitive riparian habitat (see Section 3.4). Restoration treatments and activities under both alternatives would reduce soil erosion, restore surface flow, and promote native vegetation recovery. The Preferred Alternative would allow significantly more restoration to occur by allowing for the treatment of larger, currently inaccessible areas, thereby providing more benefit to soils.

3.4 WATER QUALITY & QUANTITY

Affected Environment

SNP contains watersheds that are generally small with ephemeral (intermittently flowing) drainages. Most of the surface water in both district of the park drains into the north-flowing Santa Cruz River and contribute to the Upper Santa Cruz and Avra Basin Sole Source Aquifer (SSA), designated in 1984. Historically, the Santa Cruz River flowed year round, but today the Santa Cruz River only flows after an unusually heavy rain or snowmelt (Kiver and Harris 1999). Tucson has traditionally relied heavily on groundwater that is pumped from the deep Tucson Basin (Mott 1997), and drawdown in the wells supplying water to the city for municipal, agricultural and industrial use, has lowered the groundwater levels (ADWR 1999). Between 1947 and 1985, the majority of the Tucson area experienced groundwater declines of 40 to 80 feet; during that same time, water levels declined by more than 100 feet in Avra Valley. In recent years, Colorado River water has been brought to the area by the Central Arizona Project (CAP) canal to help recharge Tucson Basin and Avra Valley groundwater.

Water quality in the aquifer has also declined, and the presence of inorganic compounds and volatile organic compounds has required some wells to be shut down (ADWR 1999). Increasing reliance on recharge from effluent and from CAP water, which is high in suspended solids, also decreases water quality (ADWR 1999). The Tucson Basin has detectable levels of one herbicide, simazine, in its groundwater. The 2012 Annual Water Quality Reports of Tucson Water (City of Tucson 2012) reported 0.082 parts of simazine per billion (ppb); maximum contaminant level (MCL) set by the EPA is 4 ppb. Simazine is not acutely toxic, and is currently labeled for use on broad-leaved plants, and as an algaecide in aquaria, fountains, and ponds (EPA 2006). It is not one of the herbicides proposed for use in SNP.

Despite surrounding land uses and their impacts to water quality in the Tucson Basin, the limited water quality data available for the park suggest that it has not been impacted by human activities, and is good (NPS 1997). In 1968 and 1981, eight springs in the RMD were monitored for 19 parameters. Except for a pH reading of less than 6.5 for a sample from the Manning Camp Spring, no water quality samples from the park exceeded EPA criteria for freshwater aquatic life or drinking water (NPS 1997). The most serious potential threat to the water resources of SNP is excessive extraction of near surface groundwater from areas adjacent to the park (Mott 1997). The distinct and diverse riparian ecosystems in the Rincon Mountain District depend on near-surface groundwater. Thus, small water table declines or increased fluctuation in near-surface groundwater levels can negatively impact riparian habitats, which are especially crucial to bird populations. Riparian habitats are the most important and endangered habitats in the southwest (Powell et al. 2006).

Methodology and Intensity Thresholds

Analyses of the potential intensity of impacts to water quality and quantity were derived from the literature and sources cited above, and NPS staff's experience and knowledge of the effects on water quality and quantity from visitor use, wildfires, and restoration treatments and activities, including many park water and hydrology studies (Mott 1997, MacLeod et al. 2003, Graham 2010).

This analysis also incorporates a standardized system resource managers use to assess the potential risk for leaching and ground water contamination from herbicides called the Relative Aquifer Vulnerability Evaluation (RAVE; MSUES 1990). To determine the potential for ground water contamination, the RAVE system considers several factors: 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 to give a "RAVE score" that is interpreted on a scale of 30-100, where 60 is considered the threshold for the potential for groundwater contamination. A score of 80 or above indicates an herbicide should not be used at a given location, unless its potential impacts can be mitigated. RAVE scores for herbicides proposed for use in the park can be found in Appendix G.

Intensity Levels

Impact Intensity	Definitions
Negligible	There would be no measurable impacts to groundwater quantity and/or quality. RAVE score 30- 60.
Minor	Localized impacts to groundwater quality and/or quantity may be measurable. RAVE score 61-70.
Moderate	The impacts to groundwater quality and/or quantity would be measurable and may result in a change over a relatively small area. RAVE score 71-80.
Major	The impacts to groundwater quality and/or quantity would be measurable and may result in a change over a relatively large area. RAVE score 81-100.

Duration

Short-term	Impacts to water quality and quantity can be immediate (i.e., during restoration treatments and activities), but will not exceed five years.
Long-term	Impacts to water quality and quantity persist beyond five years

No Action Alternative (NAA)

Under the NAA, SNP would continue to implement post-disturbance restoration treatments and activities using ground-based treatments and techniques at small and accessible disturbed sites.

Manual

Ground-based restoration treatments, including crews using picks, rakes, shovels, and backpack herbicide pump sprayers, would cause some soil disturbances that could result in sedimentation and reduced water quality in drainages after rain events, and small changes in natural surface flow. These activities could potentially impact the quality of nearby surface waters and the amount of water percolating into the soil, but the impacts would be mitigated by standard operating procedures/best management practices, such as re-contouring impacted areas. Impacts to water quality and quantity

would be indirect, site-specific to local, negligible, short-term, and adverse. The actual restoration treatments, such as channel stabilization, and erosion and sediment control, would improve natural surface water flow conditions and would have indirect, site-specific to local, negligible to minor, short- and long-term, beneficial impacts to water quality and quantity.

Herbicides

Herbicides can affect ground water depending on their chemical ingredients and where and how they are applied, and this is reflected in their RAVE scores (described above). All RAVE scores for herbicides proposed for use in the park are below 60 except for triclopyr. Triclopyr has a RAVE score of 39 or 71 (depending on whether it's applied in an upland or wetland area, respectively) and is only used to control tamarisk, where it is hand-applied directly onto freshly cut stumps. The impacts to water quality and quantity from ground-based manual herbicide spraying would be indirect, site-specific to local, negligible, short-term, and adverse.

Mechanized

Ground-based mechanized equipment used to restore sites would include motorized equipment (e.g., chainsaws, tractors, drill seeders, and tanks mounted on trailers or vehicles). Sites that would be treated with mechanized equipment are relatively large and road accessible. Use of mechanized equipment could result in soil disturbances and compaction and/or interruptions in natural surface flow, which could affect run-off and ultimately groundwater quality and quantity. These impacts would be mitigated by the seeding, mulching, erosion control structures, and de-compaction of soils that would occur from the restoration treatments. Overall, mechanized restoration treatments would cause indirect and site-specific to local, negligible, short-term, adverse impacts, and indirect, site-specific to local, negligible to minor, short- and long-term beneficial impacts to water quality and quantity.

Use of mechanized equipment for herbicide application consists of a truck mounted sprayer driven along roads. Herbicides are still delivered via hand held sprayers onto individual target plants. Impacts to water quality and quantity from mechanized ground-based herbicide treatments would be indirect, site-specific to local, negligible, short-term, and adverse.

Summary of No Action Alternative

Overall, ground-based restoration under the NAA would have indirect, site-specific to local, negligible to minor, short-term, adverse impacts; and indirect, site-specific to local, negligible to minor, short- and long-term beneficial impacts to water quality and quantity.

Cumulative Impacts of No Action Alternative

The past, present, and reasonably foreseeable future actions cited in the cumulative impacts scenario (section 3.1) that affect water quality or quantity are those that could add pesticides or harmful chemicals to the environment and/or could otherwise affect groundwater quality or quantity (e.g., urbanization, industrialization, agriculture, cattle grazing, mining, suppression of natural wildfires in woodlands and forests, and/or facilitating fires in desert areas).

Population growth and associated increases in urbanization and development, including the use of pesticides and other chemical pollutants, are expected to continue with increasing development around both districts of the park. The proposed Rocking K development adjacent to the RMD, and areas covered by the Houghton Area Master Plan, and the Tucson Mountains Sub-regional Plan and Rincon/Southeast Sub-regional Plan would allow low intensity rural to high intensity urban housing developments adjacent to or near the park. An increasing human population around the park could add

additional demands on local groundwater; and the use of pesticides or underground storage tanks on private property (e.g., homes, commercial properties, and golf courses), particularly near Rincon Creek, could impact water quality.

Under the NAA of this Restoration Plan park staff would continue to use ground-based methods, including herbicides, to treat invasive non-native plants and restore native vegetation in accessible areas of the park. When combined with other past, present, and reasonably foreseeable future actions, the NAA would provide a negligible incremental increase to these overall negative impacts on water quality and quantity.

Preferred Alternative (PA)

The PA includes all of the ground-based restoration treatments and activities in the NAA; and thus includes all of the impacts to water quality and quantity described above. In addition it allows for the use of aircraft for delivering restoration treatments (e.g., seeding, mulching and applying herbicides) to larger, less accessible sites.

Aerial Delivery of Restoration Treatments

Under the PA, helicopters and fixed-wing aircraft could deliver seed and apply erosion control materials (mulch). The use of aircraft to deliver seeding and erosion control treatments would allow SNP to reduce erosion and facilitate revegetation in larger, more remote disturbed areas, thus providing indirect, local, negligible to minor, short- and long-term benefits to water quality and quantity.

Only three herbicides, each of which has a RAVE score ≤ 50 are proposed for aerial treatments. Best Management Practices (Section 2.4; specifically, not applying herbicides within 165 feet of any surface water) would reduce potential indirect, local, negligible to minor, short-term, adverse impacts to water quality and quantity.

Summary of Preferred Alternative

Overall, the Preferred alternative would have indirect, local, negligible to minor, short-term, adverse impacts; and indirect, local, minor to moderate, short- and long-term benefits to water quality and quantity.

Cumulative Impacts of the Preferred Alternative

This alternative would have all of the same adverse impacts on water quality and quantity as the NAA, and add the potential impacts of aerially treating larger, remote disturbed areas with herbicides or seeds and/or mulch. Aerially applied herbicides would have greater potential to reach the ground, and thus groundwater, than ground-based applications; however, such potential negative impacts (i.e., to groundwater quality) would be minimized by the herbicides chosen for use (i.e., RAVE scores of glyphosate, imazapyr and imazapic are less than 60, so the potential for groundwater contamination is negligible).

The PA would also facilitate restoration treatments in large or remote sites impacted by disturbances, and decrease the potential for flooding and soil erosion which can negatively impact groundwater quantity. When combined with other past, present, and reasonably foreseeable future actions, the PA would provide a negligible to minor incremental increase to these overall negative impacts.

Conclusion

Restoration treatments and activities proposed in both alternatives would reduce surface water runoff and sedimentation; therefore both would have potential benefits to groundwater quality and quantity in the park. To the extent that more and larger disturbed sites can be treated aerially, the PA has greater potential benefits to water quality and quantity. However, herbicides delivered aerially would have greater potential to reach the ground than ground-based efforts. Thus, though the difference would be small, the potential to impact water quality would be greater under the PA.

3.5 VEGETATION

Affected Environment

Protecting vegetation, specifically saguaros and the other plant species of the Sonoran Desert, the Rincon Mountains, and the riparian zones of Rincon Creek, is one of the core elements of SNP's enabling legislation. Furthermore, NPS Management Policies (NPS 2006, Sections 4.4.1.1 and 4.4.4) state that parks will maintain all plants and animals native to park ecosystems and that invasive non-native species will not be allowed to displace native species if that can be prevented. SNP also has several planning documents that identify invasive non-native plants as an important management issue that must be addressed (SNP 2004, NPS 2007, NPS 2009).

The park's geographic location, mild winters, bimodal (summer and winter) precipitation pattern, and variation in elevation all contribute to its exceptional plant diversity. The TMD has about 500 native plant species, and the RMD has almost 1,200 native plants (Powell et al. 2006, 2007). Although the park lies within the Sonoran Desert region, it is adjacent to the Chihuahuan Desert, and species from both biomes are present. Similarly, plant species from the Rocky Mountains to the north and the highlands of Mexico to the south occupy the upper elevations of the Rincon Mountains. In addition, some subtropical plant species reach the northern or eastern limit of their range in SNP, and some plant species from the Mojave and Great Basin Deserts are present.

In the RMD, Sonoran desertscrub occurs at the lowest elevations, transitioning into desert grassland with increasing elevation and precipitation. At higher elevations, woody plants become larger and more dominant, and plant communities change to pine-oak woodland, pine-oak forest, and pine forest. Mixed conifer forests occur on north-facing slopes at the highest elevations of the Rincon Mountains. The changes in species composition are gradual, leading to many shared species between adjacent plant communities. Riparian forest and riparian woodland occur locally in canyon bottoms, and wet and dry meadows are found in scattered clearings at high elevations. The TMD contains only desert plant communities – specifically desertscrub and desert grassland.

Mountain Meadows

Meadows are found in small patches in the RMD from 7,400 to 8,500 feet. Wet meadows occur adjacent to springs. Dominant species include various sedges, rushes, and grasses. Perennial grasses dominate dry meadows. Some dry meadows in the Rincon Mountains may be the result of disturbance (e.g., past logging or intense fire) and may revert to pine forest without further disturbance. Disturbed areas may be invaded by non-native species such as cheatgrass, dock, and Kentucky bluegrass.

Mixed Conifer Forest

Mixed conifer occurs from 7,500 to 8,665 feet in the RMD, mainly on north aspects. Douglas fir is often the dominant species in the overstory, with Ponderosa pine, southwestern white pine, Gambel oak, New

Mexico locust, and white fir also present. Four stands of quaking aspen are within or near mixed conifer forest.

Pine Forest

Ponderosa pine and Arizona pine are dominant in this vegetation type (8,000 to 8,665 feet), sometimes forming pure stands. Southwestern white pine and Gambel oak are sometimes present. Trees often reach 80 feet in height. Horehound is an invasive non-native plant that grows around Manning Camp.

Pine-Oak Forest and Pine-Oak Woodland

Pine-oak forests and woodlands (4,400 to 8,000 feet) are highly variable, with a mixture of Arizona pine, Chihuahua pine, border pinyon pine, alligator juniper and several oak species (silverleaf oak, netleaf oak, Arizona white oak, and Emory oak). Canopy height can be from 20 to 80 feet. The shrub layer can be dense and includes manzanita and Wright's silktassel.

Desert Grassland

Desert grassland is found between 4,000 and 5,000 feet in the RMD, lying between the pine-oak woodland above and the desertscrub below. In the TMD, it occurs in scattered patches at the tops of the tallest peaks. This community usually includes many desertscrub plants, but is characterized by the presence and dominance of numerous warm-season, perennial bunchgrasses. The most abundant grasses include various gramas, tanglehead, and three-awns. Many shrubs and succulents occur in desert grassland such as ocotillo, sotol, agaves, and a diverse assemblage of cacti, as well as scattered trees. Mesquite can occur as a dominant tree, especially where disturbance (e.g., grazing) has been heavy in the past. This vegetation type is maintained by wildfire, and encroached on by shrub and tree species from above and below.

Invasive non-native species present in this plant community include buffelgrass and Lehmann's and weeping lovegrasses. Lehmann's lovegrass has invaded thousands of acres of grassland in other natural areas in southern Arizona and is widespread in SNP below 6,000 feet.

The highlands of central Arizona and the Colorado Plateau have been invaded by several non-native species that have not appeared in SNP yet. The most problematic potential invaders at these elevations include non-native thistles, leafy spurge, tree of heaven, starthistles, and knapweeds.

Desertscrub

Desertscrub occurs throughout the TMD and covers about 10,000 acres of the RMD- virtually all areas of the district below about 4,500 feet. It is characterized by numerous cacti and the drought-deciduous habit of many of the trees and shrubs and plants in the sunflower, cactus, and legume families. Dominant species in the overstory include foothills paloverde, saguaro, ocotillo, velvet mesquite, and in more moist sites, blue paloverde. In the TMD, ironwood is present. Common understory plants include brittlebush, several cholla species, barrel cactus, creosote bush, fairy duster, prickly pear, jojoba, and several bursages. Numerous perennial forbs are also present, especially from the sunflower, mallow, and four o'clock families. Many species of the native grasses found in desert grassland are also found in desertscrub, but are less abundant. About half the diversity of the Sonoran Desert is from annual grasses and forbs, some of which emerge after wet summers, but the most dramatic wildflower shows follow wet winters (Shreve and Wiggins 1964).

Some of the most problematic invasive non-native plants found in desertscrub in SNP are buffelgrass, soft feather pappusgrass, tickgrass, fountain grass, Mediterranean grasses, Sahara mustard, and Malta starthistle. A non-native forb, stock (*Matthiola parviflora*), was only discovered in North America in the

last few years but has since shown up in both districts of the park and is showing potential for being invasive. Red brome was widespread from the 1970's through the late 1990's, but since then multiple dry winters have confined it to moist sites.

Riparian Woodland and Riparian Forest

Higher elevation riparian areas are characterized by Arizona alder, boxelder, and willow. Lower elevation riparian areas are highly variable in species composition, supporting not only species that are found in riparian areas, but also plant species usually found at higher elevations. Dominant riparian-obligate trees include Arizona sycamore, Goodding's willow, velvet ash, and Fremont cottonwood. Riparian forest and woodland also support a diverse mix of vines, grasses, sedges, rushes, and forbs.

By their nature, riparian areas are subject to frequent disturbance (flooding), the severity of which increases with decreasing elevation. Because of this disturbance and increased water availability, they tend to be susceptible to invasion by non-native species. Invasive non-native plants that threaten SNP's riparian areas include salt cedar (tamarisk), Bermuda grass, giant reed, Johnson grass, rabbits foot grass, onionweed, Russian thistle, yellow bluestem and wild oats. Fountain grass and buffelgrass are problematic in low-elevation riparian areas. Natal grass invades riparian areas as well as rocky areas in desertscrub and desert grassland. Horehound has been found in desertscrub, and has the potential to invade and dominate riparian areas.

Desert Riparian Scrub

These communities are classified as riparian because they are different than the surrounding desertscrub, but the plants species are also well-adapted to dry conditions. This type is generally found in lower elevation floodplains and drainages in the TMD, which are more mesic than immediately adjacent upland vegetation communities. These communities are characterized by overstory vegetation consisting of velvet mesquite, desert hackberry, blue paloverde, and catclaw acacia. The trees and shrubs are larger than in surrounding, drier areas. Common shrubs include desert lavender and canyon ragweed. Buffelgrass, fountain grass, Johnson grass, Russian thistle, and Bermuda grass are invasive non-natives in this vegetation type.

Methodology and Intensity Thresholds

Analyses of the potential intensity of impacts to vegetation were derived from the literature and sources cited above, data from park fire effects vegetation plots, the available scientific data and literature, and park staff's experience and knowledge of the effects on vegetation from visitor use, construction activities, prescribed fires, wildfires, and invasive non-native plant removal.

Intensity Levels

Impact Intensity	Definitions
Negligible	No native plant species would be affected, or some individual native plants could be affected as a result of the actions, but there would be no effect on native plant species' populations. There would be no discernible effect to native plant distribution, abundance or diversity.
Minor	The actions would affect some individual plants over a broader area, but would have no effect on that species' population. May have a minimal effect to native plant distribution, abundance and/or diversity.

Moderate	The actions would affect some individual native plants and would also affect a limited segment of the species' population over a relatively large area. Could have an effect on native plant distribution, abundance and/or diversity.
Major	The actions would have a considerable effect on individual native plants and affect a sizeable segment of the species' populations over a relatively large area.

Duration

Short-term	Impacts to vegetation can be immediate (i.e., during restoration treatments and activities), but will not exceed five years.
Long-term	Impacts to vegetation persist beyond five years.

No Action Alternative (NAA)

SNP would continue to implement post-disturbance restoration treatments and activities using ground-based treatments and techniques at small and accessible disturbed sites.

Manual

Ground-based restoration techniques would continue to be performed as they are currently (i.e., hand-raking and scarification prior to seeding and mulching, manual removal of non-native plants, spraying herbicides using back-pack sprayers, etc.). Areas of disturbed vegetation would be restored by transplanting and mulching with on-site materials, and seeding with seeds collected within the park. Nursery grown plants may also be used in highly visible locations. Some sites could be manually irrigated to aid reestablishment of native plants.

Restoration treatments and activities occurring away from trails and roadways will impact vegetation by trampling and breakage, especially small cacti or fragile plants, such as brittlebush. Manual restoration treatments result in damage to small herbaceous plants and disturbance of the seeds in the soil. Mulching (e.g., with straw, excelsior, or wood shavings) is a treatment activity that helps stabilize soil and enhances the germination of some native plants. Manual removal of invasive non-native plants also involves some trampling of native plants and breakage or uprooting of native plants intertwined with non-native plants. Impacts to vegetation would be direct, site-specific, negligible, short-term, and adverse; and there would be indirect, site-specific, minor, long-term benefits, as well.

Herbicides

SNP currently treats about 500 acres of invasive non-native plants per year, mainly buffelgrass (Figures 5 and 6). Ground-based herbicide application with a back-pack sprayer allows a high degree of control and minimizes impact to non-target species. Impacts to native vegetation from herbicides would be direct, site-specific, negligible, short-term, and adverse. Benefits include the removal of non-native species, reduction of hazardous fuels in treated areas, and facilitation of the re-establishment of native vegetation, and would be direct and indirect, site-specific to local, minor, and short- and long-term.

Mechanized

Ground-based mechanized restoration treatments and activities include the use of motorized equipment to hydro-mulch, seed, drill holes, till, or apply herbicides. Disturbed sites that warrant mechanized equipment would be primarily accessible by roads or trails. Impacts to native vegetation from these actions could include trampling, uprooting, and breakage, and would be direct, site-specific,

negligible, short-term, and adverse. However, the recovery of native plant communities and restoration of disturbed areas would be facilitated providing direct and indirect, site-specific to local, minor, long-term benefits.

Summary of No Action Alternative

Overall, the NAA would have direct, site-specific, negligible, short-term, adverse impacts; as well as direct and indirect, site-specific to local, minor, short- and long-term, beneficial impacts on vegetation.

Cumulative Impacts of No Action Alternative

The past, present, and reasonably foreseeable future actions with potential to affect vegetation are related primarily to non-native invasive plants, fire damage, cattle grazing, and wood-cutting. In order to increase cattle forage and control erosion, non-native plants, such as buffelgrass and Lehmann's lovegrass, were introduced in southern Arizona starting in the late 1800s. Other non-native plants used for landscaping or brought in accidentally have also become invasive. Livestock overgrazing coupled with woodcutting and exacerbated by drought, contributed to the decline in saguaro populations in the park in the twentieth century. In addition, human-caused fires have occurred as human population in the area has increased, and non-native plants have displaced native plants fueling unnatural wildfires. Wildfires, historically rare in the Sonoran Desert, have become more common and widespread and have damaged the desert vegetation in the park and surrounding areas. Burned desert areas would likely be converted to scrubby grasslands, with buffelgrass and few native trees or shrubs.

At higher elevations, where fire was once common and natural, many fires have been suppressed, and vegetation conditions have moved away from historical conditions. Downed limbs and logs, brush, and young trees have increased fuel for wildfires, increasing fire severity. In addition, plant community makeup, species diversity, plant productivity and other community dynamics have been altered by the lack of fire.

Development is expected to continue increasing around both districts of the park. The proposed Rocking K development adjacent to the RMD, and areas covered by the Houghton Area Master Plan, and the Tucson Mountains Sub-regional Plan and Rincon/Southeast Sub-regional Plan would allow low intensity rural to high intensity urban housing developments adjacent to or near the park. This could lead to major changes in vegetation outside the park. In addition, the disturbance associated with land clearing and the planting of non-native plant species in landscaping could increase the potential for non-native plants to establish within the park. This, in turn, could lead to increased numbers of human-caused fires along park boundaries and along trails, especially in lower elevation areas where fires are especially harmful.

The Sonoran Desert Conservation Plan and Southern Arizona Buffelgrass Strategic Plan contain numerous measures that will help lessen some of the negative impacts associated with development and invasive non-native plants. With a broad view of fire management, the Catalina-Rincon FireScape planning process and Coronado National Forest Land and Resource Management Plan may improve management of wildfires in upper elevations, helping restore native plant communities and their resilience.

The park's Trails Management Plan proposes numerous actions, including building several new trails and decommissioning some old trails. Some trailheads would be created or expanded negatively impacting vegetation, but closing and rehabilitating trails would restore and protect vegetation.

The NAA of this Restoration Plan would restore vegetation in accessible areas of the park. However large patches of buffelgrass in inaccessible areas would not be treated, and buffelgrass would continue to expand. Likewise, large, remote areas impacted by intense wildfires may not be adequately restored. Thus, degradation of vegetation in the park would continue. The cumulative impacts on vegetation would be direct and indirect, regional, moderate, short- and long-term, and adverse, with the NAA providing a minor decrease in the overall negative cumulative impact.

Preferred Alternative (PA)

Because the PA includes all of the ground-based restoration treatments and activities in the NAA, it includes all of the impacts to vegetation described above. In addition, the PA allows for the use of aircraft for delivering restoration treatments (e.g., seeding, mulching and applying herbicides) to larger, less accessible sites.

Aerial Application of Restoration Treatments

In general, aerial application of herbicide is inherently less precise than with ground-based techniques, so there would be a greater potential impact to non-target native plants. However, aerial treatments are relatively precise when delivered via helicopter with a boom or spray-ball as proposed. Some native forbs and many or all native warm-season perennial grasses and summer annual grasses in the treatment areas would likely be impacted by herbicides targeting buffelgrass during the summer growing season. Native grasses are widespread but not abundant in the Sonoran Desert. Olsson et al. (2012) found about 2% cover of native grasses in uninvaded desert vegetation, with buffelgrass invasion significantly reducing its abundance. Few native grasses are likely to be within the large, dense buffelgrass patches that would be sprayed aerially.

Broad spectrum herbicides would impact native plants that are actively growing at the time of application. For example, glyphosate, applied in the summer would affect warm-season forbs and grasses but not the numerous cool-season annual wildflowers, such as poppies and lupines, which make up a significant part of the Sonoran Desert's plant life, or cool-season perennial species, like bluedicks. However, imazypyr, which may be applied in the winter, could impact those species.

Cacti may be largely protected from herbicides by their waxy cuticle and stomata (pores) that are closed during the day, and these properties apparently inhibit the absorption of leaf-applied applied herbicide (Mayeux and Johnson 1989). Prickly-pear cacti are so resistant to glyphosate that in Australia, where they are invasive non-natives, they must be manually injected with the chemical (Edmunds 2006, WDLC 2007).

Though cacti should be minimally impacted by herbicides applied to plant leaves, they could be less resistant to herbicides that can be absorbed through the roots. Of the herbicides proposed for aerial application, only imazapic and imazapyr are absorbed through the roots. Imazapic controls a wide variety of plants, but it is somewhat selective, and many species similar to cacti are tolerant of it. Imazapyr affects a wide variety of plant species.

Plants that are beneath the canopies of native trees, shrubs, or dense grasses would receive little herbicide and would not be affected by herbicides that are absorbed by leaves. The canopy plants would receive herbicide, but results indicate that larger woody plants (i.e., trees) are not significantly affected by the aerially sprayed herbicides proposed for use (Appendix A).

"Collateral damage" to native plants from spraying invasive non-native plants would be compensated for by reduced competition from invasive non-native plants, and the eventual re-colonization or seeding of the area with native plants. Entire populations of native plants in and adjacent to buffelgrass patches are likely to be killed by buffelgrass spread without intervention. Individual plants may be killed by herbicide, but populations will survive. Impacts of aerial herbicide application to native vegetation would be direct, site-specific to local, minor to moderate, short-term, and adverse, potentially including damage to some longer-lived perennial species. It would also have direct and indirect, site-specific to regional, moderate, long-term benefits from control of invasive non-native plants throughout the park.

Large and remote disturbed areas could receive aerial treatments to minimize erosion, prevent further degradation, and initiate or augment native plant recovery. Aerial application of restoration treatments to burned areas could be used in any vegetation type located within SNP to reduce erosion and stabilize soil.

Large-scale post-fire treatments have the potential to introduce non-native species, even though materials may be guaranteed to be "weed-free" (Robichaud et al. 2003, Beyers 2009). The use of wood strands for mulch can nearly eliminate the risk of introducing non-native plants (Foltz and Dooley 2004). Seeding, especially in the Sonoran Desert, is of uncertain success, but may hold promise (Abella et al. 2009). Impacts of aerial application of other restoration techniques, such as burned area restoration, on native vegetation would be direct and indirect, site-specific to local, minor, short-term and adverse, resulting from burial of or damage to some small plants and possible introduction of non-native plants. The techniques would also have indirect, site-specific to local, minor to moderate, long-term, and beneficial impacts resulting from mitigation of damage from disturbances.

Summary of Preferred Alternative

The PA could reduce vegetation disturbance and trampling that would occur under the NAA. The potential impact of mechanical treatments, including aerial applications, in the PA would be direct and indirect, site-specific to local, minor, short-term, and adverse as well as indirect, site-specific to local, minor to moderate, short- and long-term, and beneficial.

Cumulative Impacts of the Preferred Alternative

This alternative would have all of the same adverse and beneficial impacts of the NAA, as well as the benefit of aerially treating larger disturbed areas, especially in more remote areas. Aerial spraying could result in damage or death to some native plants incidentally sprayed by herbicides or damaged by aerially delivered mulch; however, this loss should be relatively minor compared to the loss that is currently occurring from competition with buffelgrass, and from severe wildfires that could occur as buffelgrass patches coalesce into areas large enough to carry fires.

Under the PA the park may be able to treat buffelgrass faster than it is expanding and reverse the downward trend in vegetation condition in desert areas. It would also facilitate restoration treatments in large or remote sites impacted by disturbances, such as unnaturally intense wildfires, and prevent further degradation. The cumulative impacts on vegetation would be direct and indirect, regional, minor, short- and long-term, and adverse. When combined with other past, present, and foreseeable future actions in and around the park, the PA would provide a moderate decrease in the overall negative cumulative impact.

Conclusion

All restoration treatments will ultimately benefit native vegetation in the park. Despite some short-term adverse impacts from either alternative, the long-term benefits are crucial to reducing erosion and promoting native vegetation communities. The PA provides for the restoration of much more of the park, and an opportunity to control the spread of buffelgrass; it thus provides a greater long-term benefit to vegetation.

3.6 WILDLIFE

Affected Environment

Wildlife, including its scientific and recreational value, is one of the core elements of SNP's enabling legislation. NPS Management Policies (2006; 4.4.1) state that "the Service will successfully maintain native plants and animals by preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats and behaviors of native plant and animal populations and the communities and ecosystems in which they occur." In addition, as a large protected natural area in a rapidly growing metropolitan area, the park serves as a reserve and "source" for many wildlife populations in the Tucson Basin, and its importance for managing and maintaining many regional wildlife populations is relatively high (PC 2001).

Wildlife resources in SNP are unique and diverse, reflecting its ecologically strategic location. The Rincon Mountain District (RMD) is situated at the interface of the Sonoran and Chihuahuan Deserts, and it is part of the chain of "sky-island" mountaintops in southeastern Arizona that connect the Rocky Mountains to the north with the Sierra Madre Mountains to the south. Wildlife species from all four of these ecoregions are represented in the Rincon Mountains. In addition, wildlife diversity is represented in the six structurally distinct biotic communities (from desertscrub to mixed conifer forest) encompassed by the elevation range of this district (from 2,700 to 8,666 feet). The major drainages of the Rincon Mountains add riparian components to this diversity, as well as provide wildlife movement "corridors" that link mountain ranges through the surrounding desert lands. The wildlife of the Tucson Mountain District (TMD) is similar to the wildlife found in the Sonoran desertscrub of the RMD. However, the TMD includes lower elevations, and flatter and sandier areas than the RMD, and it is further west; thus, it contains some animal species not found in the RMD.

Overall, SNP supports an impressive assemblage of thousands of invertebrates, and over 325 vertebrate species, including approximately 70 mammals, 200 birds, 50 reptiles, and eight amphibians. The challenge of maintaining this biodiversity in a changing landscape is underscored by the fact that since the early 1900's, five animal species have been extirpated from SNP – desert bighorn, Mexican gray wolf, jaguar, grizzly bear, and Gila topminnow.

Rincon Mountain District (RMD)

Sonoran Desert Scrub and Desert Grasslands

Wildlife in the lower elevations (below 5,200 feet) of the RMD is comprised of species typical of Sonoran desertscrub. Resident fauna includes such well known and conspicuous animals as mule deer, coyote, javelina, diamondback rattlesnake, Gila monsters, roadrunner, Gambel's quail, and many other bird, mammal and reptile species. Many rodents (white-throated woodrat, cactus mouse, Harris' antelope ground squirrel and round tailed ground squirrel) and other small mammals (desert cottontail) abound. The RMD is one of the few places where all four species of North American skunks (striped, hooded,

hog-nosed, and spotted) can be found, as well as other medium sized carnivores, such as ringtail, gray fox and bobcat (Swann 2009a). In addition to these more common species, rarer and more reclusive animals, such as mountain lion, badger, golden eagle, and coral snake are found.

The RMD has a poorly defined desert grassland biome around 5,000 feet, which varies in size and integrity depending on location and fire history. Wildlife found in these areas include both Sonoran desertscrub and woodland species, and a few grassland specialists, such as the western harvest mouse, box turtle, scaled quail, and savannah, vesper and lark sparrows.

Riparian Areas/Corridors and Tinajas

Riparian areas (denser vegetation associated with surface water and wetter conditions) provide water, food and shelter crucial for sustaining wildlife populations well beyond obligate riparian species. Animals that rely on these areas, particularly at the lower elevations, include the park's aquatic vertebrates (e.g., Sonoran mud turtle and lowland leopard frog) and other amphibians (spadefoots, toads and treefrogs), as well as those that must drink water on a regular basis (e.g., most mammals, including bats, and birds).

Riparian areas are crucial in the desert southwest not only for the precious water resources they provide and protect, but also for creating habitat "corridors" that facilitate movements of large terrestrial vertebrates (e.g., black bear, mountain lions, and deer) between mountain ranges.

Water sources in the RMD that continue to contain surface water during drought periods (generally a few tinajas within larger drainages, but also some short reaches of Chimenea and Rincon creeks) are crucial to wildlife, and in some cases are essential to the persistence of species in the area. Loss of these resources can be caused by sedimentation events after wildfires or the invasion of non-native species, and could be disastrous for wildlife.

Rincon Mountains

Southeastern Arizona is largely desertscrub and desert grassland interspersed with mountain ranges of elevations up to 10,000 feet, including the Rincons. These mountains support woodlands and forests, including pine-oak, pine, and mixed conifer, and provide habitat for a suite of wildlife species that otherwise seem incongruous to the region. Examples include black bear, white-tailed deer, coatimundi, raccoon, Arizona gray squirrel, cliff chipmunks, Madrean alligator lizard, greater short-horned lizard, Arizona black rattlesnake, northern goshawk, yellow-eyed junco, wild turkey, and a host of neotropical migratory bird species, including elegant trogon, hermit thrush, olive warbler, painted redstart, and buff-breasted flycatcher (Powell et al. 2006).

Tucson Mountain District (TMD)

Overall, the wildlife of the TMD is similar to the wildlife found in the Sonoran desertscrub of the RMD. Conspicuous resident vertebrates include mule deer, coyote, javelina, gray fox, bobcat, Gambel's quail, roadrunner, western diamondback rattlesnake, and Gila monster. Lower elevations at the TMD contain some species, such as kit fox, desert iguana, long-nosed leopard lizard, and sidewinder, which do not occur in the RMD (Powell et al. 2007).

Methodology and Intensity Thresholds

Analyses of the potential impacts to wildlife from each of the alternatives below were derived from the literature and sources cited above, and park staff's professional experience and knowledge of the effects of human development and activities on wildlife in and around the park. Swann (2009a,b) and Swann et al. (2009a,b) mined and summarized knowledge to date in annotated species accounts of mammals, and

amphibians and reptiles, respectively, in both districts of the park. Birds are popular and often conspicuous components of SNP's biota, and the park has many records of bird observations from reliable sources, both from systematic surveys (Powell et al. 2006, 2007), and from opportunistic sightings (park files).

Toxicity data for the herbicides proposed for use in SNP on relevant animal species are summarized in Table 6, which also references mitigation measures for minimizing potential harmful effects on non-target animal species. Information in Table 6 is derived from Tu et al. (2001), White (2004), individual EPA technical fact sheets, and the National Pesticide Information Center (NPIC) website.

Intensity Levels

Impact Intensity	Definitions
Negligible	No native animal species would be affected, or some individuals could be affected as a result of the alternative, but there would be no effect on native animal populations. There would be no discernible effect on native animal species' abundance, distribution, and /or diversity.
Minor	The actions would affect some individual native animals over a broader area, but would have no effect on native animal species' populations. The actions could have a minimal effect on native animal species' abundance, distribution, and /or diversity.
Moderate	The actions would affect some individual native animals and would affect a limited segment of animal species' populations over a relatively large area. The actions could have an effect on native animal species' abundance, distribution, and /or diversity.
Major	The actions would have a considerable effect on individual native animals and would affect a sizeable segment of animal species' populations over a relatively large area. The actions would have an effect on native animal species' abundance, distribution, and /or diversity.

Duration

Short-term	Impacts to wildlife can be immediate (i.e., during restoration treatments and activities), but will not exceed five years.
Long-term	Impacts to wildlife would persist beyond five years

No Action Alternative (NAA)

Manual

In places where ground-based crews are performing manual restoration efforts (i.e. hiking to and around work sites; using picks, rakes, shovels, backpack herbicide pump sprayers; and spreading/placing mulch and implementing channel stabilization treatments), there could be impacts to wildlife habitat (e.g., trampling of soil and vegetation and soil compaction). Potential impacts to wildlife from habitat impacts would be indirect, site-specific, negligible, short-term, and adverse. The direct result to wildlife would be disturbance causing displacement of vertebrate wildlife in an area – a direct, site-specific to local, negligible, short-term, adverse impact. When ground-based crews work in the spring and summer, during bird breeding season, it is possible egg or nestling mortality could occur from predation, exposure or starvation if adult birds were kept off of their nests for extended periods.

Table 6. Toxicity of herbicides proposed for use in Saguaro National Park to wildlife by taxonomic class.

Herbicide Active Ingredient	Ecotox class[1] by taxon							Toxicity Notes[2]/Summary	Proposed Use/ Mitigation Measures
	Invert-ebrate		Amph-ibian						
	Aquatic	Terrestrial	Aquatic	Terrestrial	Reptile	Bird	Mammal		
Aminopyralid								Not covered in White (2004). Non-toxic to slightly toxic to aquatic invertebrates, and practically non-toxic to honeybees. Practically non-toxic to fish (and thus, probably amphibians). Practically non-toxic to mammals and birds (and therefore, probably reptiles). Aminopyralid is rapidly absorbed and excreted, and is not substantially metabolized in mammals.	This herbicide is proposed only for ground-based application directly on specific plants.
Clopyralid	0	0	0	1	1	1	1	Relatively non-toxic to aquatic animals. Non-toxic to slightly toxic to terrestrial animals; vertebrate eye irritant; not toxic to bees.	Standard for aerial application[3].
Dicamba	1	1	1	2	2	2	2	Highly irritating to eyes of vertebrates, but no adverse effects on birds or mammals are likely for either acute or chronic exposure. Toxic to many invertebrates; not toxic to bees.	This herbicide is proposed only for ground-based application directly on specific plants.
Glyphosate (aquatic)	0	0	0	0	0	0	0	Non toxic to wildlife.	Standard for aerial application[3].
Glyphosate (non-aquatic)	1	1	1	1	1	1	1	Eye irritant to mammals, birds and reptiles; toxic to amphibians and many invertebrates; not toxic to bees.	Will not be used within 165’ of riparian areas/surface water.
Imazapic	0	0	0	0	0	0	0	Non toxic to wildlife. Does not bio-accumulate in fish or in terrestrial animals, and is rapidly excreted in urine and feces. Not toxic to bees.	Standard for aerial application[3]. Also used as pre-emergent along roadsides.
Imazapyr (technical formulation)	0	0	0	1	1	1	1	Vertebrate eye irritant; practically non-toxic to mammals. Not toxic to bees. Low in toxicity to aquatic invertebrates; no bio-concentration in fish, crayfish, oysters or shrimp.	Standard for aerial application[3]
Imazapyr (aquatic)	0	0	0	0	0	0	0		
Imazapyr (non-aquatic)	0	0	0	0	0	0	0	Vertebrate eye irritant; practically non-toxic to mammals. Not toxic to bees.	Standard for aerial application[3].
Triclopyr (amine salt)	0	0	0	1	1	1	1	Vertebrate eye irritant. Not toxic to bees.	This herbicide is proposed only for ground-based application directly on specific plants.
Triclopyr (ester)	1	1	2	2	0	0	1	Not toxic to bees.	

Herbicide Active Ingredient	Ecotox class[1] by taxon							Toxicity Notes[2]/Summary	Proposed Use/ Mitigation Measures
	Invert-ebrate		Amph-ibian		Reptile	Bird	Mammal		
	Aquatic	Terrestrial	Aquatic	Terrestrial					
2, 4-D (acid)	1	1	1	1	1	1	1	Mammal, bird, reptile eye irritant. Not toxic to bees.	Formulations of 2, 4-D may be considered for ground-based application directly on specific plants.
2, 4-D (aq. amine salt)	2	2	0	1	1	1	1	Mammal, bird, reptile eye irritant; highly toxic to many invertebrates; not toxic to bees.	
2, 4-D (non aq. amine salt)	2	2	0	1	1	1	1	Mammal, bird, reptile eye irritant; highly toxic to many invertebrates.	
2, 4-D (aq. ester)	3	3	1	1	0	0	1	Very highly toxic to many invertebrates; not toxic to bees. Toxic to mammals and amphibians.	
2, 4-D (non aq. ester)	3	3	1	1	0	0	1	Very highly toxic to many invertebrates; not toxic to bees. Toxic to mammals and amphibians.	

[1] *Ecotox classes (from White 2004): Class 0 = no toxicity, Class 1 = slight to moderate toxicity, Class 2 = high toxicity, Class 3 = very high toxicity*

[2] *Toxicity notes compiled from NPIC (http://www.npic.orst.edu) and EPA (http://www.epa.gov) technical factsheets, Tu et al. 2001, and White 2004.*

[3] *Steep and/or inaccessible areas >1 acre are targets for aerial spraying, unless the site is <50% invasive plant cover; above 6,000'; within 165' of a spring, or other surface water; within ¼ mile of an occupied house; within ¼ mile of a trail, campground or picnic area, within 1/8 mile of private, unoccupied land; or when environmental conditions prohibit the use of aerial application, as stated on the herbicide label.*

The likelihood of this happening is low, however, because crews generally move through treatment sites within minutes and are trained to identify and avoid bird nests; but it could result in indirect, site-specific to local, negligible, short-term, adverse impacts. Removing invasive plants with hand tools may kill/remove invertebrates or negatively impact small vertebrates (e.g., rodents, lizards or snakes) that reside in/under individual plants. Based on removal efforts to date, this occurs infrequently, at least with vertebrates, so the impact to wildlife would be direct and indirect, site specific, negligible, short-term, and adverse. Restoration actions would ultimately improve wildlife habitat, resulting in indirect, site-specific to local, minor, short- and long-term benefits.

Herbicides

Ground-based crews spraying individual invasive plants with select herbicides via handheld wands onto individual plants would have direct and indirect, site-specific to local, negligible, short-term, adverse impacts to wildlife (see Table 6). Best management practices and proposed mitigation measures (Section 2.4 and Appendix E) ensure these potential adverse impacts would be minimized. The selection of herbicides proposed for use in SNP, and the methods (per label) used to apply them, preclude their long-term persistence in the environment, and/or toxic effects on wildlife. None of these herbicides contain organochlorines that can cause egg-shell thinning in birds, bio-accumulate in animal tissue, or have other harmful, long-term effects to the environment or wildlife. Nevertheless, three of the eight herbicides proposed for use in SNP can be highly to very highly toxic to certain classes of animals, depending on their formulations and use. (Note that toxicity tests are conducted in lab settings with the undiluted herbicide or active ingredients, not the diluted mixture used in the field.) These herbicides include dicamba; amine salt and ester formulations of triclopyr; and acid, amine salt and ester, and aquatic and non-aquatic formulations of 2,4-D. The potential effects of these herbicides on various animal species, and the protection measures to be implemented to ensure their safety to wildlife, are presented in Table 6, Appendix E, and discussed below.

Dicamba is highly irritating to the eyes of vertebrates, but is otherwise relatively non-toxic (Bunch et al. 2012). Triclopyr has both amine salt and ester formulations. Both are relatively non-toxic to mammals when ingested, but can have mild toxicity to skin and eyes, depending on species (NPIC 2002). Both triclopyr formulations have low toxicity for birds (and so, probably reptiles), but their toxicity varies from practically non-toxic to highly toxic for fish, amphibians, and invertebrates (NPIC 2002). In the park, Triclopyr is only applied directly onto cut stumps with a paint brush and would not come in contact with any wildlife. Amine salt and ester formulations of 2,4-D are highly to very highly toxic to fish and many aquatic and terrestrial invertebrates, and can be irritating to the eyes of many vertebrates, though toxicity to vertebrates is low through dermal exposure or ingestion (Gervais et al. 2008). The acid formulation of 2,4-D is less toxic to invertebrates (Gervais et al. 2008). Note that all formulations of these potentially toxic herbicides are proposed only for ground-based application to individual target plants. Thus, the likelihood of these herbicides adversely impacting non-target species, other than invertebrates on the plants that are sprayed, is negligible.

All seven other herbicide formulations (aminopyralid, clopyralid, two glyphosate formulations, imazapic and three imazapyr formulations) are practically non-toxic to animals, although most (clopyralid, the terrestrial formulation of glyphosate, and the technical formulation of imazapyr) can be an eye irritant to vertebrates (Tu et al. 2001, EPA 1993, EPA 2005). The likelihood of herbicide applied via a hand-held wand getting into the eyes or mucous membranes of a vertebrate is very low.

Ground-based spraying of invasive plants with select herbicides would have direct and indirect, site-specific to local, negligible, short-term, adverse impacts to wildlife.

Mechanized

Ground-based mechanized (motorized) equipment used to restore sites at SNP is generally truck-mounted herbicide sprayers used along roadsides. Potential impacts to wildlife include road mortality resulting from collisions with vehicles, as well as the disturbance/displacement and herbicide impacts caused by manual treatments (see above). Road mortality of wildlife would be minimized by training crews to be aware of and vigilant for wildlife (particularly desert tortoise and other reptiles) in roads, keeping trucks below 5 mph when spraying, or not moving the vehicle while spraying. Potential impacts would be direct and indirect, site-specific to local, negligible, short-term, and adverse.

Some mechanized site preparation activities, such as plowing or tilling, could further disturb or displace wildlife or destroy habitat, particularly burrowing animals such as rodents and reptiles, beyond the disturbance already present. Care would be taken to avoid such impacts, but direct and indirect, site-specific, negligible, short-term, adverse impacts could occur.

Both manual and mechanized ground-based restoration treatments, including invasive plant control, and erosion and sediment control, would ultimately benefit wildlife, since they would restore native habitat, improve natural surface water flow, and protect existing surface water (in streams and tinajas) from sedimentation. These benefits would be indirect, site-specific to local, minor, and short- and long-term.

Summary of No Action Alternative

Overall, the NAA would have direct and indirect, site-specific to local, negligible, short-term adverse impacts, and direct and indirect, site-specific to local, minor, short- and long-term, beneficial impacts to wildlife.

Cumulative Impacts of No Action Alternative

The past, present, and reasonably foreseeable future actions with potential to affect wildlife are generally related to the land use practices cited in the cumulative impacts scenario (section 3.1) that have, are, or will destroy, degrade and/or fragment wildlife habitat (e.g., urbanization and development, cattle grazing, agriculture, the introduction of non-native plants and animals, mining, groundwater pumping, suppression of natural wildfires in woodlands and forests and/or facilitating fires in desert areas, and other activities that convert native vegetation and landscapes into unnatural conditions). Urbanization and development also impact wildlife populations directly. Millions of birds, bats and other wildlife species are killed each year by domestic or feral cats and dogs (Loss et al. 2013), or colliding with windows in buildings, power lines, or wind turbines (Klem 2009, Smallwood 2013). Motor vehicles kill millions more, sometimes impacting or even extirpating local wildlife populations (Gerow et al. 2010). Human activities such as hunting, trapping, and poaching also directly affect wildlife populations.

Development is expected to continue increasing around both districts of the park. The proposed Rocking K development adjacent to the RMD, and areas covered by the Houghton Area Master Plan, and the Tucson Mountains Sub-regional Plan and Rincon/Southeast Sub-regional Plan would allow low intensity rural to high intensity urban housing developments adjacent to or near the park. Additional roads along the park boundary will add to the estimated 30,000 vertebrates that are killed on roads in and adjacent to SNP each year (Gerow et al. 2010). In addition, the disturbance associated with land clearing and the planting of non-native plant species in residential and commercial landscaping would

increase the potential for non-native plants to establish within the park. Development could also lead to increased numbers of human-caused fires along park boundaries and along trails, especially in lower elevation areas where fires are especially harmful.

The Sonoran Desert Conservation Plan and Southern Arizona Buffelgrass Strategic Plan contain measures that will help lessen some of the negative impacts associated with urbanization and development on wildlife habitat. The Catalina-Rincon FireScape planning process and Coronado National Forest Land and Resource Management Plan may improve management of wildfires in higher elevations, and help restore native plant communities and their resilience, which would improve wildlife habitat.

Under the NAA of this Restoration Plan park staff would continue to restore native vegetation in accessible areas of the park and provide some benefits to wildlife. However large patches of buffelgrass in inaccessible areas would not be treated, and buffelgrass would continue to expand. Likewise, large, remote areas impacted by intense wildfires may not be adequately restored. Thus, degradation of vegetation (i.e., wildlife habitat) in the park would continue.

The cumulative impact of these activities on wildlife are direct and indirect, regional, moderate, short- and long-term, and adverse; the NAA would be expected to provide a negligible to minor decrease to these overall negative impacts.

Preferred Alternative (PA)

The PA includes all of the ground-based restoration treatments and activities in the NAA; and thus includes all of the impacts to wildlife described above. In addition it allows for the use of aircraft for delivering restoration treatments (e.g., seeding, mulching, and applying herbicides) to larger and less accessible sites.

Aerial Delivery of Restoration Treatments

Potential impacts from aerial delivery of seeds or mulch to disturbed lands include covering or smothering invertebrates, or possibly smaller vertebrates, depending on the particle size and the animal. This “impact” seems unlikely; however, it would be direct, site-specific, negligible, short-term and adverse. Aircraft activity and associated noise could impact vertebrates, particularly large vertebrates and birds, by temporarily disturbing or flushing them. Such impacts would be mitigated by avoidance of sensitive areas and minimization of overall number of flights, and would be direct and indirect, site-specific to local, negligible to minor, short-term, and adverse. Restoration of habitat would result in indirect, site-specific to local, minor to moderate, short- and long-term benefits.

Aerial application of herbicides may impact invertebrate and vertebrate species that occur in/near invasive plant infestations from noise disturbance (particularly vertebrates, as described above) and by accidental spraying. Based on herbicide spraying efforts to date, the number of vertebrates found in non-native plant patches is very low; although, larger, more remote patches may support more animals. All of the herbicide formulations proposed for aerial application in SNP (two glyphosate formulations, imazapic, and three imazapyr formulations) are practically non-toxic to animals (see Table 6), although most can be irritants to mucous membranes in vertebrates. The amounts and concentrations of these herbicides that would be applied aerially, and that could fall upon an animal would make the likelihood of negative impacts to wildlife negligible. In addition, many vertebrates would flee or take cover under vegetation or rocks or in burrows when a helicopter approaches. The potential impacts of incidentally

spraying wildlife with herbicides or of wildlife consuming harmful herbicide residue would be expected to bedirect and indirect, site-specific to local, negligible to minor, short-term, and adverse.

Summary of Preferred Alternative

Overall, this alternative would have direct and indirect, site-specific to local, negligible to minor, short-term, adverse impacts to wildlife. The benefits of restoration, particularly from this alternative, which could treat larger, more remote areas, would be indirect, site-specific to regional, minor to moderate, and short- and long-term.

Cumulative Impacts of the Preferred Alternative

This alternative would have all of the same adverse and beneficial impacts of the NAA, as well as the benefit of aerially treating larger disturbed areas, especially in more remote areas. Aerial spraying could indirectly affect wildlife by damaging or killing some native plants, and directly affect some individual animals incidentally sprayed by herbicides; however, this impact should be negligible compared to the impacts that buffelgrass is having on native plant and animal species by displacing native habitat and facilitating severe wildfires.

Under the PA the park may be able to treat buffelgrass faster than it is expanding and reverse the loss of native vegetation/habitat in the park's desert areas. It would also facilitate restoration treatments in large or remote sites impacted by disturbances, such as unnaturally intense wildfires, and prevent further habitat degradation. The cumulative impacts on wildlife would be direct and indirect, regional, moderate, short- and long-term, and adverse, and the PA would be expected to provide a minor to moderate incremental decrease to these overall negative impacts.

Conclusion

Long-term, all restoration treatments are beneficial to wildlife in the park. Despite some potential short-term adverse impacts from restoration treatments from either alternative, the long-term benefits of controlling non-native invasive plants and restoring disturbed areas are crucial to managing and maintaining the components and functions of the native ecosystem on which they depend. To the extent that more area is treated and wildlife habitat restored, the PA is more beneficial for wildlife.

3.7 SPECIAL STATUS SPECIES

Affected Environment

The Endangered Species Act (ESA) of 1973 mandates that all federal agencies must determine the status of federally listed threatened and endangered species that occur on their lands and manage their habitat in ways consistent with maintaining, if not benefiting, their populations. NPS Management Policies reiterate that the NPS will survey for, protect, and strive to recover federally listed native species. The Policies further direct the agency to "manage state and locally listed species in a manner similar to its treatment of federally listed species to the greatest extent possible" and "inventory other native species that are of special management concern to parks (such as rare, declining, sensitive, or unique species and their habitats) and … manage them to maintain their natural distribution and abundance." (NPS 2006, Section 4.4.2.3). For the purposes of this document, special status species are plant or animal species known to occur in the park that are: listed, candidates for, or de-listed on the federal list of threatened or endangered species; on Arizona's highly safeguarded (HS) list of plants, or Wildlife of Special Concern in Arizona (WSCA); on Pima County's list of Priority Vulnerable Species (PVS); or of special management status in the park (e.g., saguaros).

Federally Listed Species

Of the 17 wildlife species currently listed by the U.S. Fish and Wildlife Service (USFWS) as threatened or endangered in Pima County, three are known to occur in SNP. These are the endangered lesser long-nosed bat, the endangered southwestern willow flycatcher, and the threatened Mexican spotted owl (MSO). SNP also contains designated critical habitat for the MSO. Accounts of these species and their status in the park are included below. Also included are two species, the yellow-billed cuckoo and the Sonoran desert tortoise, that are candidates for federal listing (i.e., species for which the USFWS has sufficient information to support a proposed listing rule, but not the resources to actually list them). In addition, three federally de-listed species (previously endangered species that are still being monitored), include the Tumamoc globeberry, cactus ferruginous pygmy-owl, and American peregrine falcon. Four other federally listed endangered species, the Gila topminnow, jaguar, grizzly bear, and Mexican gray wolf once occurred in SNP but have since been extirpated, and are not included in this assessment. Currently, no federally listed plant species are known to occur in SNP.

In addition to this section of the EA, and incompliance with section 7 of the ESA, a Biological Assessment of the potential impacts to federally listed species of the activities proposed in the Preferred Alternative of this Restoration Plan and EA to federally listed species has been submitted to the Arizona Ecological Services Office of the U.S. Fish and Wildlife Service.

Lesser long-nosed bat *(Leptonycteris curasoae yerbabuenae)*

The endangered lesser long-nosed bat is a nectar-feeding migratory bat that winters in southern Mexico, and breeds/summers in northern Mexico and the southwestern U.S. (mainly southern Arizona; Harvey et al. 1999). Its migration coincides with the availability of the nectar, pollen, and/or fruit of columnar cactus (e.g., cardon, organ pipe cactus, saguaros) and agaves, and increasingly, the sugar solutions in backyard hummingbird feeders (Wolf 2006). The bat was listed by the USFWS as federally endangered, primarily due to loss of roosting habitat and vulnerability to disturbance of maternity colonies (USFWS 1987).

Bat surveys in SNP have identified a lesser long-nosed bat roost in the RMD (Sidner 1991). Their occupancy at the site suggests they are using agave flowers found at higher elevations (3,000 to 7,000 feet) in this district, and/or have discovered how to take advantage of backyard hummingbird feeders in Tucson as a food source (Wolf 2006). Although surveys were conducted in 1991 and 2003 to locate lesser long-nosed bats in mines in the TMD, this species has never been documented in that district (Swann 2009b).

Southwestern willow flycatcher *(Empidonax traillii extimus)*

This endangered songbird is a riparian (cottonwood/willow, mixed broadleaf and tamarisk) obligate, and has become very rare with the loss of this habitat in the southwest over the last century (PC 2001). It is a neotropical migrant, present in Arizona from April through September (PC 2001).

Southwestern willow flycatchers are transient visitors in the spring to SNP in the riparian areas along Rincon and Chimenea creeks (Powell et al. 2006). This species has not been documented breeding in the park, and it appears SNP does not contain sufficient quality riparian habitat to support breeding.

Mexican spotted owl *(Strix occidentalis lucida)*

The threatened Mexican spotted owl (MSO) is one of three spotted owl subspecies. They occupy a variety of habitat types ranging from dense mixed conifer forests to steep-walled, rocky canyons, favoring sites with complex structure (USFWS 1995). Nest sites are generally located in closed canopy

forests or on ledges in steep-walled canyons. These owls are threatened by habitat loss from logging and wildfire and by displacement by the con-generic barred owl (USFWS 2011).

In 1995, telemetry studies of MSO documented five territories within the RMD (Willey 1997). Since then, each has been designated a Protected Activity Center (PAC) per the MSO Recovery Plan (USFWS 1995), and is managed as such, including regular monitoring and strict regulation of permitted activities. All five sites appear to be consistently occupied, though sometimes by only one bird or a non-breeding pair (Kline 2012). In February 2001, the USFWS designated virtually all of the RMD above 6,000 feet as critical habitat for the MSO. In the park, wildfire is the biggest threat to MSO and their habitat. The Helens 2 Wildfire in summer 2003 affected a large portion of MSO habitat on the north slope of the Rincons.

Sonoran desert tortoise *(Gopherus morafkai)*

The desert tortoise is a long-lived (50+ years), slow-growing terrestrial turtle found on the slopes of rocky desert foothills throughout the Sonoran Desert (Swann et al. 2009a,b). They spend the majority of the year in soil burrows, rock dens, or caliche caves, where they escape the cold winter temperatures and extreme summer heat (Swann et al. 2009a,b).

Tortoises are found throughout the TMD. In the RMD, tortoises are most common in rocky foothills below 5,000 feet (Swann et al. 2009a,b). There has been more research on desert tortoises than any other species of animal at SNP. Zylstra and Swann (2010) summarized more than 20 years of desert tortoise research at SNP covering all aspects of desert tortoise ecology. Density estimates of tortoises in the park (1 to 2 adult tortoises per 10 acres) are some of the highest reported for the Sonoran Desert tortoise (Averill-Murray et al. 2002). Esque et al. (2002, 2003) studied the effects of the Mother's Day Fire and found that many desert tortoises (an estimated 11% of the total adult population in the burn area) were killed during the fire, but survivors did not seem to be impacted by the resulting habitat changes. The study did note that invasive non-native grasses had helped fuel this unusual desert fire, which led to on-going efforts to control invasive non-native grasses in the park. Most recently, Gray and Steidl (2012) studied the effects of buffelgrass on desert tortoise in the park. They found that although the density of tortoises did not vary between plots with the amount of buffelgrass cover in the plot, the condition (weight) of adult tortoises was 10% lower in plots where cover of buffelgrass was relatively high (15-25%) versus plots where buffelgrass was absent, or its cover was low (<1%). Within plots, tortoises were also less likely to use areas with high buffelgrass cover compared to areas with native plants.

Yellow-billed cuckoo *(Coccyzus americanus)*

The yellow-billed cuckoo is a neotropical migratory bird, designated by the USFWS as a candidate species for listing under the ESA due to loss of habitat (USFWS 2013). Yellow-billed cuckoos are found throughout Arizona below 5,000 feet, generally in large blocks of riparian woodlands (cottonwood, willow, or tamarisk galleries) where they breed (USFWS 2013).

In recent years, one to two pairs of yellow-billed cuckoos have been documented breeding along Rincon Creek in SNP (Powell et al. 2006).

Tumamoc globeberry *(Tumamoca macdougalii)*

Listed as federally endangered in 1986, this cryptic perennial vine in the gourd family was delisted in 1993 when it was found to be more widespread than originally believed (PC 2001). Tumamoc globeberry plants have a tuberous root, and grow in the shade of a variety of nurse trees along sandy washes of foothills and valleys of Sonoran desertscrub below 3,000 feet (AGFD 2004). This plant is dormant in the

winter and spring; but leafs out in response to summer monsoon rains. In SNP, it is found on western bajadas of the TMD (ARPC 2001).

Cactus ferruginous pygmy-owl *(Glaucidium brasilianum cactorum)*

The cactus ferruginous pygmy-owl (CFPO) is a small (less than 7" long), long-tailed, earless diurnal owl. Although historic accounts associated this species with riparian areas in Arizona, more recent sightings of CFPOs in the state have generally been in densely vegetated Sonoran desertscrub or mesquite woodlands, with a well-developed canopy and understory from 1,000 to 4,000 feet (PC 2001). The species was proposed for listing as federally endangered in 1993 due to a dramatic decline in its abundance and distribution in the U.S. in the last 50 years (USFWS 1993). Critical Habitat was designated in 2002, including the entire TMD. The CFPO was delisted in 2006, due to a reanalysis of its taxonomy, distribution, and threats, but it remains a species of special concern in the park.

Both districts of SNP contain potential habitat for CFPO – virtually all of the TMD and areas of the RMD below 4,000 feet (some 40,000 acres total). From 1994-2004, over 800 surveys for CFPO within and nearby SNP were conducted by SNP staff, AGFD biologists, private contractors, and volunteers. Despite several credible reports from the 1980's, this extensive survey effort resulted in only one confirmed detection of a non-breeding owl.

American Peregrine Falcon *(Falco peregrinus anatum)*

This bird was delisted from endangered by the USFWS in 1999. This large, striking falcon is primarily a hunter of small to medium-sized birds often associated with water (e.g. waterfowl, shorebirds, swallows). Along with a proximity to water, the most important habitat characteristic needed by this species is the presence of tall cliffs. Within this habitat, peregrines nest on ledges, potholes or in small caves on sheer cliff faces that are relatively inaccessible to mammalian predators and that also provide protection from weather extremes.

Four known peregrine nest sites exist in the RMD, and all are on cliff faces in remote backcountry areas (Berner and Mannan 1992). Two of these sites are monitored annually and appear to be regularly occupied.

Arizona State Listed Species

One plant species found in the park has a highly safeguarded (HS) state listing in Arizona, and nineteen animal species that are known to occur in the park are listed as Wildlife of Special Concern in Arizona (WSCA; AGFD 1996). All seven of the federally listed wildlife species described above are listed as WSCA. Of the remaining 12 WSCA species, three are birds that are occasionally seen in or over the park but that would not be expected to linger due to lack of suitable habitat in either district. Ferruginous hawks prefer open grasslands and agricultural fields and breed in the northern plains. They may winter as far south as southern Arizona in response to weather or rodent population fluctuations (Glinsky 1998), but they are rarely seen in the park. Similarly, osprey are fish-eating hawks, and migrating individuals will occasionally stop over at local ponds and lakes in and around Tucson, especially in the fall. During this time they are occasionally seen soaring over the park (Powell et al. 2006). Crested caracaras are vulture-like scavengers. Common in Mexico and South America, their numbers in Arizona have remained very low, and their usual range is restricted to the Tohono O'Odham reservation (Glinsky 1998). Nevertheless, they may wander practically anywhere in southern Arizona, and have occasionally been observed in both the TMD and RMD of the park (park files, Glinsky 1998). The remaining nine WSCA species found in the park, and the one plant species with a highly safeguarded (HS) state listing in Arizona, are described below.

Whiskbroom *(Psilotum nudum)*

The whiskbroom, or bush moss, is a member of a group of small, shrubby fern-like plants of the dry tropics commonly known as "whisk ferns." This odd plant is found in moist, shady areas. Water and nutrient absorption is aided by symbiotic fungi called mycorrhizae. Whiskbroom has been documented in the RMD of the park (Powell et al. 2006).

Lowland leopard frog *(Rana yavapaiensis)*

This frog is found in permanent or semi-permanent water of Sonoran desertscrub to woodland habitats below 6,000 feet elevation (Swann et al. 2009a). In the Sonoran Desert, they generally inhabit canyon pools and streams where they breed year round (Swann et al. 2009a). Lowland leopard frogs are considered vulnerable because their populations are small and relatively isolated. In SNP they are considered a prime indicator of riparian health, and the park has been monitoring their populations since 1996 (Swann and Wallace 2008). A real threat to lowland leopard frog populations is the loss of habitat due to large amounts of sediment washing downstream after big wildfires (Parker 2006, Wallace et al. 2006). A frog population in the park in Loma Verde Canyon disappeared a few years after the Box Canyon Fire in 1999 following large-scale sedimentation that led to a complete loss of surface water in this drainage.

Northern goshawk *(Accipiter gentilis)*

Goshawks are large hawks of pine forests found throughout the northern hemisphere. Goshawks are fierce predators of large birds, squirrels and rabbits. Their habitat has declined throughout North America in the last century due to timber harvesting. In the Sky Islands of Arizona, including the Rincons, a subspecies, the Apache Goshawk, is becoming increasingly rare, perhaps due to the effects of drought (Glinsky 1998). Goshawks are uncommon residents in the pine forests of the RMD (Powell et al. 2006).

Gray hawk *(Asturina nitida)*

This medium-sized migratory hawk is largely tropical, occurring mainly in South and Central America and migrating north just into Arizona to breed in mesquite bosques and lowland (below 4,000 feet) riparian forests in otherwise arid environments (Glinsky 1998). Gray hawks eat lizards, snakes, birds and small mammals (Glinsky 1998). In the park, gray hawks sometimes breed along Rincon Creek (Powell et al. 2006).

Common black-hawk *(Buteogallus anthracinus)*

Common black-hawks, like gray hawks, are of Neotropical origin and barely range into the U.S. in Texas and Arizona to breed in the summer. In Arizona they prefer relatively undisturbed mature lowland (below 4,000') riparian forest near perennial flowing shallow streams where they hunt for fish and frogs (Glinsky 1998). This large black hawk with a white banded tail is not known to breed in the park, but has been observed in the RMD (Powell et al. 2006).

Elegant trogon *(Trogon elegans)*

This large, colorful bird is believed to have recently extended its range into southeastern Arizona from Mexico (Kaufman 1996). Migratory in Arizona, this bird is resident throughout most of its range. In Arizona, elegant trogons nest in cavities in sycamores along flowing streams in wooded canyons (Kaufman 1996). This bird has been documented, though not breeding, in the RMD of the park (Powell et al. 2006).

Buff-breasted flycatcher *(Empidonax trailii extimus)*

This small flycatcher of high (above 6,000 feet) elevations, used to nest throughout the mountains of southeastern Arizona up to the Mogollon Rim, but now may be limited to the Huachucas and Rincons

(AGFD 1996, Powell et al. 2006). It prefers dry mountain canyons with sycamore, pine and pine-oak forests, with an open understory (Phillips et al. 1964), and it is believed that lack of fire has allowed for understory growth in many of these sites, which are now unsuitable for this species (AGFD 1996). Buff-breasted flycatchers occur and probably breed in the RMD of the park (Powell et al. 1996).

Mexican long-tongued bat *(Choeronycteris mexicana)*

This nectar-feeding bat migrates between its wintering grounds in central and northern Mexico north into southeastern Arizona, as far north as the Santa Catalina Mountains north of Tucson (AGFD 2006). Its recent documented use of hummingbird feeders has apparently allowed for some individuals to overwinter in the Tucson area (PC 2001). This species occupies a variety of habitats, from desertscrub to deciduous or pine-oak forests, usually near a water source or riparian vegetation (Harvey et al. 1999). In the park, they are known to roost in very small numbers in crevices or mines throughout the year in both districts of the park (Swann 2009a,b).

California leaf-nosed bat *(Macrotis californicus)*

This insect-eating bat is found in lowland desert habitats throughout the southwestern U.S., south through western Mexico into Central America (Harvey et al. 1999). It is not migratory, but changes roost sites seasonally as environmental conditions vary. This species is often found in abandoned mines (Harvey et al. 1999), and that is where it is found in the TMD, mainly in the winter (Swann 2009b).

Western red bat *(Lasiurus blossovillii)*

This solitary, insect-eating bat roosts in the foliage of the large, broadleaf trees (cottonwoods, oaks and sycamores) of the riparian habitat on which it depends (Harvey et al. 1999, PC 2001). Western red bats are thought to be migratory, and occur throughout the western coast and Arizona in the U.S., mainly in the summer. This species has been documented along Rincon Creek in the RMD of SNP (Swann 2009a).

Pima County Priority Vulnerable Species

Seventeen animal species known to occur in SNP are on Pima County's list of Priority Vulnerable Species (PVS; PC 2001). PVS are species chosen through a process of scientific review to be potentially covered under the county's multi-species habitat conservation plan. Eight of the animal species (lesser long-nosed bat, southwestern willow flycatcher, yellow-billed cuckoo, cactus ferruginous pygmy-owl, lowland leopard frog, Mexican long-tongued bat, California leaf-nosed bat, and western red bat) are described above in the state and/or federally listed species sections. The remaining nine are described below.

Giant spotted whiptail *(Cnemidophorus burti stictogrammus)*

This large lizard inhabits riparian habitats in mountain canyons in southeastern Arizona, from 2,200 to 4,500 feet, sometimes entering lowland desert areas along streams (PC 2001). Giant spotted whiptails are wary and prefer dense, shrubby vegetation into which they can dash for safety. Giant spotted whiptails appear to be quite rare at SNP, and are almost always seen near a reliable water source (Swann et al. 2009a).

Ornate box turtle *(Terrapene ornate luteola)*

Ornate box turtles are small terrestrial turtles that are primarily a grassland species, usually associated with the Chihuahuan desert in southern Arizona, but also found in the flatlands and low valleys of semidesert grasslands and lower Madrean evergreen woodland, between 3,000 to-6,500 feet (Swann et al. 2009a). They are rare in the RMD of SNP, which is close to the western edge of this species' range (Swann et al. 2009a).

Groundsnake *(Sonora semiannulata)*

Groundsnakes are secretive, nocturnal snakes, which prefer the loose soils of dry river bottoms in foothills and valleys of eastern and southern Arizona, from 2,000-5,500' elevation (PC 2001). They may be widespread in the RMD, but are rarely observed (Swann et al. 2009a).

Burrowing owl *(Athene cunicularia hypugaea)*

Burrowing owls are medium-sized owls of open areas that are active in the daytime (diurnal) and live in abandoned underground animal burrows (usually those of ground squirrels or prairie dogs). In more developed areas, burrowing owls inhabit other open sites, such as airports, golf courses or even vacant lots, where they feed on insects and small mammals. Such sites occur near the park, so this species may occasionally be seen in either district (Powell et al. 2007, 2006).

Swainson's hawk *(Buteo swainsoni)*

This large, slender hawk spends its winters in South America and migrates to North America, including Arizona, to breed in open grasslands (Kaufman 1996). Migrating Swainson's hawks may be found in any open areas, including agricultural fields and cleared areas near the park (PC 2001), and are occasionally sighted over either district of the park (Powell et al. 2006).

Bell's vireo *(Vireo bellii)*

This small insect-eating bird is a riparian obligate that prefers dense, low shrubby vegetation. Populations are threatened by habitat loss and cowbird nest parasitism (PC 2001). In the park, it is found in the lower elevations (below 3,500 feet) of Rincon Creek, and other dense riparian and xeroriparian vegetation of either district (Powell et al. 2006, 2007).

Abert's towhee *(Pipilo aberti)*

Abert's towhees are sparrow-like birds that forage for seeds and insects on the ground in low elevation riparian areas with dense shrub understories. In the park, they can be found in the lower elevations (below 3,500 feet) of Rincon Creek, and other dense riparian and xeroriparian vegetation of either district (Powell et al. 2006, SNP files).

Rufous-winged sparrow *(Aimophila carpalis)*

The rufous-winged sparrow is a seed- eater that prefers flat or rolling Sonoran desertscrub or grasslands, usually with a mesquite component (PC 2001). Loss of habitat from overgrazing and development have cause large declines in their populations (PC 2001). In the park they are most common in the Cactus Forest of the RMD, but can be found in both districts below 4,500 feet.

Townsend's big-eared bat *(Corynorhinus townsendii)*

This wide- ranging bat occurs throughout western North America south into Central America and occupies a wide variety of habitats, from desertscrub to coniferous forests. They are equally unparticular about their roost sites, using caves, mines and/or structures; though they do tend to be faithful to a particular site (Harvey et al. 1999). Human disturbance seems to be the reason for their precipitous population declines in recent years (PC 2001). Townsend's big-eared bats are not known to be migratory; instead, they hibernate in small groups (Harvey et al. 1999). This species appears to be common throughout the RMD of the park, but rare in the TMD (Swann 2009).

Saguaro National Park Special Status Species

The species below have special status in SNP for the reasons stated below.

Saguaro *(Carnegiea gigantea)*

The park's namesake is the tallest columnar cactus in the U.S.; it is an icon of the American southwest, though in the U.S. it only ranges throughout the Sonoran Desert, mostly in the southern half of Arizona, up to about 4,500 feet. The oldest saguaros may live to be over 150 years, and attain heights of 50 feet. Their flowers and fruits, which develop at the ends of their main stem and "arms" and eventually fall to the ground, provide food and moisture for many animal species. SNP was set aside to study and protect exceptional stands of these "giant cactus" and the surrounding ecosystem; thus, saguaros are found throughout the TMD, and up to 5,000 feet in the RMD. Saguaros are aptly the most studied organism in the park (Ahnmark and Swann 2009) and have been shown to be vulnerable to wildfire (Wilson et al. 1996, Esque et al. 2002).

Organ pipe cactus *(Stenocereus thurberi)*

This large cactus has numerous columnar branches arising from the base of the plant that resemble the pipes of an organ. The organ pipe cactus is widespread in the Sonoran Desert, mostly on hills and bajadas below 3,000 feet in Arizona. It is common in southwestern Arizona, and the namesake of Organ Pipe Cactus National Monument; however, only one specimen is known from SNP. This individual, located in the TMD, is of special management concern since it is separated by well over 20 miles from the rest of the known organ pipe cactus population farther southwest (AGFD 2005).

Palmer's century plant *(Agave palmeri)*

This is the largest native agave in the U.S., and it occurs throughout most of the southeastern quarter of Arizona. It is found in rocky sites on limestone grassy plains and oak woodlands, from 3,500 to 7,500 feet. This species can live up to 25 years, and grows a flowering stalk up to 25 feet tall in the late spring through summer. Its flowers are yellowish and produce copious nectar and pollen at night. This plant, found in the RMD, has special status in the park due to its importance as a food source for the lesser long-nosed bat.

Methodology and Intensity Thresholds

Analyses of the potential impacts to special status species from each of the alternatives below were derived from the sources cited above and the scientific literature, and park staff's professional experience, including the many studies and research projects conducted on special status species in the park. Many special status species have been the subjects of long-term monitoring programs (e.g., saguaros, Tumamoc globeberry, Mexican spotted owls, Sonoran Desert tortoise, lowland leopard frogs, lesser long-nosed bats) and their status and ecology in the park is well-known. Others have been less studied (yellow-billed cuckoo, Bell's vireo, Abert's towhee, peregrine falcon, southwestern willow flycatcher, northern goshawk), but regular monitoring of their abundance and/or habitats has provided valuable trend data (Powell et al. 2006, 2007).

The potential effects of the herbicides proposed for use in SNP on various animal taxa, and the mitigation measures to be implemented to ensure their safety to sensitive animal species in the park, are presented in Tables 6 and 7, respectively. Toxicity data for the herbicides proposed for use in SNP on various plant taxa are shown in Table 3 and in Appendix F.

Intensity Levels

Impact Intensity	Definitions
Negligible	No special status plant or animal species would be affected, or some individuals could be affected as a result of the actions, but there would be no effect on their populations. There would be no discernible effect on special status species' abundance, distribution, and/or diversity.
Minor	The actions would affect some special status species and could also affect a limited portion of that species' population. The actions could have a minimal effect on special status species' abundance, distribution, and/or diversity.
Moderate	The actions would affect some special status species and would also affect a limited segment of the species' populations over a relatively large area. The actions could have an effect on special status species' abundance, distribution, and/or diversity.
Major	The actions would have a considerable effect on special status species and would affect a sizeable segment of that species' population over a relatively large area. The actions would have an effect on special status species' abundance, distribution, and/or diversity.

Duration

Short-term	Impacts to special status species can be immediate (i.e., during restoration treatments and activities), but would not exceed five years.
Long-term	Impacts to special status would persist beyond five years

No Action Alternative (NAA)

Under this alternative, SNP would continue to implement post-disturbance restoration treatments and activities using manual and mechanical ground-based treatments (including herbicide application) at small, accessible sites.

Potential impacts to special status plant and animal species from the No Action alternative are described and assessed in general, below. Table 7 presents relevant information regarding the potential impacts to these species, and summarizes impact assessments for each.

Manual

Ground-based crews conducting manual restoration could trample vegetation, including inadvertent impacts to special status plant species, especially small or inconspicuous plants or seedlings. The known organ pipe cactus is easily identifiable and will be avoided, as would whiskbroom, Palmer's agave and saguaros. Very small saguaros can be hard to see, but would likely be protected under a nurse plant, as would Tumamoc globeberry. Impacts to special status species would be direct, site-specific, negligible to minor, short-term, and adverse.

Removing invasive plants or mitigating erosion with hand tools might disturb or even harm some special status plant or animal species that could reside in/under individual invasive plants. Based on removal efforts to date, impacts from this activity to any special status species (e.g., small saguaros, lowland leopard frogs, giant spotted whiptails, groundsnakes, desert tortoise, box turtles) would be rare. Small saguaros that are unearthed would be replanted. If such impacts occurred, they would be direct or indirect, site-specific, negligible, short-term, and adverse.

Table 7. Impact summaries for No Action and Preferred Alternatives on special status species in Saguaro National Park

Species	Relevant Factors Regarding Potential Impacts	Applicable Mitigations	Impact Assessment	
			No Action Alternative	Preferred Alternative
PLANTS				
Whiskbroom	Found in wet drainages. Could benefit from erosion control after wildfires.	No aerial spraying would occur within 165' of surface water/drainages.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible, short-term, beneficial	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible to minor, long-term beneficial
Tumamoc globeberry	Grows under nurse plants; unlikely to be exposed to aerially applied herbicides.	Known range in park is in accessible areas; not likely to be found in areas with potential to be treated aerially.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible to minor, long-term, beneficial	Direct, local, negligible, short-term, adverse; AND indirect, local, negligible to minor, long-term, beneficial
Saguaro	Widespread throughout both districts of the park below 5,000'. Populations threatened by buffelgrass, and potential for wildfire.	Main herbicide (glyphosate) proposed for aerial treatments is less toxic to cacti.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, minor, short-term, beneficial	Direct, local, negligible to minor, short-term, adverse; AND indirect, local to regional, minor to moderate, long-term, beneficial
Organ pipe cactus	Only one in park.	Known specimen would be avoided/protected during all restoration activities.	Indirect, local, minor, short-term, beneficial	Indirect, local, moderate, short and long-term, beneficial
Palmer's century plant	Patchy distribution in grassland areas of the park between 3,000'-6,500' elevation.	Proposed aerial treatment areas comprise only about 5% of Palmer's century plant habitat in the park.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, minor, long-term, beneficial	Direct, local, negligible, short-term, adverse; AND indirect, local, minor, long-term, beneficial
AMPHIBIANS				
Lowland leopard frog	Surface water obligate. Could benefit from erosion control.	No aerial spraying would occur within 165' of surface water/drainages.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, minor, short-term, beneficial	Direct, site-specific, negligible, short-term, adverse; AND in-direct, local, minor to moderate, short- and long-term, beneficial
REPTILES				
Sonoran desert tortoise	Widespread throughout park in Sonoran desertscrub, but inactive above ground most of the time. Threatened by buffelgrass and potential for wildfire. Herbivorous.	Herbicides used for aerial application have little or no toxicity to reptiles.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, minor, short-term, beneficial	Direct, local, negligible, short-term, adverse; AND indirect, local to regional, minor to moderate, short and long-term, beneficial

Species	Relevant Factors Regarding Potential Impacts	Applicable Mitigations	Impact Assessment	
			No Action Alternative	Preferred Alternative
Desert box turtle	Uncommon to rare in grassland habitats in the park. Omnivorous.	Herbicides used for aerial application have little or no toxicity to reptiles. Aerial treatments to occur in about 6% of potential box turtle habitat in the park.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible to minor, short-term, beneficial	Direct, local, negligible, short-term, adverse; AND indirect, local, minor, short- and long-term, beneficial
Giant spotted whiptail	Riparian obligate.	No aerial spraying would occur within 165' of surface water/drainages.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible to minor, short-term, beneficial	Direct, local, negligible, short-term, adverse; AND indirect, local, negligible to minor, short- and long-term, beneficial
Groundsnake	Nocturnal	Herbicides used for aerial application have little or no toxicity to reptiles. No treatments would occur during their activity period.	Indirect, local, minor, short-term, beneficial	Indirect, local, minor to moderate, short- and long-term, beneficial
BIRDS				
Southwestern willow flycatcher	Riparian obligate.	Herbicides used for aerial application have little or no toxicity to birds. No aerial spraying would occur within 165' of surface water/drainages.	Direct, site-specific, negligible, short-term, adverse; AND indirect, minor, local, short-term, beneficial	Direct, local, negligible, short-term, adverse; AND indirect, local, minor to moderate, long-term, beneficial
Mexican spotted owl	Found in forests above 6,000'. Nesting pairs may be impacted by aircraft/noise.	No aerial spraying of herbicides above 6,000'. Aircraft would avoid and/or minimize over-flights of MSO habitat.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible to minor, short-term, beneficial	Direct, local, minor, short-term, adverse; AND indirect, local, minor to moderate, short- and long-term, beneficial
American peregrine falcon	Nests on steep cliffs above 7,000'. Nesting pairs may be impacted by aircraft/ noise.	No aerial spraying of herbicides above 6,000'. Aircraft would avoid and/or minimize flights near peregrine nests.	Direct, local, negligible, short-term, adverse; AND indirect, local, negligible, short-term, beneficial	Direct, local, negligible to minor, short-term, adverse; AND indirect, local, negligible to minor, long-term, beneficial
Cactus ferruginous pygmy-owl	Very rare. If present in the park, probably associated with drainages.	Herbicides chosen for aerial application have little or no toxicity to birds. No aerial spraying would occur within 165' of surface water/drainages.	Direct, local, negligible, short-term, adverse; AND indirect, local, negligible to minor, short-term, beneficial	Direct, local, negligible, short-term, adverse; AND indirect, local, negligible to minor, long-term, beneficial

Species	Relevant Factors Regarding Potential Impacts	Applicable Mitigations	Impact Assessment	
			No Action Alternative	Preferred Alternative
Yellow-billed cuckoo	Riparian obligate.	Herbicides chosen for aerial application have little or no toxicity to birds. No aerial spraying would occur within 165' of surface water/drainages.	Direct, site-specific to local, negligible to minor, short-term, adverse; AND indirect, local, minor, short-term, beneficial	Direct, local, negligible, short-term, adverse; AND indirect, local, minor to moderate, short- and long-term beneficial
Burrowing owl	Ground-dwelling, diurnal owl. Non-breeding, "occasional" status makes any potential impacts very unlikely.	Herbicides used for aerial application have little or no toxicity to birds.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible, short-term, beneficial	Direct, local, negligible, short-term, adverse; AND indirect, local, negligible, short- and long-term, beneficial
Northern goshawk	Found in pine forests above 7,000'. Nesting pairs may be impacted by aircraft/noise.	No aerial spraying of herbicides above 6,000'. Aircraft will avoid or minimize flights near known nest sites.	Direct, local, negligible to minor, short-term, adverse; AND indirect, local, negligible to minor, short-term, beneficial	Direct, local, negligible to minor, short-term, adverse; AND indirect, local, minor, short- and long-term, beneficial
Gray hawk	Riparian obligate. Nesting pairs may be impacted by aircraft noise.	No aerial spraying would occur within 165' of surface water/drainages.	Direct, local, negligible to minor, short-term, adverse; AND indirect, local, minor, short-term, beneficial	Direct, local, negligible to minor, short-term, adverse; AND indirect, local, minor, short- and long-term, beneficial
Common black-hawk	Riparian obligate. Nesting pairs may be impacted by aircraft /noise.	No aerial spraying would occur within 165' of surface water/drainages.	Direct, local, negligible to minor, short-term, adverse; AND indirect, local, minor, short-term, beneficial	Direct, local, negligible to minor, short-term, adverse; AND indirect, local, minor, short- and long-term, beneficial
Swainson's hawk	Non-breeding, "occasional" status in park makes any potential impacts very unlikely.	Herbicides chosen for aerial application have little or no toxicity to birds.	No impacts	No impacts
Ferruginous hawk	Non-breeding, "occasional" status in park makes any potential impacts very unlikely.	Herbicides chosen for aerial application have little or no toxicity to birds.	No impacts	No impacts
Osprey	Non-breeding, "occasional" status in park makes any potential impacts very unlikely.	Herbicides chosen for aerial application have little or no toxicity to birds.	No impacts	No impacts
Crested caracara	Non-breeding, "occasional" status in park makes any potential impacts very unlikely.	Herbicides chosen for aerial application have little or no toxicity to birds.	No impacts	No impacts

Species	Relevant Factors Regarding Potential Impacts	Applicable Mitigations	Impact Assessment	
			No Action Alternative	Preferred Alternative
Elegant trogon	Woodland riparian obligate. Non-breeder in park.	No aerial spraying would occur within 165' of surface water/drainages, or above 6,000'.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible to minor, short-term, beneficial	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible to minor, short- and long-term, beneficial
Buff-breasted flycatcher	Found in open forests above 6,000'.	No aerial spraying of herbicides above 6,000'.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, negligible, short-term, beneficial	Direct, local, negligible to minor, short-term, adverse; AND indirect, local, negligible to minor, short- and long-term, beneficial
Bell's vireo	Neo-tropical migrant. Riparian obligate.	No aerial spraying would occur within 165' of surface water/drainages.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, minor, short-term, beneficial	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, minor to moderate, short- and long-term, beneficial
Abert's towhee	Resident riparian obligate.	No aerial spraying would occur within 165' of surface water/drainages.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, minor, short-term, beneficial	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, minor to moderate, short- and long-term, beneficial
Rufous-winged sparrow	Found in Sonoran desertscrub with grassy components, often associated with drainages or mesquite bosques.	Herbicides chosen for aerial application have little or no toxicity to birds. No aerial spraying would occur within 165' of surface water/drainages.	Direct, site-specific, negligible, short-term, adverse; AND indirect, local, minor, short-term, beneficial.	Direct, local, negligible, short-term, adverse; AND indirect, local, negligible to moderate, short- and long-term, beneficial
MAMMALS				
Lesser long-nosed bat	Known roost site is protected from disturbance. Feed on pollen, nectar and fruits of saguaros and agaves. Nocturnal.	Herbicides used for aerial application have little or no toxicity to mammals. Treatments would not occur during their activity periods.	Indirect, local, negligible, long-term, beneficial	Indirect, local, negligible to moderate, long-term, beneficial
Mexican long-tongued bat	Known roost site is protected from disturbance. Feed on pollen, nectar and fruits of saguaros and agaves. Nocturnal.	Herbicides used for aerial application have little or no toxicity to mammals. Treatments would not occur during their activity periods.	indirect, site-specific, negligible, short-term, beneficial	Indirect, local, negligible to minor, long-term, beneficial
California leaf-nosed bat	Known roost site is protected from disturbance. Insectivorous. Nocturnal.	Herbicides used for aerial application have little or no toxicity to mammals. Treatments would not occur during their activity periods.	Indirect, negligible to minor, local, short-term, beneficial	Indirect, negligible to moderate, local, short- and long-term, beneficial

Species	Relevant Factors Regarding Potential Impacts	Applicable Mitigations	Impact Assessment	
			No Action Alternative	Preferred Alternative
Western red bat	Insectivorous riparian obligate. Nocturnal.	Herbicides used for aerial application have little or no toxicity to mammals. No aerial spraying would occur within 165' of surface water/drainages. Treatments would not occur during their activity periods.	Indirect, local, negligible to minor, short-term, beneficial	Indirect, local, minor, short- and long-term, beneficial
Townsend's big-eared bat	Insectivorous. Ubiquitous. Nocturnal.	Herbicides used for aerial application have little or no toxicity to mammals. Treatments would not occur during their activity periods.	Indirect, local, negligible, short-term, beneficial	Indirect, local, negligible to minor, short- and long-term, beneficial

Special status wildlife species (e.g., Mexican spotted owls, peregrine falcons, northern goshawks, gray hawks, common black-hawks) could be disturbed and temporarily displaced when crews are working in an area; and in the summer, during bird breeding season, it is possible egg or nestling mortality of special status species, particularly smaller birds (e.g., yellow-billed cuckoo, Bell's vireo, Abert's towhee, rufous-winged sparrow), could occur from predation, exposure or starvation if adult birds were kept off of their nests for extended periods. The likelihood of this happening would be low due to SNP's standard mitigation measures to minimize impacts to special status species (Appendix E) and because crews generally move through treatment sites within minutes; but it could result in direct and indirect, site-specific to local, negligible to minor, short-term, adverse impacts.

Backcountry staging areas for ground-based herbicide treatments would be selected to minimize impact to all park resources, including avoidance of any special status plant or animal species or habitat. These impacts would be further minimized by best management practices (Section 2.4) and park mitigation measures (Appendix E). Potential impacts to special status plant species or animal species from these activities would be direct, site-specific, negligible, short-term, and adverse.

Manual treatments for erosion and sediment control, restoring habitat, and controlling invasive plants would benefit special status species overall, and especially those associated with riparian or aquatic habitats (whiskbroom, lowland leopard frogs, giant spotted whiptail, yellow-billed cuckoo, gray hawks, Bell's vireo, Abert's towhee), since they would reduce erosion, restore natural surface water flow, and protect existing surface water (in streams and tinajas) from sedimentation. The degree and duration of such benefits to special status species would depend on the area of the disturbed site. Impacts would be indirect, site-specific to local, minor to moderate, short- and long-term, and beneficial.

Herbicides

Ground-based herbicide treatments/application would not be expected to have impacts to special status plant and animal species, since the applications are hand delivered to specific individual plants and special status species would be avoided. The herbicides used are not highly toxic to most of these animals (see Tables 6 and 7). In the cases of herbicides with higher toxicity, such impacts would be mitigated. For example, terrestrial formulations of glyphosate are toxic to amphibians, so less toxic, aquatic formulations would be used to treat individual non-native plants near any surface water or riparian habitat. Other means of reducing impacts to non-target species would be application techniques. For example, triclopyr, used to kill tamarisk, is manually applied directly to the freshly cut stump. Overall, impacts to special status species from herbicides applied via ground- based methods are expected to be direct and indirect, site-specific to local, negligible to minor, short-term, and adverse; the actions will also provide indirect, site-specific to local, minor to moderate, long-term benefits from restoring habitat, and removing invasive non-native plants.

Mechanized

As with manual restoration operations, impacts to special status plant and animal species from mechanized restoration treatments and activities could include trampling, uprooting, breakage, and unintentional herbicide application to plants as well as disturbance to wildlife and/or destruction of their habitats (e.g., burrows or nest trees). Such impacts would be minimized by training field crews to identify and avoid special status species and their habitats, and by following other mitigations and best management practices, and would be direct and indirect, site-specific, negligible to minor, short-term, and adverse.

Truck mounted herbicide sprayers would be used to control invasive plants along roadsides. Other than saguaros, most of SNP's special status plant species would not be expected to be found along the roadsides, but some might be impacted if they were concealed within or under invasive plants (e.g., a Tumamoc globeberry vine). Potential impacts to special status plants from this activity would be direct, site-specific, negligible to minor, short-term, and adverse. Potential impacts to special status wildlife species from truck mounted equipment include road mortality. Road mortality of special status species (e.g., desert tortoise and box turtles) would be minimized by training field crews to be aware of and vigilant for wildlife in roads and keeping trucks at less than 5mph while spraying. Crews would also be trained to check for animals, especially reptiles, resting in the shade under parked vehicles before driving. Thus, the impacts of truck mounted herbicides to special status wildlife species would be direct, site-specific, negligible to minor, short-term, and adverse.

Mechanized treatments would improve habitat conditions in treated areas by reducing competition or interference from invasive species and helping restore native species and natural ecosystem processes, resulting in benefits to special status species, especially those associated with riparian or aquatic habitats (whiskbroom, lowland leopard frogs, giant spotted whiptail, yellow-billed cuckoo, gray hawks, Bell's vireo, Abert's towhee). The treatments would reduce erosion, restore natural surface water flow, and protect existing surface water (in streams and tinajas) from sedimentation. The degree and temporal scale of such benefits to sensitive species would depend on the area of the disturbed site, but would provide indirect, local, minor to moderate, short- and long-term benefits.

Summary of No Action Alternative

Overall, the NAA would have direct and indirect, site-specific to local, negligible to minor, short-term, adverse impacts as well as indirect, site-specific to local, minor to moderate, short- and long-term beneficial impacts to special status species in the park.

Cumulative Impacts of No Action Alternative

The past, present, and reasonably foreseeable future actions with potential to affect special status species are generally related to land use practices cited in the cumulative impacts scenario (section 3.1) that have, are, or will destroy, degrade and/or fragment native vegetation communities/wildlife habitat (e.g., urbanization and development, cattle grazing, agriculture, the introduction of non-native plants and animals, mining, groundwater pumping, suppression of natural wildfires in woodlands and forests and/or facilitating fires in desert areas, and other activities that convert native vegetation and landscapes into unnatural conditions). In particular, the loss and degradation of riparian areas throughout the southwestern U.S. have been major factors contributing to the sensitive status of many species, including those in the park (i.e., whiskbroom, lowland leopard frog, giant spotted whiptail, southwestern willow flycatcher, yellow-billed cuckoo, gray hawk, common black-hawk, elegant trogon, Bell's vireo, Abert's towhee, western red bat). Rincon Creek is the park's only true riparian area and has a higher number of bird species than any other area of the park (Powell 2006). Surface water in Rincon Creek, and riparian vegetation along the creek, have been impacted by cattle grazing, and appear to be threatened by drought and groundwater pumping. The introduction of non-native species, such as bullfrogs and crayfish, to aquatic habitats has further threatened some native aquatic vertebrate populations (e.g., lowland leopard frog), though these species are not currently threats in the park.

Development is expected to continue increasing around both districts of the park. The proposed Rocking K development adjacent to the RMD, and areas covered by the Houghton Area Master Plan, and

the Tucson Mountains Sub-regional Plan and Rincon/Southeast Sub-regional Plan would allow low intensity rural to high intensity urban housing developments adjacent to or near the park. Urbanization and development directly impact plant and animal species, including special status species. Housing developments change local bird communities by introducing aggressive, generalist species, many of which are introduced and outcompete the native birds for resources. House sparrows and European starlings are aggressive introduced species that are known to compete with native species, such as Gila woodpeckers, purple martins, and elf owls, for cavity nest sites in saguaros (Kerpez and Smith 1990).

Roads associated with increasing development along the park boundary will add to the estimated 30,000 vertebrates that are killed on roads in and adjacent to SNP each year (Gerow et al. 2010). Motor vehicles on roads kill many animals, sometimes impacting or even extirpating local populations of special status species (Gerow et al. 2010). Long-lived species that are slow to reproduce, such as desert tortoise, are particularly vulnerable to the impacts of roadkill, and roads are thought to play a major role in their threatened status in many areas (Nafus et al. 2013).

In addition, the disturbance associated with land clearing and the planting of non-native plant species in landscaping would increase the potential for non-native plants to encroach into the park. This could lead to increased numbers of human-caused fires along park boundaries in lower elevation areas where fires could be harmful to special status species, particularly saguaros – the namesake of the park. Changes in fire regimes in both upper and lower elevations have affected vegetation communities and structure, which in turn has impacted special status species (e.g., box turtle, desert tortoise, buff-breasted flycatcher; Conway and Kirkpatrick 2007, Lovich et al. 2011).

The Sonoran Desert Conservation Plan and Southern Arizona Buffelgrass Strategic Plan contain measures that will help lessen some of the negative impacts associated with urbanization and development on special status species. The Catalina-Rincon FireScape planning process and Coronado National Forest Land and Resource Management Plan may improve management of wildfires in higher elevations and help restore native plant communities and their resilience, which would also improve habitat for special status species

Foreseeable development in the park would be limited to trails and trailheads, including parking lots in the RMD. The park's GMP proposes mitigation measures to reduce the impacts of TMD roadways on park resources, including special status species (e.g., saguaros and desert tortoise). Restoration of several miles of TMD roads and areas around the Madrona Ranger Station in the RMD could benefit special status species (i.e., saguaros, Tumamoc globeberry, desert tortoise, and lowland leopard frog). However, all of these actions are currently unfunded. Restoration treatments and activities proposed under the NAA are effectively treating relatively small, accessible sites in the park, but are insufficient to address larger, more remote sites, particularly non-native plant infestations. Under this alternative, the spread of buffelgrass would continue and would increase the potential for wildfire in desert areas, which could harm special status plants and animals in desert areas, especially the saguaro. Likewise, large, remote areas impacted by intense wildfires would not be treated, and the potential for erosion and sedimentation in aquatic habitats, crucial for lowland leopard frogs, would remain high (Parker 2006).

When combined with other past, present and reasonably foreseeable future actions, the NAA would provide a negligible incremental decrease to the overall negative impacts to special status species in the park.

Preferred Alternative (PA)

The PA includes all of the ground-based restoration treatments in the NAA; thus, all of the impacts to special status species described above apply to this alternative as well. In addition, this alternative allows for the use of aircraft as a delivery method for restoration treatments (e.g., seeding, mulching, and herbicide application) to larger and less accessible sites.

Potential impacts to special status plant and animal species from the PA are described and assessed in general below. Table 7 presents relevant information regarding the potential impacts to each special status species and provides impact assessments for each.

Aerial Delivery of Restoration Treatments

Aerial operations occur more remotely than ground-based activities, so small-scale features, such as special status plants, would not always be identified or avoided. Nevertheless, potential impacts to special status species from aerial treatments at a given site will be assessed beforehand, and instructions provided to pilots to minimize or avoid them. This alternative illustrates the trade-off between ground versus aerial activities: the ability to identify and avoid impacts to special status species/resources by ground-based crews versus the scale at which aerial restoration treatments can be applied. Whenever ground-based operations are feasible in the park, they are used; however, for large or inaccessible sites, aerial treatments are the only option.

Aerial delivery of seeds and/or mulch to could potentially cover and injure or kill small, terrestrial special status wildlife (e.g., desert tortoise or box turtles), and larger, more mobile species (e.g., birds, especially raptors) could be disturbed and temporarily displaced by aircraft activity or noise. Due to their size and/or micro-habitats, it is unlikely that special status plants in the park would be impacted by aerially dispersed seeds or mulch. Since aircraft activity would be limited to daylight hours and to specific sites and since pilots would be instructed to avoid/minimize flying near known special status species roosts and nest sites, these impacts would be direct and indirect, site-specific to local, negligible to minor, short-term, and adverse.

Aerial spraying of herbicides would also be used as a restoration technique. Aerial application of herbicide would be less precise than ground-based techniques, so there would be a greater potential impact to non-target native plant species. However, in the dense buffelgrass patches that would be treated aerially, few native plants would be left. Furthermore, due to the habitats and other life history traits of these species and proposed mitigation measures, such impacts would be unlikely (see Table 7) and would be direct and indirect, site-specific to local, negligible, short-term, and adverse. For example, two of the five special status plant species are cacti (saguaro and organ pipe cactus) and are minimally affected by glyphosate, the primary herbicide proposed for aerial spraying (see Appendix A; Mayeux and Johnson 1989).

Due to the properties of the herbicides proposed for use, the low rates at which they would be applied, and the small quantities of herbicide to be used, long-term persistence of herbicides in the environment is not expected to occur. Special status wildlife species would be largely unaffected by aerially delivered herbicides since all of the herbicides proposed for such use act upon plant-specific enzyme pathways that do not affect vertebrates. Some herbicides are toxic to some vertebrate taxa, particularly fish and amphibians, and/or may be irritants to the mucous membranes of other vertebrates. Lowland leopard frogs are the only special status amphibian species in SNP, and they are closely associated with surface water in drainages and other riparian areas. Best management practices (specifying a minimum 165 foot

buffer between aerially sprayed areas and surface water or riparian areas) and the standard mitigation measures described in Appendix E would protect lowland leopard frogs and other aquatic or riparian special status species from the effects of aerially delivered herbicides. The likelihood of aerially delivered herbicides contacting the mucous membranes of other special status vertebrate species is relatively small, and would be direct and indirect, site-specific to local, negligible, short-term, and adverse. The benefits of habitat restoration of large and/or remote areas resulting from the PA would be indirect, local to regional, moderate, long-term, and beneficial. Especially important for desert species (i.e., desert tortoise, lesser long-nosed bat, California leaf-nosed bat, groundsnake, saguaro and Tumamoc globeberry) is the control of buffelgrass and prevention of the conversion of Sonoran Desert areas to a high-fire frequency grass-shrubland. Riparian and aquatic special status species would benefit greatly from restoration efforts that would minimize erosion and sedimentation and restore disturbed sites and their watersheds at a larger scale.

Summary of Preferred Alternative

Overall, actions from the Preferred Alternative would provide indirect, site-specific to local, moderate, short- and long-term beneficial impacts as well as direct and indirect, site-specific to local, negligible to minor, short-term, adverse impacts.

Cumulative Impacts of the Preferred Alternative

The same general scenario of the past, present and reasonably foreseeable future actions that apply to the NAA, would apply to the PA. Human activity and developments both within and outside of SNP would continue and could negatively impact special status species in the park. In addition, the PA could negatively affect some special status species (i.e., saguaros or Tumamoc globeberry) by incidentally spraying them with herbicides; however, this impact should be negligible, particularly when compared to the impacts that buffelgrass is having on special status species by displacing native habitat.

Implementation of the PA could mitigate some of those impacts by restoring large, remote disturbed sites in the park. Since the park is an important refugia/source for special status species, the contribution of the PA to the cumulative effects of these past, present, and reasonably foreseeable future actions would provide a minor to moderate decrease to the overall negative impacts to special status species in the park.

Conclusion

Restoration treatments are ultimately beneficial to all vegetation and wildlife in the park, including special status species. Despite some potential short-term adverse impacts from restoration treatments from either alternative, the long-term benefits of controlling non-native invasive plants and restoring disturbed areas are crucial to managing and maintaining the components and functions of the native ecosystem and special habitats on which special status species depend. To the extent that more area is treated and native habitat restored in the PA, it is more beneficial for protecting special status species in the park.

Based on the information presented above, we determine that the PA will have no effect on: whiskbroom, organ pipe cactus, groundsnake, southwestern willow flycatcher, burrowing owl, Swainson's hawk, ferruginous hawk, osprey, crested caracara, elegant trogon, lesser long-nosed bat, Mexican long-tongued bat, California leaf-nosed bat, western red bat, and Townsend's big-eared bat; and may affect, but will not adversely affect: Tumamoc globeberry, saguaro, Palmer's century plant, lowland leopard frog, Sonoran desert tortoise, desert box turtle, giant spotted whiptail, Mexican spotted

owl, American peregrine falcon, cactus ferruginous pygmy-owl, yellow-billed cuckoo, northern goshawk, gray hawk, common black-hawk, buff-breasted flycatcher, Bell's vireo, Abert's towhee, and rufous-winged sparrow.

3.8 CULTURAL RESOURCES

Affected Environment

SNP's cultural resources reflect the region's long history of human presence, and reveal the changing human relationship with the landscape. The NPS is mandated to preserve and protect cultural resources through the Organic Act of 1916 and through specific legislation such as the Antiquities Act of 1906, the National Environment Policy Act of 1969 (as amended), the National Historic Preservation Act of 1966 (NHPA, as amended through 2000), NPS Management Policies, NPS Director's Order 28 (Cultural Resource Management Guidelines), and the Advisory Council on Historic Preservation's implementing regulations regarding Protection of Historic Properties. Cultural resources refer to archeological sites, prehistoric and historic, as well as historic buildings and structures, and cultural landscapes (Section 3.9).

Approximately 25% of SNP has been formally surveyed for archeological sites, and 423 sites (both prehistoric and historic) have been recorded. Archeological sites found in SNP can be broadly categorized as prehistoric or historic. Prehistoric sites can be further categorized as undated prehistoric, Archaic (2,500 to 10,000 years old), and Ceramic (450 to 1400 years ago). Historic sites can be categorized as Historic Native American (post circa 1500 A.D.) and Historic Euro-American. In the RMD the area below 4,000 feet elevation and selected high elevation areas (i.e., camp sites and trails) have been intensively surveyed for cultural resources. At TMD, all developed areas (e.g. picnic areas, trails, road corridors, and park facilities) as well as all lands acquired by the park after 1990, have been intensively surveyed for archeological sites (Simpson and Wells 1983, Simpson and Wells 1984, Wells 1986, Clemensen 1987, Donohoe 1994, Wellman 1994, Wells and Reutter 1997, Neff et al. 2001).

The biggest threat to cultural resources/sites in the park is from erosion and wildfire. Since most cultural resources in the park are located in the same elevations and areas as many invasive non-native plant infestations, particularly buffelgrass, there is a potential for unnatural fuel loads to facilitate/carry very hot wildfires that could negatively impact cultural resources (Figures 4 and 15).

Rincon Mountain District

In the RMD, 312 archeological sites have been recorded. Eighty-nine percent of these are prehistoric, and all but 39 of the 312 sites lie below 4,000 feet elevation. This distribution of sites, combined with the small number of sites found during high elevation surveys, indicates that most prehistoric sites are found below about 3,500 feet elevation. Most of the historic mine sites are also found below this elevation. Other historic archeological sites at RMD include ranching and homestead sites, as well as four historic lime kilns. The Freeman Homestead and the lime kilns are on the State Register of Historic Places. There are also a number of historic structures at RMD. These include Manning Cabin and the Rincon Mountain District Visitor Center, both of which are on the National Register of Historic Places. The Cactus Forest Drive, constructed by the Civilian Conservation Corps (CCC), is identified as a Cultural Landscape and is also on the National Register of Historic Places (NPS 2008b; see Section 3.9).

Tucson Mountain District

In the TMD, 111 archeological sites have been recorded; 75% of these are prehistoric. It is difficult to categorize the distribution of prehistoric sites at TMD due to the limited archeological survey effort. To

date, no large prehistoric habitation sites have been found at TMD, only small artifact scatters, resource procurement sites, and rock art sites. There are 78 CCC features at TMD that are on the park's List of Classified Structures, and they are considered eligible for the National Register of Historic Places (Donohoe 1994). These, along with the Gould Mine powder house, are the only historic, non-archeological structures recorded at TMD. There are 137 abandoned mine sites throughout the TMD; eleven of these have been determined eligible for the National Register by the Arizona State Historic Preservation Office (ASHPO 2010). Other historic archeological sites include small artifact scatters, two lime kilns, and a CCC camp.

Figure 15. Archeologist conducting condition assessment of an archeological site covered with buffelgrass.

Methodology and Intensity Thresholds

Analyses of the potential impacts to the cultural resources for each of the alternatives below were derived from the literature and sources cited above, as well as park staff's professional experience and knowledge of the effects of visitor use, wildfires, and restoration treatments and activities on cultural resources.

Intensity Levels

Impact Intensity	Definitions
Negligible	No cultural resources would be affected, or there would be no discernible effects to cultural resources as a result of the actions.
Minor	Cultural resources may be minimally affected, resulting in no loss of integrity.
Moderate	Cultural resources may be affected, resulting in some loss of integrity, detection of artifact depletion or displacement (based on baseline information), effects to elements having research potential, or increased instability of the site landscape. A determination of adverse effect would initiate the establishment of an MOA with the SHPO.
Major	Cultural resources may be affected, resulting in loss of overall integrity and changes to character-defining, cultural or structural elements to the extent that a property that had been eligible for inclusion in the National Register of Historic Places would no longer be eligible.

Duration

Short-term	Impacts to cultural resources can be immediate (i.e., during restoration treatments and activities), but would not exceed five years.
Long-term	Impacts to cultural resources would exceed five years.

Pursuant to the National Historic Preservation Act of 1966 (as amended), NPS Management Policies, NPS Director's Order 28, and the Advisory Council on Historic Preservation's implementing regulations regarding Protection of Historic Properties, no ground disturbing activities would be allowed within archeological or historic site boundaries. All park undertakings are reviewed by the park archeologist and others through SNP's project review process to identify and mitigate any possible direct or indirect impacts to cultural resources. If a planned undertaking is found to have or potentially have an adverse effect on a cultural resource, the State Historic Preservation Office (SHPO) is notified. The undertaking would not commence until after consultation with the SHPO and all agreed mitigations are enacted. In the event that park actions could not mitigate the impacts to the cultural resources, the undertaking would not continue. In the event an accidental encounter with previously undiscovered archeological resources or historic structures occurs during a park undertaking (e.g., restoration activities), the activity would be halted immediately, and both the park archeologist and the SHPO would be notified. There would be no further activity for that undertaking until after consultation with the SHPO and all agreed mitigations were enacted. If the impacts to cultural resources could not be mitigated, the undertaking would not continue.

No Action Alternative (NAA)

Under this alternative, SNP would continue to implement post-disturbance restoration treatments and activities using manual and mechanical ground-based treatments (including herbicide application) at small, accessible sites.

Manual

Since sites would be surveyed for cultural resources before restoration activities occur, no ground disturbing treatments would occur on them. Under the NAA, the only restoration treatments that would occur at or near known archeological sites would be herbicide application to non-native plants via backpack sprayer. Any discoloration of artifacts and archeological features due to the photo-degradable dye used in the herbicide would be minimal and short-term. Under manual herbicide application individual plants are treated, reducing the possibility of unintentional spraying of artifacts and archeological features.

Therefore direct impacts to cultural resources would be limited to the field crew's foot travel, and temporary discoloration of artifacts and archeological features, and would be direct and indirect, site specific, negligible, short- to long-term, and adverse. These treatments, however, could have direct and indirect, site-specific to local, minor to moderate, short- and long-term, beneficial impacts by reducing the type or amount of erosion impacting the cultural resource site and the potential for wildfire.

Manual restoration treatments such as digging and raking could also have direct and indirect, site-specific, negligible to minor, short- to long-term adverse impacts by accidental encounter with previously undiscovered archeological resources and historic structures. If this occurred, restoration activities would halt until the park archeologist and SHPO concurred on mitigations. Other manual

treatments (i.e. herbicide application to non-native plants via backpack sprayer) would improve plant cover and soil stability, resulting in indirect, site-specific to local, minor, long-term beneficial impacts to cultural resources.

Mechanized

No mechanical treatments would be used at known archeological or historic sites. Accidental encounter with previously undiscovered archeological resources and historic structures by field crews using mechanical equipment could impact cultural resources, but due to park standard operating procedures (SOPS) and other mitigations, work would stop immediately. Impacts would be expected to be direct and indirect, site specific, negligible to minor, short- to long-term, and adverse. If, after cultural resource consultation occurred, mitigations for continued restoration activities were approved by the SHPO and implemented, the impacts of that work would be indirect, site-specific to local, minor, long-term, and beneficial by decreasing the potential for erosion and wildfire.

Summary of No Action Alternative

Overall, the NAA would have direct and indirect, site-specific, minor to moderate, short- and long-term, beneficial impacts on archeological and historic structures, and direct and indirect, site- specific, negligible to minor, short- to long-term, adverse impacts to these cultural resources.

Cumulative Impacts of No Action Alternative

The past, present, and reasonably foreseeable future actions with potential to affect cultural resources are those that cause inadvertent damage, vandalism, and surface disturbance that facilitate flooding and soil erosion (e.g., urbanization and development, cattle grazing, agriculture, non-native plant introductions, mining, wildfires, suppression of natural wildfires in woodlands and forests and/or facilitating fires in desert areas, on- and off-road or -trail use by park staff and visitors, and other activities that promote surface erosion). Negative impacts to cultural resources could result from removal or loss of surface archeological materials, such as ceramic and chipped stone artifacts; alteration of artifact distribution or other changes in their context that provide information about their use; and alteration or destruction by fire of artifacts and historic structures.

Population growth and associated increases in urbanization and development are expected to continue around both districts of the park. The proposed Rocking K development adjacent to the RMD, and areas covered by the Houghton Area Master Plan, the Tucson Mountains Sub-regional Plan and Rincon/Southeast Sub-regional Plan would allow low intensity rural to high intensity urban housing developments adjacent to or near the park. These activities could result in the loss of cultural resources due to the disturbances associated with land clearing, and artifact collecting.

Within the park, past developments and activities such as homesteading, mining, road and trail construction, park housing and visitor center construction, cattle grazing, wood cutting and wood gathering as well as vandalism in the form of illegal collecting and excavating may have resulted in disturbance and some loss of archeological resources.

Under the NAA of this Restoration Plan park staff would continue to use ground-based methods, including herbicides, to treat invasive non-native plants and rehabilitate disturbed areas. These activities reduce erosion that could negatively impact cultural resources. However, large patches of buffelgrass in inaccessible areas would not be treated, and buffelgrass would continue to expand increasing the likelihood of wildfires and soil erosion in lower elevations. Likewise, large, remote areas impacted by

intense wildfires may not be adequately restored and could increase the potential for flooding and soil erosion that could affect archeological sites and historic structures.

When combined with other past, present, and reasonably foreseeable future actions, the NAA would be expected to provide a negligible to minor decrease to these overall negative cumulative impacts on cultural resources.

Preferred Alternative (PA)

The PA includes all of the ground-based restoration treatments and activities in the NAA; and thus includes all of the impacts to archeological and historic resources described above. In addition, it allows for the use of aircraft for delivering restoration treatments (e.g., seeding, mulching and applying herbicides) to larger and/or less accessible sites.

Aerial Delivery of Restoration Treatments

The potential to treat large, remote disturbed areas aerially would provide indirect, site-specific to regional, minor to moderate, short- to long-term, beneficial impacts to cultural resources, especially within the Rincon Foothills Archeological District of RMD, by providing erosion control and reducing the risk of wildfire on and around archeological and historic features, without the surface impacts to these sites inherent with field crews.

Summary of Preferred Alternative

Overall, the PA (including ground-based activities) would have direct and indirect, site-specific to regional, minor to moderate, short- and long-term, beneficial impacts. It would also have direct and indirect, site-specific, negligible to minor, short- and long-term adverse impacts from ground-based manual and mechanical treatments.

Cumulative Impacts of the Preferred Alternative

This alternative would have all of the same adverse impacts on cultural resources as the NAA, but would allow for the restoration of larger and more remote disturbed areas, including infestations of non-native, invasive plants. More soils would be stabilized or enhanced, and surface hydrology restored, aiding in the recovery of native vegetation communities. Under this alternative, the cover and extent of buffelgrass and other flammable non-native grasses would be decreased, and the probability, size, and severity of potential wildfires would be lowered, lessening the occurrence of post-fire soil erosion and decreasing the possibility of fire effects on archeological sites and historic structures.

When combined with other past, present, and reasonably foreseeable future actions, the PA would provide a minor to moderate incremental decrease to these overall negative impacts.

Conclusion

The biggest threat to cultural resources/sites in the park is from erosion and wildfire. Since most cultural resources in the park are located in the same elevations and areas as most non-native invasive plant infestations, particularly buffelgrass, these plants have the potential to create fuel loads that could facilitate very hot wildfires that would negatively impact cultural resources. Thus, to the extent that the PA has greater potential to treat/restore larger, more remote disturbed areas and to reduce invasive non-native plants, fuel loads and potential wildfires, it would provide a greater contribution to the stability and integrity of archeological resources and historic structures in the park.

3.9 CULTURAL LANDSCAPES

Affected Environment

A cultural landscape, as defined in the 1996 Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes, is a geographic area (including both cultural and natural resources and the wildlife or domestic animals therein) associated with a historic event, activity, or person, or exhibiting other cultural or aesthetic values. There are four general types of cultural landscapes, not mutually exclusive: historic sites, historic designed landscapes, historic vernacular landscapes, and ethnographic landscapes. A cultural landscape is broadly defined as "a reflection of human adaptation and use of natural resources and is often expressed in the way land is organized and divided, patterns of settlement, land use, systems of circulation, and the types of structures that are built." The character of a cultural landscape is defined both by physical materials, such as roads, buildings, walls, and vegetation, and by use reflecting cultural values and traditions (NPS Director's Order 28, Cultural Resource Management). The Secretary's Standards emphasize the importance of identifying, retaining, and preserving historic features and materials when performing vegetation restoration, including utilizing methods that will not destroy or degrade topography, such as using heavily weighted equipment on steep or vulnerable slopes or failing to perform preventive maintenance of vegetation.

The Cactus Forest Drive in the RMD is the only cultural landscape in SNP that has been inventoried and evaluated, resulting in the Cactus Forest Drive Cultural Landscape (CFDCL) Inventory (NPS 2008b). The Cactus Forest Drive was constructed by the Civilian Conservation Corps in the 1930s. The boundary of the CFDCL encompasses all land and features within 30 feet of either side of the centerline of Cactus Forest Drive, and incorporates all associated structures (including road bed, shoulders, culvert headwalls, and retaining walls) as well as the vegetation (Figure 16).

Figure 16. Close-up of stone capping and water control feature built into a retaining wall that is a contributing element of the Cactus Forest Drive Cultural Landscape in the Rincon Mountain District of Saguaro National Park.

Plants may be significant features of a cultural landscape, and vegetation management must occur in a cultural as well as natural resource context. In the case of the CFDCL, non-native plant removal and restoration of the native vegetation benefits the cultural landscape re-establishing the landscape of the period of significance. Any action occurring within the CFDCL would be reviewed at the park level and would also need the approval of the Arizona SHPO (cultural landscapes require the same compliance process used for cultural resources described above in Section 3.8).

Methodology and Intensity Thresholds

Analyses of the potential impacts to cultural landscapes for each of the alternatives below were derived from the literature and sources cited above, cultural landscape assessments in the park (NPS 2008b), as well as park staff's professional experience and knowledge of the effects of visitor use, wildfires, and restoration treatments and activities on cultural landscapes.

Intensity Levels

Impact Intensity	Definitions
Negligible	The cultural landscape would not be affected, or there would be no discernible effects to the cultural landscape as a result of the actions.
Minor	The cultural landscape may be minimally affected, resulting in no loss of integrity.
Moderate	The cultural landscape may be affected, resulting in some loss of integrity, and minor changes to character-defining, cultural or structural elements. Determination of adverse effect would initiate the establishment of an MOA with the SHPO.
Major	The cultural landscape may be affected, resulting in loss of overall integrity and changes to character-defining, cultural or structural elements to the extent the property would no longer be eligible for inclusion in the National Register of Historic Places.

Duration

Short-term	Impacts to the cultural landscape could be immediate (i.e., during restoration treatments and activities), but would not exceed five years.
Long-term	Impacts to the cultural landscape would exceed five years.

No Action Alternative (NAA)

Under this alternative, SNP would continue to implement post-disturbance restoration treatments and activities using manual and mechanical ground-based treatments (including herbicide application using backpack sprayers) at small, accessible sites.

Manual

Under the NAA, the only manual restoration treatments that would occur in or near the CFDCL, would be herbicide application to non-native plants via backpack sprayer. Therefore direct impacts to cultural resources would be limited to the field crew's foot travel and would be direct and indirect, site specific, negligible, short-term, and adverse. These same treatments could have direct and indirect, site-specific

to local, minor to moderate, short- and long-term beneficial impacts by reducing the type or amount of erosion impacting the cultural landscape.

Mechanized

Under the NAA no mechanical restoration treatments would be used within a cultural landscape, so they would have no direct impacts to the CFDCL. Mechanical treatments do, however, have the potential to protect the Cactus Forest Drive Cultural Landscape by restoring disturbed areas around it, thereby having indirect, local, minor, short-term, beneficial impacts.

Summary of No Action Alternative

Overall, the NAA would have direct and indirect, site-specific to local, minor to moderate, short- to long-term, beneficial impacts; and direct and indirect, site specific, negligible, short-term, adverse impacts to the CFDCL.

Cumulative Impacts of No Action Alternative

The past, present, and reasonably foreseeable future actions with potential to affect the Cactus Forest Drive Cultural Landscape are park management actions, inadvertent damage caused by automotive accidents, vandalism, wildfires, and other activities that promote surface erosion. Negative impacts to the Cactus Forest Drive Cultural Landscape could result by way of a loss of contributing elements, such as rock retaining walls, or distinctive stone capping and water control features, and loss of roadway due to mass erosion.

The rehabilitation of the Cactus Forest Drive in 2006 was conducted according to the 1995 Secretary of the Interior's Standards for the Treatment of Historic Properties, and had no adverse effects. The park's Fire Management Plan (NPS 2007) calls for suppression of fire below 4,000 feet elevation. Trail rehabilitation proposed in SNP's Trails Plan (NPS 2009) proposes to rehabilitate social trails that originate on the Cactus Forest Loop Road, and to formalize one that would provide access to a geologic formation within the loop. These actions have and would be conducted in accordance with the 1995 Secretary of the Interior's Standards for the Treatment of Historic Properties and be designed to have no adverse impacts.

Under the NAA of this Restoration Plan park staff would continue to use ground-based methods, including herbicides, to treat invasive non-native plants, rehabilitate disturbed areas, and restore native vegetation in accessible areas of the park, including the Cactus Forest Drive. However large patches of buffelgrass in inaccessible areas would not be treated and buffelgrass would continue to expand and increase the likelihood of wildfires and soil erosion in lower elevations, including areas around the Cactus Forest Loop Drive.

When combined with other past, present, and reasonably foreseeable future actions, the NAA would be expected to provide a minor decrease to these overall negative cumulative impacts on cultural resources.

Preferred Alternative (PA)

This alternative includes all of the ground-based restoration treatments and activities in the NAA; thus it includes all of the impacts to archeological and historic resources described above. In addition, it allows for the use of aircraft for delivering restoration treatments (e.g., seeding, mulching and applying herbicides) to larger, less accessible sites.

Aerial Delivery of Restoration Treatments

Since the CFDCL is an accessible area, aerial treatments would not occur in or near it and would have no effect on the cultural landscape.

Summary of Preferred Alternative

Since the CFDCL is an accessible area, aerial treatments would not occur in or near it and would have no effect on the cultural landscape. Ground-based manual and mechanical treatments included in the PA would have indirect, site-specific to local, minor to moderate, short- to long-term, beneficial impacts; and direct and indirect, site specific, negligible, short-term, adverse impacts, as described above.

Cumulative Impacts of the Preferred Alternative

This alternative would have all of the same cumulative impacts on the Cactus Forest Drive Cultural Landscape as the NAA. Although aerial delivery of restoration treatments would not occur on or near the Cactus Forest Loop Drive, the ability to restore larger and more remote disturbed areas could benefit the CFDCL by providing treatments that decrease the cover and extent of buffelgrass and other flammable non-native grasses. They would thus reduce the probability, size, and severity of potential wildfires that could affect the Cactus Forest Drive Cultural Landscape.

When combined with other past, present, and reasonably foreseeable future actions, the PA would provide a minor decrease to these overall negative impacts to the CFDCL.

Conclusion

Since aerial restoration treatments available in the PA would not be used on or near the CFDCL and the PA includes all of the actions and impacts of the NAA, there is no difference between impacts to cultural landscapes between the two alternatives.

3.10 WILDERNESS

Affected Environment

Wilderness areas are special, wild places designated by an act of Congress to remain forever in their natural state as a prized part of our national heritage. Currently less than three percent of the contiguous U.S. has been officially designated as wilderness. Most of the land base in SNP (78%) was formally designated as wilderness in 1976 (PL 94-567). It is managed under the provisions of the Wilderness Act of 1964 and now totals 70,905 acres. Figure 1 shows the wilderness boundary within SNP and on adjacent USFS lands.

Subsection 2(c) of the Wilderness Act defines wilderness as follows: "A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." The same subsection 2(c) further defines wilderness as having the following characteristics:

- Undeveloped land retaining its primeval character without permanent improvements or human habitation,
- Generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable,
- Has outstanding opportunities for solitude or a primitive and unconfined type of recreation, and
- May contain ecological, geological, scientific, educational, scenic, or historical value.

The Wilderness Act describes authorized uses of officially designated wilderness areas and also states that agencies are responsible for preserving the wilderness character of designated areas. To maintain wilderness character, the Act prohibits commercial enterprises, permanent and temporary roads, motor vehicles, motorized equipment, motor boats, landing of aircraft, mechanical transport, structures, and installations within wilderness. The latter 8 of these 10 prohibitions can be excepted as necessary to provide for the administration of the wilderness area after using the Minimum Requirements Decision Guide (MRDG), or for human health and safety of persons within the area. The MRDG provides a process to analyze and identify management actions that are the minimum necessary for wilderness administration. First, it must be determined whether the action is necessary in wilderness; and then, the minimum activity, method, or equipment that is necessary to accomplish the action is determined.

Defining Wilderness Character

This EA uses the framework of Landres et al. (2008) for monitoring conditions related to wilderness character. The five qualities of wilderness character, as defined in the Wilderness Act, are:

- *Untrammeled* – Wilderness is essentially unhindered and free from the actions of modern human control or manipulation. A trammel is a device that restrains a horse's feet and restricts its movement. As used in the Wilderness Act, trammeling is human action restricting or controlling the wildness or forces of nature. This includes actions taken to restore natural conditions in wilderness after some human-caused disturbance, because humans are making decisions and taking actions that affect the outcome.
- *Natural* – Wilderness ecological systems are substantially free from the effects of modern civilization. Native plants and wildlife are part of the "community of life" that the Wilderness Act recognizes as being so valuable. Because non-native species were brought here by humans and did not evolve in this setting, they are viewed as harming an area's natural character.
- *Undeveloped* – Wilderness retains its primeval character and influence and is essentially without permanent improvement or modern human occupation.
- *Solitude or primitive and unconfined recreation* – Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation.
- *Other features* – Wilderness preserves unique attributes or other features that reflect the character of a specific wilderness. This includes any special ecological, geological, scientific, educational, scenic, or historical value resources or sites. "Scientific interest" was specifically listed in the original presidential proclamation establishing the area as a National Monument in 1933.

Wilderness in Saguaro National Park

The challenges of managing SNP's Wilderness include its relatively small size, urban context, and the inherent conflicts between different aspects of wilderness character. In SNP's recent Wilderness Character Assessment, Engebretson (2012) noted some of the factors that impact wilderness in SNP. Many of these are activities over which the park has little control, such as overflights by private, military, and commercial aircraft; light and sound pollution; ecosystem degradation from past land uses; climate change; and surrounding urbanization and development.

Negative impacts also occur from agency activities, such as aircraft landings for emergency medical evacuations, fire management operations, and occasionally for other administrative reasons. Many management actions intended to benefit one aspect of wilderness may negatively impact another. For example, fire suppression activities in desert areas (and prescribed fire at higher elevations) are conducted to protect or improve "naturalness" by restoring natural fire return intervals and preserving native plant communities, but they also result in "trammeling." Administrative installations for safety, such as weather stations and radio repeaters, as well as facilities for the public such as outhouses, campsites, and signs, adversely impact "naturalness," "solitude," and "primitive recreation," but they provide valuable information for managing "naturalness" and SNP's "other values." Camping permit systems restrict "unconfined recreation," but have positive impacts on "solitude" and "naturalness."

SNP attempts to implement best management practices for its wilderness through its interdisciplinary review and assessment of park projects or activities proposed to occur within the wilderness portions of the park.

Methodology and Intensity Thresholds

Analyses of the potential impacts to wilderness from each of the alternatives below were derived from the literature and sources cited above, as well as park staff's professional experience and knowledge of the effects of human presence, wildfires, and restoration treatments and activities on wilderness character, including wilderness studies in the park. The actions being proposed under both alternatives are assessed in a MRDG (Appendix D).

Intensity Levels

Impact Intensity	Definitions
Negligible	Wilderness character would not be affected, or there would be no discernible effects on natural conditions. Human actions affecting appearance of natural conditions and natural function would be absent or mostly undetectable. There would be no visible improvements or human occupation. Outstanding opportunities for solitude and a primitive and unconfined type of recreation and other values would be practically unaffected.
Minor	Impacts to wilderness character might be slightly detectable within limited areas of the wilderness. Human actions affecting natural function and appearance of natural conditions might be measureable or perceptible, but not consequential. There would be few improvements or human occupation, and they would be mostly undetectable to visitors. Opportunities for solitude and a primitive and unconfined type of recreation and other values would be practically unaffected.
Moderate	Impacts to wilderness character would be readily apparent within limited areas of the wilderness. It would be readily perceptible that humans have altered natural conditions. There would be no permanent improvements or human occupation, but temporary improvements might be readily apparent. Opportunities for solitude or a primitive and unconfined type of recreation would be somewhat restricted. Other values might have measurable and/or perceptible impacts.

Major	Impacts would substantially alter the wilderness character through much of or throughout the wilderness area. Natural conditions would be substantially altered by humans. Improvements made by people, while not permanent, would be long-term and become part of the landscape. Opportunities for solitude or a primitive and unconfined type of recreation would be restricted in much of the wilderness. Other values would be severely and/or permanently affected.

Duration

Short-term	Impacts to wilderness character can be immediate (i.e., during restoration treatments and activities), but would not exceed one year.
Long-term	Impacts to wilderness character would persist beyond one year.

No Action Alternative (NAA)

Under this alternative, SNP would continue to implement post-disturbance restoration treatments and activities using manual and mechanical ground-based treatments (including ground-based herbicide application) at small, accessible sites.

For this impact topic, total impacts will be discussed for each of the five wilderness characters separately.

Manual

Current manual restorations techniques are generally compatible with wilderness.

Mechanized

Disturbed sites that warrant mechanized restoration equipment would be primarily accessible by roads or trails and not within designated wilderness boundaries. Mechanical restoration equipment identified in an MRDG as the minimum tool needed to meet project objectives in wilderness would be limited to hand-held motorized equipment for hydro-mulching, seeding, drilling holes, or herbicide application.

Effects of the NAA on Wilderness Character

Untrammeled – The NAA would trammel wilderness by manipulating plant communities by removing some species and, in some places, introducing other species. Mulch could be spread or used, along with erosion-reducing devices. The park would attempt to recreate natural plant communities and soil and hydrological processes through artificial means, thereby trammeling nature. The NAA would have direct, local, minor, short- and long-term, adverse impacts to the untrammeled quality of wilderness character.

Natural – The NAA would improve the natural quality of wilderness by attempting to restore native vegetation/communities and natural ecosystem processes. This alternative would have direct and indirect, local, minor to moderate, long-term, beneficial impacts to the natural quality of wilderness.

Undeveloped – The NAA would utilize mules and occasionally helicopters to deliver water and supplies to staging areas. There would be temporary storage of supplies and equipment/tools and shade structures/staging areas in wilderness. This would give the few visitors that might witness these actions or see these staging areas the feeling that there is some form of development in wilderness. Such impacts would be direct, site-specific to local, minor, short-term, and adverse.

Solitude or primitive and unconfined recreation – The NAA would affect visitor solitude by increasing the potential that a visitor might see restoration crews and equipment (which is delivered by mules or helicopter) staged in backcountry areas. A non-toxic temporary dye used when spraying herbicide to indicate which areas have been sprayed could affect a visitor's sense of solitude or naturalness. The dye begins to degrade almost immediately after application with exposure to sun and rain. Where herbicide is applied heavily, such as pre-emergent applications or thick buffelgrass, it may be visible for about 10 days. The sights and sounds of helicopters in particular could impact backcountry visitors' sense of solitude. Signs would be posted when herbicide treatments occur along trails, and these could impact some visitors' experiences. Such impacts would be direct, local, minor, short-term, and adverse.

Other features – The NAA would restore and maintain native plant and animal communities and therefore enhance scientific opportunities to study them as well as interpretive and other educational opportunities, resulting in indirect, site-specific, minor to moderate, short- and long-term, beneficial impacts.

Summary of No Action Alternative

Overall, the NAA would result in direct, site-specific to local, minor, short- and long-term, adverse impacts as well as direct and indirect, site-specific to local, minor to moderate, short- and long-term beneficial impacts to wilderness character.

Cumulative Impacts of No Action Alternative

The past, present, and reasonably foreseeable future actions with potential to affect wilderness character are related primarily to the presence or evidence of humans or their developments inside, or in the viewshed of, the park, including non-native invasive plants, fire damage, the manipulation of vegetation, and ground disturbance. Non-native invasive plants are displacing native plants, creating unnatural plant mixes and creating an unnatural fire risk. Human-caused fires, which also negatively impact an area's naturalness, have occurred as human population of the area has increased. In upper elevations, where fire was once common, many fires have been suppressed and vegetation conditions have moved away from natural conditions.

Development is expected to continue around both districts of the park. The Rocking K area will become a major development adjacent to the RMD, and areas covered by the Houghton Area Master Plan, the Tucson Mountains Sub-regional Plan, and the Rincon/Southeast Sub-regional Plan would allow low intensity rural to high intensity urban housing developments adjacent to or near the park. This will lead to major changes in the appearance of the land outside the park and increase the human population near the park. Increasing human population around the park has resulted in increased development (including homes, businesses, power lines, and other infrastructure) within view of park wilderness areas. Accompanying this population growth has been an increase in air traffic over both districts of the park and other noise, such as traffic noise and barking dogs. These factors decrease the feelings of solitude for park visitors in the wilderness parts of the park.

The Sonoran Desert Conservation Plan and Southern Arizona Buffelgrass Strategic Plan contain numerous measures that will help lessen some of the negative impacts associated with development and invasive non-native plants. With a broad view of fire management, the Catalina-Rincon FireScape planning process and Coronado National Forest Land and Resource Management Plan may improve management of wildfires in upper elevations, helping restore natural fire regimes.

Park management plans call for managing vegetation, such as removing non-native plants (SNP 2004) and managing fires (NPS 2007), including putting fires out, altering how they spread, or lighting prescribed fires. Humans are therefore affecting the direction and progression of changes to plant and animal communities to something different than would have otherwise occurred. This is considered "trammeling" wilderness, even if the intent is to restore an area's naturalness. Numerous fires have been put out in the wilderness in recent times, and several prescribed burns have been conducted in the park's wilderness.

The park's Trails Management Plan proposes numerous actions, including maintaining trails and building new trails in wilderness. These actions could lead to a decrease in solitude, though formalizing or closing and restoring social trails will enhance naturalness. The impacts from the Trails Plan on wilderness character are anticipated to vary from beneficial to adverse (NPS 2009).

The NAA would continue restoration activities in accessible areas of the park. However, inaccessible areas and large patches of buffelgrass would not be treated, and buffelgrass would continue to expand. Large, remote areas degraded by the effects of unnaturally intense wildfires would likely not be treated. Treatments that do occur would adversely affect visitors' sense of solitude, as well as the untrammeled condition of the park. Other values, such as educational and scientific values of the desert areas of the park, would be improved or maintained in treated areas.

When combined with other past, present, and foreseeable future actions, the NAA would provide a minor incremental decrease in the overall negative cumulative impacts.

Preferred Alternative (PA)

Because the PA includes all of the ground-based restoration treatment in the NAA, all of the impacts to wilderness character described above would occur. In addition, it allows for the use of aircraft as a delivery method for restoration treatments (e.g., seeding, mulching, and herbicide application) to larger and less accessible sites.

Effects of the PA on Wilderness Character

Untrammeled – With the PA, using aerial delivery for treatments would be allowed, and more acres of wilderness could be trammeled. This alternative would result in additional use of aircraft, which will lead to direct, local, moderate, short- and long-term, adverse impacts to the untrammeled quality of wilderness character.

Natural – The use of aircraft to deliver treatments will allow restoration treatments to be implemented over a larger area, including invasive plant treatments. The PA would increase the removal of non-native plants and restoration of natural plant communities and soil erosion processes, which would result in indirect, local, moderate, long-term, beneficial impacts.

Undeveloped –The PA would have the same impact as the NAA on the undeveloped quality of wilderness character: direct, site-specific to local, minor, short-term, adverse impacts.

Solitude or primitive and unconfined recreation – Under the PA, more aircraft use would occur. However, that use may be offset by less on the ground activity in wilderness. Areas likely to be treated by air are relatively remote, with little or no recreational use, resulting in slightly more, but less concentrated, impact to solitude compared to the NAA. Presence of marker dye should be less obvious in areas sprayed aerially because the herbicide is applied more evenly, like raindrops, instead of patchy,

but more solid coverage as when applied with back-pack sprayers. Aerial application of herbicides would be conducted mostly during 'optimum' treatment times (i.e., during the summer monsoon season, from July through mid-September, when the plants are actively growing). This is a time when visitation is relatively low at SNP; however, mulching and seeding could occur during any time of the year. Due to the additional use of aircraft, the PA could lead to direct, local, minor, short-term, adverse impacts to the solitude or primitive and unconfined recreation quality of wilderness character.

Other Features – Restoration strategies and treatments would enhance opportunities to study the Sonoran Desert by restoring and maintaining this ecosystem. This alternative would have similar impacts as the NAA, except aircraft would be used to deliver treatments and would result in the restoration of more of the park. This would generate more benefits for the scientific and educational aspects of wilderness character. The PA would lead to indirect, regional, moderate, short- and long-term, beneficial impacts to the other features quality of wilderness character in SNP.

Summary of Preferred Alternative

Overall, the PA will result in direct, site-specific to local, minor to moderate, short- and long-term, adverse impacts as well as indirect, local to regional, moderate, short- and long-term beneficial impacts to wilderness character.

Cumulative Impacts of the Preferred Alternative

The same general scenario of past, present and reasonably foreseeable future actions that apply to the NAA, would apply to the PA. This alternative would have all of the same adverse and beneficial impacts of the NAA. It would add the impacts of aerial restoration treatments, which would allow larger areas to be treated, especially in more remote areas; but it would also increase aircraft use, which would negatively impact visitors' sense of solitude. More areas would be restored to their natural condition, but this increases the amount of trammeling in wilderness. Other wilderness values, such as scientific and educational values, would benefit more than under the NAA, because native plants and animal communities would be less adversely affected by buffelgrass and other non-native invasive plant species. When combined with other past, present, and foreseeable future actions in and around the park, the preferred alternative would provide a moderate incremental decrease in the overall negative cumulative impact.

Conclusion

The PA would include all of the treatments and impacts of the NAA and would allow aerial delivery of restoration treatments so that invasive plants could be treated in more remote areas. In addition, larger, remote areas could receive restoration treatments. Despite short-term adverse impacts to the untrammeled nature of the area, undeveloped character, and feelings of solitude, this alternative would help preserve naturalness and other wilderness values, such as scientific and educational values, thereby providing more long-term benefits to SNP's wilderness character.

3.11 IMPACT TOPIC SUMMARY

Table 8 provides a summary and comparison the impacts on each impact topic analyzed for both the No Action Alternative and the Preferred Alternative.

Table 8. Summary of impacts from the No Action Alternative and the Preferred Alternative on analyzed topics.

IMPACT TOPIC	IMPACT SUMMARY	
	NO ACTION ALTERNATIVE	PREFERRED ALTERNATIVE
Human Health and Safety	Negligible to minor, short-term adverse impacts due to manual activity, use of equipment, and herbicide application. A certified applicator would be used on projects involving herbicides, herbicide label would be strictly followed, and personal protective equipment would be used. Visitor access would be prevented in the vicinity and during restoration activities. Decrease the potential for wildfire in lower elevation areas.	Negligible to minor, short-term adverse impacts due to manual activity, use of equipment, and herbicide application. A certified applicator would be used on projects involving herbicides, herbicide label would be strictly followed, and personal protective equipment would be used. Aerial treatments may reduce the potential injuries that result from manual and other mechanized treatments. Visitor access would be prevented in the vicinity and during restoration activities. Decreases the potential for wildfire in lower elevation areas.
Soils and Surface Hydrology	Negligible to minor, short-term adverse impacts due to manual disturbance from hand tools, hiking, mechanized equipment, and chemical residue from herbicide application. Minor long-term benefits due to native plant resurgence, top soil conservation, and erosion control to reestablish natural surface water flow.	Negligible to minor, short-term adverse impacts due to broad application of herbicide in direct contact with soil and surface hydrology. Moderate short- and long-term beneficial impacts to soil and surface hydrology due to application of seeds and mulch and eradicating invasive non-native plants.
Water Quality and Quantity	Negligible to minor, short-term adverse impacts due to manual disturbance of soil from hand tools, hiking, mechanized equipment resulting in sedimentation in drainages after rainfall events, and herbicide residue. Erosion control measures and sediment control would result in negligible to minor beneficial impacts.	Negligible to minor short-term adverse impacts due to aerial herbicide application. Negligible to minor, short- and long-term beneficial impacts due to aerial seeding and erosion control measures over a large area.
Vegetation	Negligible short-term adverse impacts due to trampling, breaking, and uprooting vegetation, and due to unintentional herbicide application. Minor short- and long-term beneficial due to soil stabilization and native plant community recovery.	Minor short-term adverse impacts due to less precise herbicide application. Minor to moderate, short- and long-term beneficial due to reduced erosion, increased soil stabilization, and thus prevention of further degradation.

IMPACT TOPIC	IMPACT SUMMARY	
	NO ACTION ALTERNATIVE	**PREFERRED ALTERNATIVE**
Wildlife	Negligible short-term adverse impacts due to habitat disturbances, the presence of crew during breeding seasons, and inadvertent wildlife mortality resulting from manual or mechanical tools. Protection measures will be taken to minimize adverse impacts from herbicides. Minor short- and long-term beneficial impacts due to invasive plant control, erosion control, and measures to restore wildlife habitat.	Negligible to minor, short-term adverse impacts due to noise from aircraft and wildlife consuming herbicide residue from aerial spraying. Minor to moderate short- and long-term beneficial impacts would be realized due to the large areas of wildlife habitat restoration, especially in remote areas, and increased native plant establishment.
Special Status Species	Negligible to minor, short-term adverse impacts due to the presence of working crew, use of tools unearthing plants or displacing species, trampling, and unintended herbicide exposure. Minor to moderate short- and long-term beneficial due to habitat restoration and invasive plant removal.	Negligible to minor, short-term adverse impacts due to the inability to target individual species, noise disturbance from aircraft, injuring small terrestrial species from aerial delivery of seed and mulch, and less precise herbicide applications. Moderate, short- and long-term beneficial impacts due to habitat restoration across a large area.
Cultural Resources	Locales identified for restoration would be surveyed for cultural resources prior to treatments. Restoration would not result in adverse effects on known cultural resources. Accidental encounters with previously undiscovered cultural resources is possible. Cultural resource specialist would help identify potential impacts. Minor to moderate, short- and long-term beneficial impacts would be realized due to site stabilization, removal of invasive species, and ecosystem restoration.	Locales identified for restoration would be surveyed for cultural resources prior to treatments. Restoration would not result in adverse effects on known cultural resources. Accidental encounters with previously undiscovered cultural resources is possible; accidental encounters with previously undiscovered cultural resources is minimal from aerial restoration techniques. Minor to moderate, long-term beneficial impacts would be realized by site stabilization and erosion control.
Cultural Landscapes	Only manual application of herbicides would occur in or near the cultural landscape, and these activities will have no adverse effects on the cultural landscape. Beneficial effects would be realized by reducing the type or amount of erosion that would occur.	Aerial treatments would not occur in or near cultural landscapes; therefore, there are no effects to the cultural landscape.

IMPACT TOPIC	IMPACT SUMMARY	
	NO ACTION ALTERNATIVE	PREFERRED ALTERNATIVE
Wilderness	Minor, short- and long-term adverse impacts due to manipulating plant communities, use of aircraft to deliver water and supplies, and the evidence of herbicide treatments from dyes would affect the untrammeled, undeveloped, and sense of solitude characters of wilderness. Minor to moderate, short- and long-term beneficial impacts due to restoring native communities and ecosystem processes, which would provide for enhanced scientific and educational opportunities for the	Minor to moderate, short- and long-term adverse impacts to untrammeled, undeveloped, and sense of solitude due to the presence of aircraft. Moderate, short- and long-term beneficial impacts due to larger and more remote areas of the park receiving restoration treatments.

CHAPTER 4: CONSULTATION AND COORDINATION

4.1 INTERNAL SCOPING

Scoping is a process to identify the resources that may be affected by a project proposal and to explore possible alternative ways of achieving the proposal while minimizing adverse impacts. Internal scoping was conducted on several occasions by an interdisciplinary team of professionals from SNP, from the NPS Washington Office's Natural Resources staff, and from Intermountain Regional Office's environmental compliance staff and directorate. The interdisciplinary team met over the course of two years. Discussions included the purpose and need for the project; various alternatives; potential environmental impacts; past, present, and reasonably foreseeable future projects that may have cumulative effects; and possible mitigation measures. The team also gathered background information and discussed public outreach for the project. The results of all meetings are documented in this EA.

4.2 EXTERNAL SCOPING

The public has been invited to participate in this planning effort through several outlets: mailed letters, online through the NPS's PEPC website, an open house, and informational meetings. This public scoping was conducted to inform the public about SNP's Restoration Plan, and to solicit input for the preparation of this EA.

The scoping effort dates back to early 2009 and included a meeting with representatives from six local environmental organizations regarding concerns over aerial application of herbicides. Input at that meeting prompted additional tests and evaluations of the aerial methods being considered. In the summer of 2010, Pima County held a public meeting to address this effort, and ultimately moved forward with testing aerial application of herbicides in Pima County's Tucson Mountain Park.

As a result of the positive results from the intensive post-treatment monitoring, SNP decided to move forward with this proposal for aerial application of herbicides. The project was initiated in the NPS's Planning, Environment, and Public Comment (PEPC) system, and in May 2012, a general scoping letter was sent to 18 local, state, and federal land management agencies; nine Native American tribes; and 23 other interested parties, mainly environmental organizations. Recipients were asked to respond with issues or concerns to the alternatives. In November 2012, over 500 postcards were sent to the interested parties mentioned above, as well as park neighbors and stakeholders, and a press release was issued to invite the public to an Open House on November 27. The Open House provided a forum for the public to learn and ask questions about restoration issues and methods at SNP, the proposed alternatives, and to provide comments. Also in November 2012, eight environmental organizations that had previously expressed interest in this project were invited to participate and provide input at a separate scoping meeting. Additional informal meetings were held with various other organizations and neighborhood groups in January and February 2013.

As a result of all of this scoping effort, 39 comments were received during the entire scoping period from May 21, 2013 to present. The scoping response and input from the public was used to ensure that all concerns expressed were addressed in the Environmental Assessment.

Regulatory Agency Consultation

In accordance with the Endangered Species Act and NPS policy, the NPS contacted the USFWS regarding federally listed species in the project area. In a letter dated May 17, 2012, the NPS outlined the proposed project and requested comments and concerns for the project. In a response dated June 14,

2012, the USFWS requested a copy of the EA when it becomes available and the opportunity to review the determination of effect to species in a biological assessment.

In accordance with §106 of the National Historic Preservation Act, the NPS informed the Arizona State Historic Preservation Officer about this project in a letter dated May 18, 2012, and will follow up by sending a copy of the EA when it is available.

SNP contacted the Environmental Protection Agency since the park lies within the Upper Santa Cruz & Avra Basin sole source aquifer. Our proposal was outlined in a letter to the EPA, and SNP provided a response to 14 evaluation factors to help determine potential to contaminate the sole source aquifer. No response was received.

Native American Consultation

SNP sent scoping letters to nine Native American tribes to determine if there were any ethnographic resources in the project area and to invite their participation in the environmental compliance process. In addition, park staff met with Tohono O'odham tribal cultural representatives on January 23, 2013. The Tohono O'odham did not identify any concerns. A response from the Hopi Tribe dated July 9, 2012, identified no ethnographic resources for the area, and requested SNP to address the identification and protection of the cultural resources in the proposed EA so they are not inadvertently impacted during restoration treatments and activities. The Hopi also requested that they be provided with a copy of a treatment plan if any are prepared due to adverse effects on prehistoric features. No other responses were received. Consulted tribes included:

Ak-Chin Indian Community
Gila River Indian Community
Hopi Tribe
Mescalero Apache
Pascua Yaqui Tribe
Pueblo of Zuni
Salt River Pima-Maricopa Indian Community
San Carlos Apache Tribe
Tohono O'odham

Federal Scoping

Bureau of Land Management
Environmental Protection Agency
National Park Service – Desert Southwest Cooperative Ecosystems Studies Unit
National Park Service – Rivers, Trails and Conservation Association
Natural Resource Conservation Service
U.S. Fish and Wildlife Service
U.S. Forest Service- Coronado National Forest
U.S. Forest Service – Forest Health
U.S. Geological Survey

State Scoping

Arizona Game and Fish Department
Arizona State Historic Preservation Office
Arizona State Parks
University of Arizona

Local Scoping

Arizona Native Plant Society
Arizona Sonora Desert Museum
Arizona Wilderness Coalition
Center for Biological Diversity
City of Tucson Parks and Recreation
Coalition for Sonoran Desert Protection
Colossal Cave Mountain Park
Defenders of Wildlife
Human Ecology Action League (HEAL) of Southern Arizona
International Mountain Bicycle Association

Friends of Ironwood Forest National Monument

Friends of Saguaro National Park

Friends of Sonoran Desert National Monument

National Parks and Conservation Association

The Nature Conservancy, Arizona

Pima Association of Governments

Pima County Parks and Recreation

Rincon Institute

Sierra Club, Grand Canyon Chapter

Sky Island Alliance

Sonoran Desert Weedwackers

Sonoran Institute

Southern Arizona Buffelgrass Coordination Center

Tucson Audubon Society

Tucson Herpetological Society

Tucson Mountains Association

Tucson Parks and Recreation

Western National Parks Association

The Wilderness Society

Wildlands Network

and many others…

Media/Public Access

Arizona Daily Star

Pima County Public Library

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APPENDICES

Appendix A. Aerial Spraying of Herbicide to Control Buffelgrass in Southern Arizona: Efficacy, Non-Target Impacts and Application Recommendations

Aerial Spraying of Herbicide to Control Buffelgrass in Southern Arizona: Efficacy, Non-Target Impacts and Application Recommendations

Summary of Efficacy and Vegetation Response

Ground-based buffelgrass control efforts include manual removal using digging bars and picks, as well as herbicide. These methods continue to be effective and successful control of buffelgrass is possible but only at a small scale. These efforts cannot keep pace with the rapid growth and spread of buffelgrass. Infestations can form large, continuous, monoculture patches that are doubling in size every 2-7 years (based on research from the Santa Catalina Mountains in Coronado National Forest). Research has also documented that as buffelgrass patches become larger and denser, native plant diversity and abundance declines. Buffelgrass is present not only in disturbed urban areas but in natural areas, some of which are remote steep and rocky slopes where it can be difficult or impossible to access and where it is unsafe to send field crews.

To address these challenges, local and national public land managers and researchers joined together to evaluate the use of herbicides applied from a helicopter to control buffelgrass. Glyphosate, the active ingredient in the product used in these tests, was applied at 2 concentrations and 2 water carrier rates. In addition to monitoring the effects of the herbicide on buffelgrass, over 1,600 native plants were tagged for monitoring before the experiment and will be monitored for three years following the treatment. Percent greenness of each individual was recorded at each monitoring event.

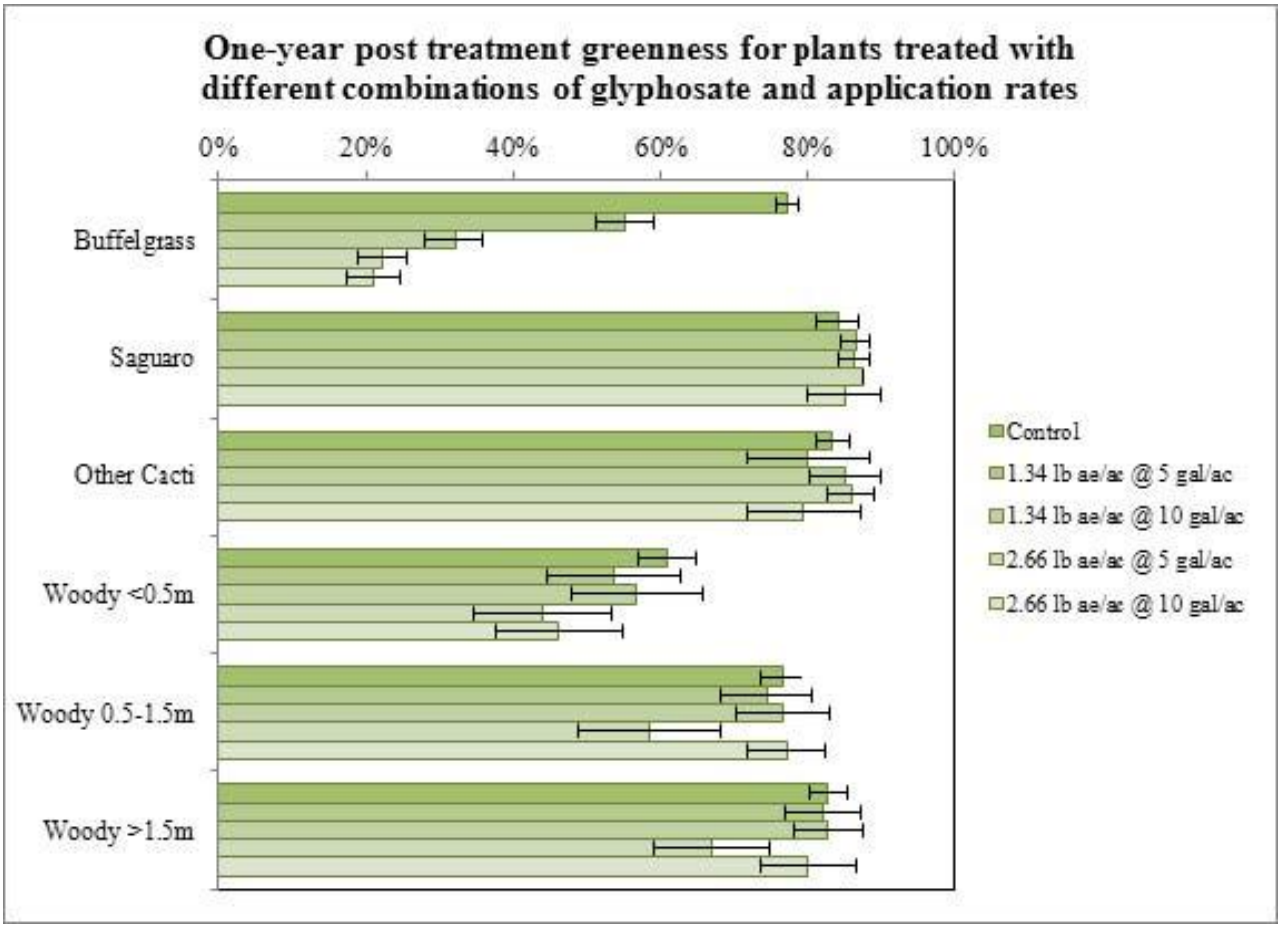
Results from the first year of post-treatment monitoring indicate that the higher concentration of glyphosate at either application rate significantly reduces buffelgrass greenness while saguaros and cacti were unaffected. Large woody species were susceptible to minor damage at higher concentrations and lower carrier rates. Smaller woody species like brittle bush, limber bush and mallows were most sensitive to glyphosate of natives present, also at higher concentration and lower carrier rate. While the areas tested had a high density of native vegetation, this technology will be deployed in areas where buffelgrass dominates and most of the native vegetation is no longer present.

Vegetation Response

Vegetation in twelve plots (each approximately one acre in size) was monitored for effects of aerially applied glyphosate (Roundup Pro®) herbicide treatments at two concentrations (1.34 pounds acid equivalent/acre and 2.66 pounds acid equivalent/acre) and two carrier (water) rates (5 gallons/acre and 10 gallons/acre). Each plot was paired with a control transect. Plots were purposefully chosen to have a mix of buffelgrass (<50% cover) and native vegetation to allow for the evaluation of any potential damage to native vegetation. This scenario does not represent a situation where aerial boom spraying would occur. To that end, over 1,600 individual native plants were tagged and then monitored prior to treatment, one year after treatment, and two years after treatment. This discussion presents the one-year post treatment data results. Data analysis for two- year post treatment vegetation response is ongoing.

Herbicide effects are measured as percent greenness of a plant. Greenness was visually estimated as the proportion of green actively growing tissue to dead or dormant tissue. The greenness categories were <10%, 10-40%, 41-75%, and >75% for non-target native plants and <10%, 10-75%, and > 75% for buffelgrass. The actual amount of herbicide that reached the plots was less than that released from the helicopter because of evaporation, drift and targeting issues and the amount decreased as the humidity lowered and thermal convection increased over the course of the day. Some material landed off-target due to both drift and difficulty in hitting small target plots in broken terrain. Buffelgrass was suppressed most effectively with the higher application rates of glyphosate (2.66 pounds acid equivalent/acre) at either carrier rate. However, higher rates will be required if mortality of mature buffelgrass plants is the objective. In general, mean greenness for the untreated buffelgrass was 77%, which was significantly greener than any of the treatments (Figure 1). Mean buffelgrass greenness for the low concentration and low carrier rate treatment was 58% and was significantly greener than other treatments. Mean greenness for the low concentration and high carrier rate and high concentration-low carrier treatments were 28% and 25%, respectively. These were not significantly different from each

Figure 1: One-year post treatment greenness for target and non-target life forms. Error bars indicate 95% confidence intervals for least squares means.



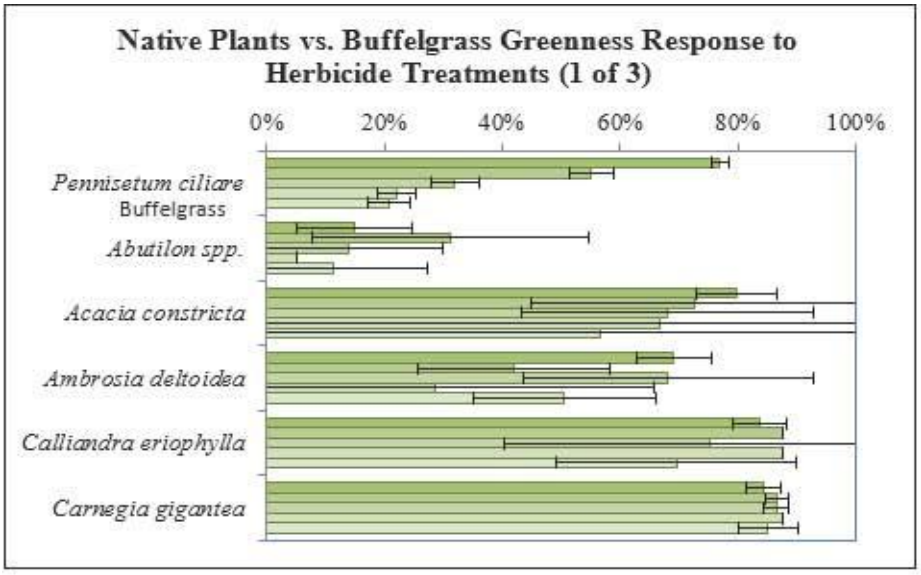
other, though they were significantly greener than the high concentration and high carrier treatment for which the mean greenness was 19%. Greenness measurements of non-target plants by treatment type are summarized in Figure 1 and 2.

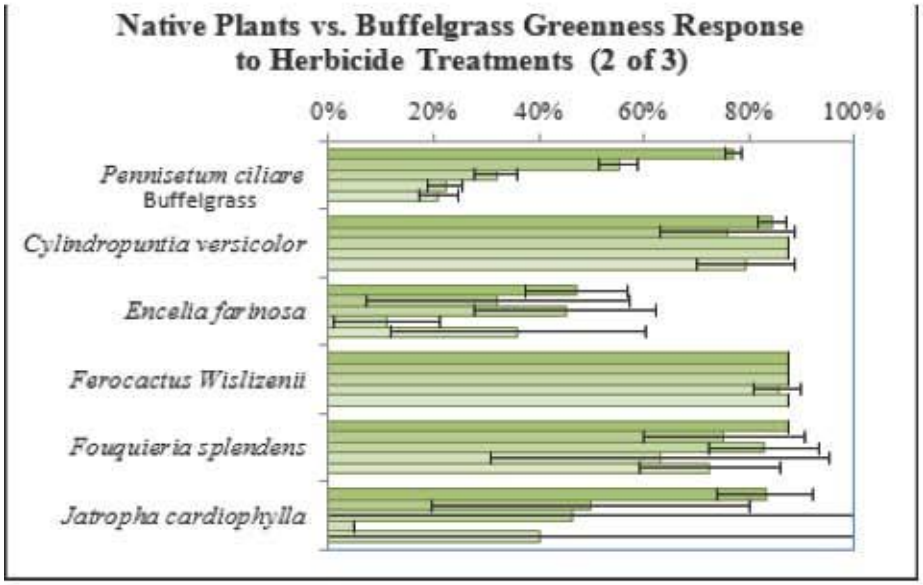
Some treatment combinations affected various native plant species; however, there was no consistent pattern (Figure 1).

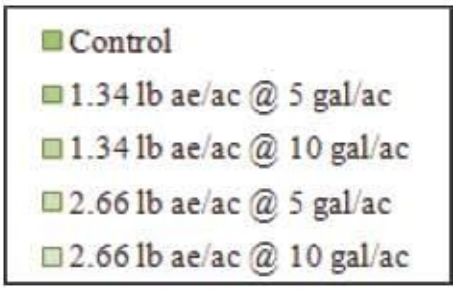
A comparison of the controls to combined treatments showed significant differences which were dependent upon life form, species, and rates for glyphosate and the carrier (Table 1). No significant differences were observed among the control and treatments for saguaros and other cacti. Cacti and most other desert plants have epicuticular waxes that extrude from the leaf surface in addition to the membranous cuticle layer . This waxy coating makes absorption of herbicide difficult.

Recommendations: Given the effect of glyphosate on native vegetation, although minor and species specific, only areas with a high percent cover of buffelgrass should be considered for aerial boom treatments. Higher deposition rates or multiple applications are needed to achieve mortality in mature buffelgrass plants. It is not known what the effects from multiple applications of glyphosate would be for Sonoran Desert vegetation, and further research on vegetative impacts from continuous applications of glyphosate or other herbicides should be a priority.

Figure 2. Native plants and buffelgrass greenness as a response to the different herbicide treatments and control. Error bars indicate 95% confidence intervals for least squares means.







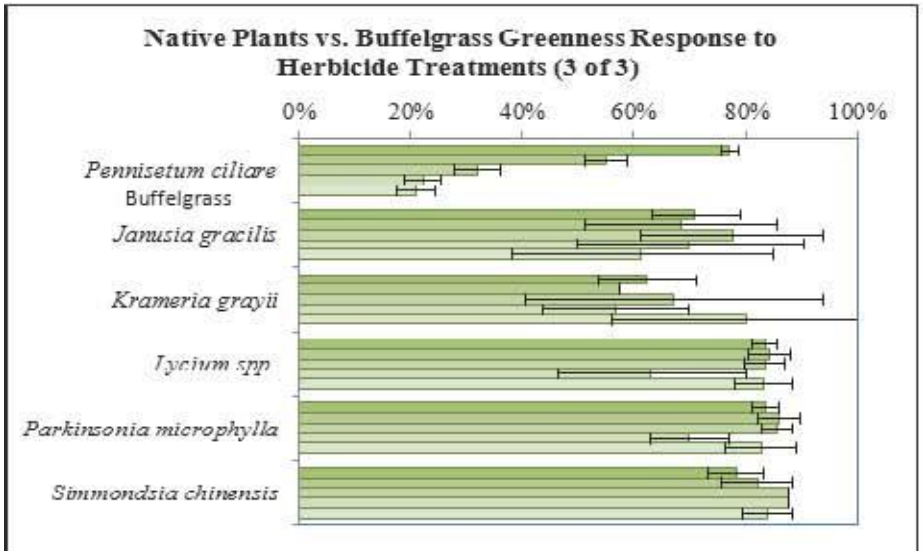


Table 1: Percent green means separations for lifeforms and species for (1) all treatments combined vs. control, (2) glyphosate rates vs. control (all carrier rates combined), and (3) carrier rates vs. control (all glyphosate rates combined). Means followed by the same letter within the same row are not significantly different (P ≤ 0.05).

		Control	Treatment
Lifeform	Other Cacti	83.4A	82.6A
	Saguaro	84.2A	86.3A
	Shrub	76.3A	71.8A
	Subshrub	60.9A	50.1B
	Tree	82.9A	77.6B
	Tree (*Fouquiesian splendens* excluded)	81.9A	78.4B
Species	*Abutilon* spp.	14.9A	17.8A
	Acacia constricta	79.8A	67.0A
	Ambrosia deltoidea	69.0A	47.3B
	Calliandra eriophylla	83.6A	76.6A
	Cylindropuntia versicolor	84.4A	80.9A
	Encelia farinosa	47.1A	31.7B
	Ferocactus Wislizenii	87.5A	86.8A
	Fouquieria splendens	87.5A	75.6B
	Jatropha cardiophylla	83.2A	39.7B
	Janusia gracilis	71.1A	68.7A
	Krameria grayii	62.4A	62.8A
	Lycium spp.	83.2A	79.6B
	Parkinsonia microphylla	83.4A	80.2B
	Pennisetum ciliare	76.9A	32.4B
	Simmondsia chinensis	84.2A	78.0B
Glyphosate rate	1.34 lb ae/ac	76.0A	60.0B
	2.66 lb ae/ac	75.9A	42.9B
Carrier rate	5 gal/A	79.3A	51.3B
	10 gal/A	72.0A	50.8B
All lifeforms, species, glyphosate and carrier rates combined		76.0A	51.0B

Application Recommendations

Aircraft Operation

The Sonoran Desert terrain flown in the demonstration project consisted of extremely complex terrain including steep hillsides, rocky outcrops, and arroyos that presented an extreme scenario for precision aerial application. Ground elevation varied by tens of feet over short distances, and slopes approached vertical in some places. In addition to the steep terrain, helicopter operations were also affected by the presence of saguaro cacti (*Carnegiea gigantea*) which can grow to 30-50 feet in height. *Recommendation:* Because of the variable topography associated with the Sonoran Desert, a licensed aerial applicator with experience in spraying over complex terrain should be used.

Summary of Application

An aerial spray project near the city of Tucson was performed in August, 2010 to test effects of two rates of the herbicide glyphosate at two rates of dilution on invasive buffelgrass (*Cenchrus ciliaris*, syn. *Pennisetum ciliare*). Buffelgrass is currently impacting the Sonoran Desert ecosystem by introducing a fire cycle and by competition with native vegetation. Roundup Pro® was the glyphosate formulation used in the spray project. The spray project was conducted during the morning on 12 test plots (one acre in size) to determine the feasibility of applying glyphosate using rotary wing aircraft with a boom sprayer to control buffelgrass in southern Arizona. Aerial spraying in this desert landscape presents challenges due to uneven, steep, and rocky terrain which can have target infestations of buffelgrass potentially existing on rocky knobs and in deep gullies. Buffelgrass is only susceptible to herbicide treatment during a green-up period that may last only a few weeks from the onset of monsoon precipitation.

In addition to the buffelgrass spray project, an auxiliary study was also conducted in September, 2010 at Ironwood Forest National Monument northwest of Tucson to evaluate the use of a tethered spray nozzle technique to accomplish small spot applications rather than the swath applications made by a helicopter boom sprayer. In the auxiliary study, water with a blue dye was used to test spray results. The tethered spray nozzle approach uses either a weighted "spray ball" with a single nozzle or a set of spray nozzles contained in a small pyramidal housing. Each of these two nozzle configurations can be lowered over relatively small infestations of buffelgrass for precise application. During application, herbicide is discharged onto target plants from the spray ball nozzle (or nozzles in the pyramid housing) which is suspended by a 50-foot hose beneath the helicopter.

The buffelgrass spray project and auxiliary study highlighted the difficult application scenarios that can occur with aerial application of herbicide to control buffelgrass in the Sonoran Desert. Based on previous experience as well as observations and results obtained from the spray project and the auxiliary study, the considerations outlined below should be incorporated into the design of any aerial application program.

Application Precision

Considerable variability of herbicide deposition was measured in the target area. Some of this variability is inherent in aerial application as deposition tends to be higher near the center of the spray swath and tapers toward the edges. If the aircraft is flying across slope, the area underneath the spray swath will be larger than if the aircraft is flying over flat ground, thus lowering the application rate. Furthermore, aircraft fly more slowly when headed up a slope. This will result in more material being applied per area if a flow control system is not used. Another source of variability is the constantly changing altitude of the aircraft with respect to changes in ground elevation beneath the moving helicopter.

Small target areas (approximately an acre in size as in the buffelgrass spray project) present a challenge as the pilot needs to anticipate turning the spray system on and off at the target edges. The initiation and termination of spraying are both a matter of pilot reaction and the mechanical lag in the spray system. Although automated systems using the electronic map information are available to compensate for these errors, such systems are not perfect. Therefore, many pilots prefer to retain control of this function. This can result in application errors at the target edges with both underspray occurring within the spray target and overspray past the edge of the target. On large spray blocks, this error is relatively minor as a percentage of total area; however, it can amount to a relatively large percentage error on small targets such as the one-acre plots used in the aerial study.

Recommendations: The aircraft used for spraying needs to be equipped with differential global position system (DGPS) guidance that allows logging of the position of the aircraft as well as whether the spray boom is ‘on’ or ‘off’. The aircraft should also be equipped with a spatially registered flow controller to compensate for variation in aircraft speed as the plane flies up and down over this terrain. Electronic logging of flow allows the amount applied where and when to be evaluated by the spray manager on a post-application basis. It is desirable to map buffelgrass infestations electronically by creating spatially registered files prior to the initiation of a spray project. These map files should be loaded into the aircraft at the time of spraying and used to guide the pilot.

Meteorology

Relative humidity during the demonstration project in the morning hours varied between 35% and 60%, and application became more problematic later in the morning as the landscape heated up. Even during monsoonal weather in the Southwest, surface heating during the summer causes convection (i.e., ‘thermals’ or lifting of air from the surface) which interacts with evaporating falling spray droplets thereby decreasing deposition. Because of this effect, many spray programs invoke humidity cut-offs when humidity drops to a certain point to avoid inadequate deposition of chemical. Terrain can influence local meteorological conditions. In areas with varying topography, local air flows can occur early

in the morning, which tend to move cold air downslope. These air flows can transport airborne material in unexpected directions as the flows are very local and are inadequately addressed by regional weather observations and forecasts. The air flows are most likely to occur under windless, clear conditions near dawn (spraying in these conditions may be precluded by low wind speed cut-offs on the herbicide label). These air flows are indicative of temperature inversions. Should such conditions occur, the herbicide label should be referenced and appropriate action taken.


Helicopter with boom sprayer. (US Forest Service)

Pesticide labels often specify high wind speed cut-offs (often around 10 mph). If spray drift is a major concern, conservative wind speed cut-offs such as 7 or 5 mph may be invoked by the spray manager. Lower wind speeds also allow more precise application as the pilot may feel more comfortable operating in lower wind speeds. Many labels also have low wind speed cut-offs (generally < 2 mph when present). The label for the glyphosate product used in this spray demonstration project advised that drift potential is lowest between wind speeds of 2 to 10 mph. The downside of very narrow weather constraints is that it reduces the time frame in which spraying will be allowed.

Recommendations: Based on the conditions encountered during the buffelgrass spray project, the window for spray operations should occur only from the time of operationally safe light after dawn until conditions warrant ceasing the operation. This window has the added advantages of avoiding winds arising during mid-day and a cessation of work during the hottest parts of the day. It may be possible to resume spraying two hours before dusk, but the window in the evening is necessarily smaller to allow the heat of the day to dissipate and convection to subside. A negative aspect of evening spraying is that work may end in conditions of low light which can cause safety problems.

Release Height

Complex terrain makes flying difficult, and pilots tend to fly higher in this type of terrain to avoid slopes and obstacles (e.g., saguaro cacti). Increases in release height will influence accuracy and drift.

Recommendations: Operationally, release height cannot be dictated because it is a major safety concern and must be left to the pilot. However, the effect of release height on application precision and drift should be discussed with the pilot. The release height must be sufficient to avoid collision with saguaro cacti which can grow to a height of 30-50 feet and are generally the tallest vegetation present in the Sonoran Desert. The spray manager should understand the influence that tall vegetation or extremely uneven terrain will have on release height above the target and allow for the greater potential for drift when release height is increased.

Droplet Size

It is critical in desert applications that large droplet sizes be used. This is due to the need to get material down to ground level in the evaporating, convective environment that is common in arid landscapes (as described above in the **Meteorology** section). Since droplet size is the most important variable in controlling spray drift, large droplets are also necessary to minimize drift. The trade-off with increasing droplet size is that larger droplets reduce coverage and efficacy in some cases. In the buffelgrass spray project, droplets with a size distribution of 600-800 micrometer (µm) volume median diameter (VMD) were used. The VMD represents the droplet size where half of the spray volume is contained in droplets larger than the VMD, and half of the volume occurs in droplets smaller than the VMD.

Recommendation: Assuming that acceptable buffelgrass control can be achieved, it is recommended that droplet VMDs of > 600 µm be used in buffelgrass applications using glyphosate products in this landscape.

Drift and Overspray

In general, major variables affecting spray drift are droplet size, wind speed, and release height. In the desert, humidity also becomes a major factor due to its influence on droplet size. Droplets smaller than 150-200 µm in diameter are more likely to move off-target, and generation of these relatively small droplet sizes should be minimized for most spray applications. Although there is always some drift of fine material during spraying, this drift greatly attenuates over distance and may have little if any impact on non-target species in the area affected by drift. In the buffelgrass spray project, there was no substantial drift at 75 feet away from the one-acre spray blocks involved in

the trial (the detection limit was around 5% of the application rate). To investigate drift further, the measured conditions and type of equipment used during the project were entered into a computer model. The modeling exercise indicated that drift resulted in 1% of the application rate at 90 feet downwind. This modeled data corresponds to the measured data, i.e., 1% modeled at 90 feet vs. 5% measured at 75 feet. These numbers for drift must be combined with biological information to determine whether this amount of drift is damaging to non-target species.

Overspray as discussed in the **Application Precision** section above is not considered drift since it is part of the spray volume directly sprayed rather than limited to fine droplet sizes associated with drift. However, overspray may be a consideration if there are sensitive areas or species near the spray target. Overspray generally occurs on the order of tens of feet and may be a consideration in sample transects used to determine off-target impacts from drift.

Test spraying with "spray ball" nozzle assembly (US Forest Service)

Recommendations: Buffer zones sufficient to allow for adequate attenuation of drift should be established if sensitive non-target species or areas occur near the spray target. Similarly, no-spray buffers should be established to prevent problems with overspray if non-targets may be impacted.

Adjuvants

Adjuvants are ingredients added to spray mixes to improve herbicide performance and minimize potential failures under adverse conditions. Adjuvants include surfactants (wetting agents), spreaders, emulsifiers, dispersants, and penetrants. There is an ongoing debate in the technical literature discussing the effect of hardwater on glyphosate efficacy. In the buffelgrass spray project, ammonium sulfate (AMS) adjuvant was used as a conditioner to lower the water pH

"Pyramid housing" nozzle assembly (US Forest Service)

and to improve uptake of herbicide by the target species. Roundup Pro® itself actually contains a surfactant in the formulation to provide greater uptake of the herbicide. Surfactants help herbicide uptake by reducing the surface tension of liquids.

Recommendations: Given that depositional rates apparently fell during the buffelgrass spray project as the humidity dropped and convection increased in late morning, an anti-evaporant adjuvant should be considered for use in aerial applications. The anti-evaporant adjuvant would have the effect of slowing the decrease in droplet size due to evaporation thus increasing deposition on-target.

Auxiliary Study with Tethered Spray Nozzle Technique

Results of the auxiliary study indicate that the tethered spray nozzle technique with the spray ball or pyramid housing is a highly accurate delivery system for small areas. With the close proximity of the nozzle assembly to the target, drift can be minimized. The spray ball was capable of being navigated to within 3 to 5 feet above the ground while avoiding obstacles. In comparison to the spray ball, the pyramid housing assembly was less maneuverable but did cover a greater area with spray. The smallest observed target that the pilot was able to spray with the spray ball was 12 feet in diameter.

Helicopter time is very expensive, and treatment of buffelgrass with the tethered spray nozzle technique may prove to be cost prohibitive. The cost of helicopter time is approximately $1,200 per hour of flight time as opposed to a cost of $300-$500 per hour for fixed wing aircraft. The cost for spraying an individual area will depend on (1) the size and number of spots to be treated, (2) the time to ferry between spots, and (3) the ferry time to and from the helibase. In addition, the need for hovering by the helicopter while spraying with tethered spray nozzle equipment compromises some of the aerodynamic efficiency of

a rotary wing aircraft. This practice may be more dangerous than application during forward flight.

Recommendations: Buffer zones sufficient to allow for adequate attenuation of drift should be established if sensitive non-target species or areas occur near the spray target. Similarly, no-spray buffers should be established to prevent problems with overspray if non-targets may be impacted.

Interagency Contributors

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Pesticide Precautionary Statement

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended. CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife--if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

FHTET-12-10

Appendix B. Restoration Strategies and Factors

Strategies and techniques that are used to restore damaged lands depend on the condition of the site pre- and post-disturbance. The environmental factors such as the condition of the native plant community, the invasive non-native plant community, and the soil resources, influence the restoration strategy (Table 1). The degree to which the conditions are met for each factor help the natural resource manager evaluate the appropriate treatments or combinations of treatments for each restoration site.

Table 1. Factors used in combination for determining the restoration strategies. The factors are common to both the No Action and Proposed Action alternatives

	PASSIVE	FACILITATED	ACTIVE
Native Plant Communities			
Abundance	Native plants dominate the site and are similar to undisturbed sites.	Natives are present but not dominant. Noticeably different from undisturbed areas.	Natives are absent or have only a minor presence; abundance is not sufficient for natural regeneration.
Age Distribution	All age classes are represented, including young.	An age class is absent or the young recruits are absent. The reproductive age class is still present but few.	The reproductive and young age classes are absent.
Seed Bank	The native plant seed bank is robust and key species are well represented.	Common native plants are not well represented in the seed bank.	Common native plants are not sufficient in the seed bank to allow for natural regeneration.
Vigor	Key species are actively growing and mostly alive.	Key species are actively growing but show signs of stress.	Key species are decadent or dead and are not reproducing.
Fire Adaption	Dominant species are mostly fire-adapted.	Some of the dominant species are fire-adapted.	Dominant species are not fire-adapted.
Invasive Non-native Plant Communities			
Abundance	Invasive plants are absent or have only a minor presence. Present species are ranked Low (AZWIPWG 2012).	Invasive plants have a minor to high presence. Present species are ranked Low-Med-High (AZWIPWG 2012).	Invasive plants have a minor to high presence. Present species are ranked High (AZWIPWG 2012).
Age Distribution	The reproductive and young age classes of the invasive plants are absent.	An age class is absent for invasive plants or young regeneration is absent. The reproductive age class is still present but is low in numbers.	All age classes of invasive plants are represented, including young.
Seed bank	Invasive plant seeds are not sufficient in the seed bank to allow for regeneration.	Invasive plant seeds are well represented in the seed bank.	The invasive plant seed bank is robust.
Vigor	Invasive plants are decadent or dead and are not reproducing.	Invasive plants are actively growing but show signs of stress or lackluster growth.	Invasive plants are actively growing and are mostly alive.
Fire Adaption	Invasive plants are not fire-adapted.	Invasive plants have none to some fire-adaptation.	Invasive plants are mostly fire-adapted.

	PASSIVE	FACILITATED	ACTIVE
Soil			
Stability	Soil stability is high; ground cover is near to natural. Resistant to non-native plant invasions.	Soil stability is moderate. Some instability and loss of ground cover is perceptible.	Soil stability is low. Significant loss of ground cover and signs of active erosion are evident. Conducive to invasion by non-native plants.
Compaction	Soil compaction is low to none.	Soil compaction is moderate; signs of entrenchment and micro-topography disruption exist.	Soil is highly compacted; micro-topography disruption is evident.
Slope	The disturbed area is located on a gentle slope (< 15 degrees) and has a low erosion potential.	The disturbed area is located on up to 30 degrees slope and has a moderate erosion potential.	The disturbed area is located on slope > 30 degrees and has a moderate to high erosion potential.
Location of Disturbance			
Visibility to Visitors	The disturbed area is seldom seen or visited.	The disturbed area is moderately visible and has moderate visitation rates.	The disturbed area is highly visible and is commonly visited.
Sensitive Habitat and Resources	Sensitive resources are not present in the disturbed area.	Some sensitive resources are present in the disturbed area.	A significant amount of sensitive resources are present in the disturbed area.

Saguaro National Park
Herbicide Training and Safety Plan

Table of Contents

Signature page on file and dated July 2008.

Superintendent	**Date**
Safety Officer	**Date**
Chief of Resource Management	**Date**

I. Purpose and Goals

Invasive non-native plants are well established and pose a threat to the ecosystems of both district of Saguaro National Park. If left unmanaged, these plants could impair park resources. GPRA goal Ia1B (Invasive Species) explicitly requires parks to control invasive species and the federal government has an Executive Order to prevent the introduction of invasive species, provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause (Executive Order 13112 of Feb. 3, 1999).

Safety is first and foremost in all of our work at Saguaro National Park. It is important to recognize the inherent risks and safety challenges when applying herbicides to buffelgrass infestations within the park and to make every attempt to mitigate them. The purpose of the "Herbicide Training and Safety Plan - Field Operations" is to address the safety concerns and necessary precautions, serve as a training manual for all herbicide applicators, and summarize the environmental, chemical, and wilderness compliance documents.

II. Program Background & Commonly Treated Species Information

Buffelgrass *(Pennisetum ciliare)*

Buffelgrass, a perennial bunchgrass from Africa, was introduced into Arizona in the early 1940s for livestock forage and to prevent erosion. The species is extremely invasive; and over time it has displaced native plants, increased the likelihood, intensity and size of wildfires in an ecosystem not adapted to fire, and degraded habitat for native wildlife. Today, buffelgrass directly and indirectly threatens the integrity of the Sonoran desert ecosystem, including the iconic saguaro cactus. Unlike some ecosystems, the Sonoran Desert is not fire-adapted; saguaros in particular, readily succumb to wildland fires fueled by buffelgrass. If buffelgrass is not controlled within the next decade, many scientists believe that local extinctions of saguaros will occur and the Sonoran Desert ecosystem may be irreversibly damaged. Due to these concerns, buffelgrass was listed by the State of Arizona as a noxious weed in 2005.

The park will continue to focus efforts on controlling buffelgrass and to a lesser extent fountain grass (as well as other perennial grasses) via manual pulling and herbicides. Staff, interns, emergency hires, short-term crews from other organizations (SWCC, CREC, ACE), and volunteers/groups will be used throughout the year to manually and/or chemically control buffelgrass. Chemical control of buffelgrass is more cost effective but is limited to when the plant is actively growing which is dependent upon rainfall. Buffelgrass seeds germinate, and dormant mature plants begin to put on new growth in the summer in response to the monsoon rains; so the opportunity to spray buffelgrass is generally limited to August and September. However, if temperature and rainfall are favorable, there may also be times during the winter months when spraying can be effective. When buffelgrass is not green, manual removal is the most effective method of control. Once an area is treated, either manually or with herbicides, repeat treatments are necessary for 3-5 years, the period that seeds remain viable; otherwise, that effort is wasted.

The active ingredient, glyphosate is currently the herbicide of choice for effective control of both buffelgrass and fountain grass *(Pennisetum setaceum).* For infestations located near active washes, tinajas, or surface water, an aquatic approved form of glyphosate will be used. Other non-native invasive grasses that are treated while spraying buffelgrass include natal grass (*Melinis repens*), Lehmann lovegrass (*Eragrostis lehmanniana*) and African lovegrass (*Eragrostis echinochloidea*).

Malta starthistle (*Centaurea melitensis*)

Centaurea melitensis is a winter annual, or annual to biennial herbaceous plant, reproducing by seeds. Flowering occurs from the late spring to the early summer in southern Arizona. *Centaurea melitensis*' seed production is highly variable. Plants are reported to produce from 1-100 flower heads with 1-60 seeds per head. Seeds fall near the parent plant, are dispersed short distances by wind or longer distances by humans, animals, water, and soil movements.

Its native range is described as Africa (Algeria, northwest Libya, Morocco, Azores, Canary Islands, Tunisia) and southern Europe (France including Corsica, Greece including Crete, Italy including

Sardinia and Sicily, Portugal, Spain including Baleares, Yugoslavia). *Centaurea melitensis* was introduced onto this continent from southern Europe in the 1700's. In Europe, it is used as a medicinal plant. It was brought to California during the Spanish mission period with the earliest record from seed in adobe bricks in San Fernando in 1797; possibly a contaminant of grains. *Centaurea melitensis* has been in the Tucson, Arizona area since 1901, and probably later in other areas of the Sonoran Desert.

At Saguaro National Park, infestation levels of malta starthistle are relatively unknown, though a recent increase in surveillance has revealed an abundant population. The seed seems to be dispersed primarily through equestrian use and along game trails. Additionally, it seems to prefer the loose sandy soils of washes, though infestations have been located in multiple areas which conform to none of these criteria. Malta starthistle can easily be removed by hand for small infestations. Plants with seed heads should be bagged. Herbicides are used to treat larger patches of malta starthistle. The most effective chemical currently being used is aminopyralid tri-isopropanolammonium (Milestone). Milestone is most effective when sprayed at the rosette stage. It is less effective after the plant has bolted and ineffective once the plant has flowered. The germination and life stage of malta starthistle are dependent on winter rains. The best time for treatments are between January and March. Herbicide treatments are in the front country thus there is no need for staging areas at this time.

III. **Implementation Strategy**

A. Water Transport and Staging Areas

Logistical considerations, particularly providing water to mix with the herbicide concentrate, for spraying remote sites can be very challenging. Water can be transported to remote sites by helicopter, mules or humans (crews). A programmatic pilot decision flowchart for determining the most efficient and least impact methods for water transport has been developed (Appendix B).

Although helicopters are expensive, and may present Wilderness issues, they are preferred for delivering large amounts of water to remote sites that are relatively inaccessible by mules or taking mules off trail would create significant amount of disturbance. This water transport method minimizes the amount of walking over difficult terrain crew members must do to reach a staging area and the impacts a mule string would create in delivering water off-trail. There is an inherent risk associated with helicopter activity and aviation safety protocols need to be adhered to at all times. Mules are less expensive to use than helicopters, but are not as efficient (a string of 6 mules can carry approximately 100 gallons of water). Depending on where mules are allowed to travel (on or off trail) they may not be able to deliver water directly to staging sites, and thus people may still be required to carry water cross-country. Humans are very inefficient transporters of water (5 gallons/person maximum). Carrying water cross-country also presents human safety issues. An alternative to transporting water from developed areas to staging sites is to use "local" water from flowing streams in close proximity to buffelgrass infestations.

Table 1 summarizes the amount of water delivered to each site in summer 2008 and the method of transport. These figures are indicative of summer field seasons to come as well. All water drop locations will be staging areas where chemicals are mixed, crews take breaks, and supplies are stored. These areas have been selected to minimize impacts on surrounding vegetation and habitat. Preparation of transportable water, access points, transportation vectors, and blivet landing zones preceded the physical movement of the water into the field. Staging areas and routes to staging areas may require restoration both in the short and long term.

Table 1: Water Drop and Quantity

Location	Type of Drop	Gallons
RMD		
1A West	M	80
1A Main	H	250
Javelina Hill	P	100
1A Bowl	H	100
1AB	H	150
1B	M	105
1B West	H	200
1B Center	H	250
TMD		
RedH1b	M	110
RedH1a	M	30

H= Helicopter, M=Mules, P= Personnel

B. Pre-Season

Appropriate equipment, including chemicals, protective personal equipment, and supplies will be purchased and assembled. Field kits, such as spill kits and mix kits, will be assembled for dispersal prior to the onset of the field season. All certified herbicide applicators will have current certification. Prior to the field season, safety and logistic meetings will take place.

Resource management staff will develop a strategy on how to allocate resources based on previous experience, plant growth and density, and crew sizes. NPS staff will provide training and orientation for the spray crew members. In addition to the topics covered in this manual, other topics include the basics of the spray operations and equipment, flagging protocol, directional terminology, how to work in lanes, protocol during wildlife encounters, and proper personal field equipment.

C. Summer Field Season

The goals of the herbicide spray season are to: 1) reapply in all areas that were chemically treated in previous summer and winter seasons, 2) treat areas that were manually pulled and 3) treat previously untreated corridors and pathways. Every attempt will be made to be mobilized by mid-July and work as long as the buffelgrass is green enough to spray

Each year areas are proposed for treatment and approved by park management. Selected areas are based on the following criteria: 1) treatment of areas previous treated (manual and chemical); 2) sensitive habitat and natural resource value; 3) accessibility (strongly associated with cost); 4) visitor viewshed (what it would look like after it burns); and 5) pathway and vector corridors.Table 2 provides a sample of areas proposed for treatment in 2008.

In addition to NPS permanent and seasonal staff, crews will consist of contract crews and SCA interns, who may have little or no previous herbicide application experience. Many of these individuals are from out of town and not accustomed to the heat, physical work, or terrain, therefore, every measure to ensure safety will be identified and discussed. Safety and logistical training will take place prior to on the ground application.

Table 2: Summer 2008 Proposed Herbicide Treatment Sites and Area (or length)

Location	Area (acres) or Length (miles)
RMD	
Roadside - all	10 mi
Riparian Overlook Hill	5 ac
Loma Verde drainage that parallels road	1 mi
Earth Day patch	0.4 ac
Javelina Drainage/Hill	25 ac
Tanque Verde 1A	17 ac
Tanque Verde 1AB	20 ac
Tanque Verde 1B	24 ac
Tanque Verde 1 C	10 ac
Tanque Verde 1C upper	2.4 ac
25mph patch	0.1 ac
Site 45 Patch (west side CFLD)	0.2 ac
Roadside patch @ Culvert Riparian Overlook	0.1 ac
TMD	
Roadsides - minimum Kinney X Sandario X Mile Wide	6.5 mi
Roadside - Kinney Road at boundary of SAGU ant Tucson Mtn Park (need LE)	0.25 mi
Hill to the east of park entrance	6 ac

IV. Safety

A. Basic Equipment

1. Mandatory Safety equipment will be carried to staging areas & placed in a designated area
    a. First aid kits – 1 group kit at staging area and another in vehicle
    b. Spill kit including eye wash and poison control phone number
    c. MSDS and chemical labels – ensure they are available at all times during project operations storage, mixing, transport, cleaning & disposal
2. Mandatory Field Operations Communications
    a. Park radio and spare battery (crew leader)
    b. Cell phone (crew leader) and emergency contact card
    c. Two – way radios for line of sight operations
    d. Inform LE (radio check) of management area working each day
3. Personal Protective Equipment
    a. All applicators and handlers must wear PPE as stated on the label
    b. PPE will be worn at all times when herbicides are being mixed and applied
    c. Mandatory PPE: long pants, long sleeves, hat, boots, nitrile gloves, eye protection, and other as stated on label. * Park mandatory PPE - handling concentrated LI-700 requires wearing a face shield and chemical resistant apron
    d. Mandatory equipment/supplies: small pack with hydration system minimum liter capacity, snacks, comb, toilettes, spare latex gloves
    e. Desirable equipment: tweezers and multi-tool with pliers (i.e. “leatherman”)
    f. Optional (but highly advisable): snake/cacti guards, plastic vest, glove liners
    g. Change of clothing in case of a spill- a tyvex suit (found in spill kit) will work as a temporary
    h. Always have extra PPE at staging area for resupply
    i. Another change of clothes, for after spraying, is optional

4. Backpack Sprayers
    a. Each crew member is responsible for ensuring proper functioning of sprayer; Alert a NPS crew leader if there is a problem with the sprayer.
    b. Daily demobilization and cleaning will be a group responsibility.
    c. Repair of equipment will be overseen by designated crew member.
    d. Faulty equipment MUST be labeled if unable to repair on site.
    e. Calibration - before application, sprayers will be calibrated to determine how much chemical is being applied on a per acre basis and to establish the rate of application.
    f. See Section VI for backpack sprayer maintenance, and cleaning.

B. Herbicides
1. Handling
    a. Wear PPE when handling concentrated and diluted herbicides
2. Mixing; *Most probable time of contamination to self, others and objects*
    a. Mix herbicides at least 100 feet from wellheads or surface waters unless using aquatic registered herbicide
    b. Place a tarp down at staging area; mix over the tarp and have absorbent pads readily available, or mix in secondary container
    c. When filling the sprayer with a hose, never allow the nozzle to come into contact with any part of the sprayer or its contents
    d. Tank mix herbicides according to label and in proper order, agitating when instructed
    e. Immediate replace chemical lids once you are finished with the chemical.
    f. Mix only the quantity of herbicide that can be used within one day
    g. Use the correct formulations provided on the backpack sprayer
    h. Record amount mixed and used daily on the Herbicide Log
    i. Empty containers and mixing equipment will be triple rinsed. Add rinsate (water used to rinse containers) to the next batch of mixture or dispose of properly (see page 18)
    j. Dispose of containers according to label
3. Storage and Transport
    a. Always have secondary containment for any type of transport or storage (plastic tub, dry bag, tarp, etc.)
    b. Lock herbicides in action packer when not in use and not within sight
    c. When not in use or transport, hazardous materials should be stored in a designated herbicide store room according to the manufactures label and AZ SPCC regulations
    d. All unused herbicide mixture at the end of the day needs to be consolidated into one sprayer, labeled with contents, and used the following day; otherwise disposed of properly (see page 18).
    e. Each container of herbicide MUST have correct and legible label
    f. Never transport herbicides in passenger areas of vehicles
    g. Keep herbicides separate from PPE
    h. Have contents of containers labeled (i.e. 3x rinsed, trash, contaminated).
4. Application
    a. Avoid contamination and be aware of it at all times; Consider <u>everything</u> to be contaminated
    b. Always carry toilettes, shop cloths, and spare gloves
    c. Have hand soap at staging area and wash hands frequently. Wash hands prior to eating, drinking, smoking, or using the bathrooms.
    d. Backpack sprayer need to be pressurized - pump handle until you feel the pressure build up. Avoid over pressurizing equipment, damage can occur.
    e. Adjust stream size with nozzle to achieve different objectives (slightly open for fine mist is generally preferable; open to a steady stream to extend reach or hit small target).
    f. Particle size can be adjusted with the nozzle. Small particles (mist) travel further than larger particles. Open nozzle slightly to increase droplet size and avoid drift.

g. Drift = herbicide moving in the air; be aware of yourself, others, and non-target plants.
h. Be aware of the wind speed. Wind speeds less than 5 mph should not cause drift if properly spraying the plant. Caution should be exercised for wind speeds 5-10 mph. If gusts over 10 mph, temporarily halt spraying. For steady winds over 10mph do not spray.
i. Hold the spray wand directly over the plant (within 8-12 inches) or within the plant. Spray such that at least 80% of the plant is covered (may need to walk around plant to get complete coverage).
j. Spray to wet, but not so that herbicide is running off
k. Unidentified seedlings – look at what is in the immediate proximity to seedling. If mature plants are nearby then spray seedling, if not then leave it.
l. Re-entry time into sprayed area is after the herbicide is dry (usually less than 1 hour)

5. Methods for Application
   a. Grid spacing between crew members should be great enough to avoid drift and small enough to ensure entire area is covered
   b. Scout and rove beyond what has sprayed/mapped in previous years; looking for outliers
   c. Daily operation strategies include walking lines or swaths, patches, roving, etc. Be sure directions are clear and understood regarding the desired plan of attack. Orient crew members to a site by using site maps, indicating the cardinal directions, and using landmarks for "lane" management. Check-in frequently with crew members, and encourage open communication to ensure that plans are adhered to and understood. In dense infestations, use narrow lanes.
   d. Do not spray yourself in so that you have to walk through treated areas to get out
   e. Avoid spraying animals, amphibians, reptiles, and non-target plants
   f. Watch for burrows and pack rat nests and be mindful when spraying around them
   g. Use aquatic registered herbicide products on plants in active drainage (water present), tinajas, or saturated soil.
   h. When practical, use "sherpas" to mix and bring herbicide to the applicators to minimize amount of traversing.
6. Considerations
   a. <u>Aquatic Considerations:</u>
      - Does the drainage contain leopard frogs, currently or historically? If so, use aquatic approved glyphosate herbicide
      - Amount of bedrock vs. soil or sand
      - Time until next rain event or forecast
      - Size of drainage
   b. <u>Public Area Considerations</u>:
      - If near Visitor Center, picnic area or trail side, post signage including: "Notice: Herbicide Use in Progress, Do Not Enter"
      - When spraying or staging trailside, post notification and outreach material barricade at trail head
      - Be prepared to interact with the public, what you are doing and why
      - Inform LE of where working
      - Post map of work areas on Park website and at VC
   c. <u>Roadside Considerations:</u>
      - Applicator must wear safety vest at all times on roadways
      - Always be aware of traffic
      - Traffic may cause drift so space yourselves adequately
      - DO NOT work both sides of the road at the same time
      - Stay within right-of-way boundaries (fence line, signage, power lines) on private side of road

- put on yellow flashers on truck with mounted sprayer
- refer to Appendix D for appropriate traffic sign control and signage
- request assistance from Law Enforcement for roadside work when a) there is no shoulder; b) using truck mount sprayer and shoulder space is limited; or c) working in an area of known traffic problems (primarily Picture Rocks Rd)

d. Other Considerations:

- Know current and forecasted weather conditions*;* particularly precipitation wind speed and direction

C. Herbicides Spills

Accidental spills happen, even though many measures are taken to prevent them. Read and thoroughly understand the spill containment procedure for each herbicide in the product's label and MSDS in the event a spill occurs. In the event of a spill, immediately notify the project supervisor. Identify the nature of the incident and extent of the spill. Remove any injured or contaminated person to a safe place. Remove contaminated clothing and follow MSDS guidelines for emergency first aid procedures following exposure. Obtain medical help for any injured employee.

An emergency spill kit will be available where ever herbicides are stored, mixed, transported and used. The key components of a spill are CONTROL, CONTAIN, CLEAN-UP.

1. Procedures for Herbicide Spill Containment
   a. *Prevent the spill from spreading!* Stop the additional spillage first.
   b. If the spill is contained (e.g., it has occurred in a pick-up bed, or secondary container) use absorbent material to soak up the liquid
   c. If the spill is not contained (e.g., if it occurs on the ground or in a parking lot) use the shovel to scrape the earth or use absorbent material to form dikes to contain the liquid.
   d. Flag the area of the spill to indicate parameters.
   e. Once the spill is contained, contact a crew leader. He or she will determine whether the spill is minor and can be handled using readily available equipment and materials, or major, requiring notification of appropriate authorities (see numbers below).
2. Methods for collection of spilled pesticides and materials:
   a. If the material *is not in contact with soil*, collect spilled liquids with absorbent material, put contaminated material into heavy plastic bags or empty containers, and tag the container to indicate the contents.
   b. If the spilled material *is in contact with the soil*, collect liquids with absorbent material; gather all material, including soil that came into contact with the spilled herbicides, and put it into empty containers; tag the container to indicate the contents
3. Plan for storage, handling, and disposal of spilled pesticides and materials:
   a. All material will be handled as hazardous material and stored in secondary containment in pesticide storage cabinets and will be disposed of according to instructions from the appropriate states Division of Emergency Management.
4. Rule of Thumb for Spill Size
   a. **Minor Spills (Less than 1 gallon of herbicide concentrate or less than 10 gallons of herbicide mixture).*

      Areas where chemicals are spilled will be roped off or flagged to warn people and restrict entry. Qualified personnel will always be present on the site to confine the spill and warn of danger until it is cleaned up. The spill will be confined with earthen or sand dikes if the chemical starts to spread. The spill will be soaked up with absorbent material such as sawdust, soil, or clay. Contaminated material will be shoveled into a leak proof container for disposal and labeled. Contaminated material will be disposed of using the same method as for herbicides. The spill area will not be hosed down.
   b. **Major Spills (More than 1 gallon of herbicide concentrate or more than 10 gallons of herbicide mixture).*

Areas where chemicals are spilled will be roped off or flagged to warn people and restrict entry. Qualified personnel will always be present on the site to confine the spill and warn of danger until it is cleaned up. The spill will be confined with earthen or sand dikes if the chemical starts to spread. The spill will be soaked up with absorbent material such as sawdust, soil, or clay. The local fire department and State pesticide authorities will be notified. Follow their instructions for further action. Whenever possible, someone familiar with the situation will remain at the site until help arrives. Emergency phone numbers will be carried by the herbicide applicators. Decontaminate the soil by removing it to a depth of at least 2 inches below the contaminated zone and place in clearly labeled leak proof containers for disposal.

5. Reporting Spills
   Complete an herbicide spill sheet for all incidents. The following list is a guide for the information regarding spills that should be reported. Incidents should be reported even if there is doubt as to whether the spill is an emergency or whether someone else has reported it. Emergency phone numbers are in the spill kit and on herbicide clipboards.

Emergency Numbers for Chemical Spills:

AZ Dept of Agric-Environmental Services Division	(602) 542-3578
Pesticide Poison Information	1-800-732-2200
CHEMTREC	1-800-424-9300
Tucson Poison Control	1-520-626-6016
Poison Control	1-800-222-1222

D. Human Safety Factors
*Never make guesses when dealing with herbicides. Ask questions. Protect yourself and the park. All of the following should be read and understood by all applicators.

1. Statement of precaution
   "Warning pesticides can be harmful. Keep children and pets away from pesticides/herbicides applications until dry, dissipated, or aerated."
2. Precautions
   a. Read Material Safety Data Sheets (MSDS) and herbicide labels (Appendix G) before purchase, mixing, application, storage, and disposal
   b. Ensure MSDS, labels, herbicide use log, and herbicide spill forms are accompanied in transport and at remote staging areas.
   c. ALWAYS wear protective clothing when handling herbicide and herbicide contaminated equipment
   d. Maintain and carry emergency spill response kit and first aid at all times
3. Job Hazard Analysis
   Read the "Herbicide Spraying/Weed Control Job Hazard Analysis" for general precautionary information (Appendix E)
4. Daily safety circles
   a. Include stretching, particularly neck, shoulders and back.
   b. Daily situational awareness including identified threats during previous spray period
   c. Encourage individuals to stretch at the beginning and after each tank load
   d. Document safety training, topics covered, who in attendance.
5. Lifting
   When hoisting heavy packs or backpack sprayer of more than two gallons, another crew member will assist to avoid unnecessary twisting. The packs and sprayers should be properly

adjusted and the chest harness will be securely fastened to avoid undue weight on the shoulders.

6. Activities outside work
   Crew members will be counseled to allow their muscles to rest during spraying season and not engage in outside work activities that may further stress muscles. This should include consideration of avoiding specific activities that would further stress muscles (such as certain swimming strokes or yoga positions).
7. Daily debriefing
   Discuss safety concerns, pluses and minuses, crew considerations, and crew physical condition. Follow with a cool-down stretching session.
8. Scheduling
   Personnel who have invasive plant control as part of their primary or collaborative duties and who will be working on invasive plant eradication for less than 3 consecutive weeks, the recommended work schedule is 4 days spraying herbicide with back pack sprayers (usually about 5 hours actual spraying per day) and 3 days off or not spraying. Personnel working more than 3 consecutive work weeks of 4 days herbicide spraying and 3 days off or not spraying, every effort will be made to assign rotational work on less strenuous terrain and roadside spraying during their regularly scheduled hours. Every attempt will be made to rotate crew members to avoid overuse and repetitive motion injuries.
9. Injuries
   Any injury, whether or not it seems serious at the time, MUST be reported.

E. Environmental
   1. Africanized Bees
      a. Be on the lookout for bee activity at all times
      b. Avoid working near known or newly detected bee colonies
      c. Know the signs of and appropriate responses to bee behavior
   2. Venomous Snakes
      a. Be trained in/convey information on snake identification, habits, and threats
      b. Avoid contact with venomous snakes
      c. Place hands and feet only in areas you can see
      d. Where snake/cacti chaps
   3. Sun/Heat Related Hazards
      a. Activity will be conducted as early as possible in the day
      b. Take breaks often and utilize shade
      c. Carry and drink plenty of water
      d. Wear proper sun protection, including a hat, sunglasses and sunscreen lotion
   4. Terrain
      a. Walk slowly and cautiously. Always watch your footing
      b. Make sure that your path is stable, and clear of potentially hazardous vegetation i.e. prickly pear, cholla, shin daggers, etc.
      c. Wear boots in good condition with adequate ankle support
      d. Formulate a pathway for your working space
      e. Be aware of cacti especially when backing up or squatting
      f. Avoid contact with or stepping on cholla/cholla balls
   5. Thunderstorms and Lightning
      a. Use the 30/30 Rule
         "Flash-To-Bang" delay (length of time in seconds between a lightning flash and its subsequent thunder), is 30 seconds or less. The second 30 corresponds to remaining under cover for 30 minutes after the final clap of thunder.
         If you see lightning, count the number of seconds until you hear thunder. Divide the number of seconds by five to get the distance the lightning is away from you. If you see lightning and it takes 10 seconds before you hear the thunder, then the lightning is 2 miles away from you (10 divided by 5 = 2 miles, too close!).
      b. What to do if you are outside:

i. Seek shelter in a truck, car, or van. If this is not an option, crouch down with your feet together and cover your ears to protect them from the thunder.
ii. Stay 15 feet away from other people
iii. Stay away from trees, picnic shelters or rain shelters, and canopies.
iv. Avoid hill tips, open spaces, wire fences, metal wires, exposed tool sheds and elevated objects. Avoid being on the highest object in the area. v. Keep away from isolated high trees.
v. Caves, canyons, ditches, or under a head-high clump of trees in an open area in the forest are your best bet. Try to avoid water.
vi. Crouch in a sitting position preferably on a mat or sleeping pad.

6. Walk out Rules

Occasionally someone will need to leave the field early due to fatigue, injury, poor time planning, or other reasons. It is important that staff know that they must not leave the field without thinking through all the potential safety issues first with the crew leader. If someone must leave the field, these procedures are to be followed:

a. If inexperienced, or working in a remote area, the person leaving must be accompanied by another person, preferable an experienced staff person.
b. They must have a form of communication, either a park radio or cell phone.
c. If there is any question about driving safely, the other person should drive the person exiting the field to park headquarters and consult with the rangers.
d. If the person leaving the field has a medical problem that could affect his or her ability to walk off, the rangers should be notified by radio and a decision made as to how best to proceed with the evacuation or rescue.

V. Impacts and Mitigations

Impacts and mitigations to a) cultural resources, b) aquatic resources, c) threatened and endangered species, d) wilderness values, and e) other issues of concern to the park are thoroughly discussed in Appendix C.

A. Project Specific Mitigations
1. Ground disturbance and removal or impact to native vegetation will be minimized as much as possible.
2. Every attempt will be made to avoid impacting any saguaro.
3. Care will be taken not to disturb any other sensitive wildlife species (reptiles, desert tortoise, migratory birds, raptors, or bats) found nesting, hibernating, estivating, or otherwise living in, or immediately nearby, the worksites.

VI. Equipment Maintenance

A. Vehicles

Pick-up trucks will be used for herbicide and sprayer transportation.
Consider the vehicle to be contaminated.
Clean throughout the season and clean thoroughly at end of field season.

B. Truck Mounted Sprayer – see separate instructions
C. Daily Field Kits and Data Collection
1. Ensure spill, mix, and herbicide kits are fully stocked daily (Appendix F).
2. Ensure data collection equipment, clipboard and forms are available.
3. Have public outreach materials available

D. Backpack Sprayer Cleaning
1. Daily
a. Attempt to have all mixed herbicide used by the end of each day, in the event this is not the case, consolidate herbicide into one sprayer and label the sprayer with the contents.
b. If appropriate, spray remaining contents on other non-native target species (tick grass, Lehmann's lovegrass, RMD gravel area of plant holding facility, or TMD corral area).
c. Relieve pressure in tank by holding open the handle and allowing pump, hose and wand to drain

d. Fill sprayer with 0.5 to 1 gallon of water to store overnight
e. Triple rinse the mixing equipment (rinse out three times). This water is called rinsate and can be used as water to mix future batches of herbicide
f. Clean hand held equipment as it becomes contaminated
g. Wash gloves and hands with dish soap

2. Weekly or Biweekly
   Triple rinse sprayers (DO NOT USE SOAP)
   a. Fill empty sprayer with 1 gallon of clean water
   b. Insert spray wand into tank and spray rinsate back into tank for 30 seconds
   c. Dump out remaining water on the gravel of the plant holding area (RMD) or corral at TMD
   d. Fill again with 1 gallon and close lid and shake aggressively.
   e. Dump out water.
   f. Fill tank again with half gallon and pump last rinse through the nozzle
   g. Remove nozzle, piston and other detachable parts (including filter and lids) rinse with water and brush out any clumps
   h. Lubricate O-ring in piston, lid and other rubber parts with motor oil (in herbicide shed)
   i. Wash and scrub chaps, straps, and outside of sprayer with Woolite (rinse thoroughly)
   j. Wash spray vests
   k. Wash out bins and truck as needed
3. End of Season
   a. Triple rinse sprayers using 3-in-1 neutralizer solution. Follow instructions on neutralizer.
   b. Pump entire amount of solution through nozzle
   c. Disassemble and lubricate parts as described above
   d. Clean chaps, sprayer, and vests as described above
   e. Clean out bladders and camelback packs.

Manufacturer's recommendation for SP0 Backpack Sprayer

pre-mix NO have crew read

The SPØ, SPØ-V Knapsack Sprayer

We would like to congratulate you on the purcharse of your new ***SPØ***, ***SPØ-V***, The sprayer that allows you the easiest, Most comfortable way of carrying out your farm and garden projects with the revolutionary piston-diaphragm pump (Patented), that but eleminates the problems inherent in most spayers.
As a new owner of the skillfully engineered ***SPØ***, ***SPØ-V***, we strongly recommend you carefully read and follow all the information on this sheet before use, and then save, and then save for future reference.
Please read the attached trouble shooting guide.

HOW TO ASSEMBLE

1. Attach spray wand to spray gun and tighten firmly.
2. Take pump handle Kit 7 (solid) and insert into the tube on the pump lever Kit 5 ("T" shape lever on sprayer). You will notice holes drilled through both the pump handle and the pump lever. Align these holes, take the "R" pin provided and place through the holes. This affixes the handle in place and is ready for use.
   For storage reverse process and then place "R" pin through the pump lever Kit 5 to keep from losing "R" pin.
3. Instructions for installing shoulder strap plastic buckle:
   First put the sprayer on a hard flat surface, take the white plastic buckle and while holding the sprayer up slightly, place buckle under the tubular metal frame. Slowly push down forcing the frame into the buckle. Repeat the same procedure for other side.

HOW TO PREPARE YOUR UNIT FOR USE

1. Remove cap.
2. Mix solution in a separate receptacle, following manufacturers directions on the container.
3. Pour pre-mixed solutions into sprayer and cap.
4. Place sprayer on back and pressurize tank by pumping approximately 10 to 15 times. **For best results, the sprayer should be pumped every 5 seconds on a continuous basis. This will maintain your spraying pressure. If you do not pump, you will not have pressure to spray.**
5. Always oil the seal on cap of unit as well as the check valve, this will extend life of seal and is important for obtaining proper seal with no leaks.
6. A unit that has been used with herbicides should never be used to spray insecticides, unless the sprayer has been properly cleaned and all other chemicals neutralized. Failure to do this could cause you to kill plants that have been sprayed. Consult with the manufacturer of the chemicals in use to obtain proper instructions.

HOW TO CLEAN AND MAINTAIN

1. Remove cap and pour out remaining solution, then rinse all parts thoroughly with clean water.
2. Leaving approximately ½ gallon of fresh water in tank, pressurize and flush pumping systems by depressing trigger at least 2 minutes, then drain all remaining water.
3. Always store tank clean and empty in a dry, shaded location.

CAUTIONS

Failure to follow manufacturers recomendation on use and care of unit will void any expressed or implied warranty.

Do not use chlorine or clorox. It will permanently damage pump system.

Please read and follow all instructions before using sprayer.

- Before using, filling or cleaning any sprayer, read all parts of the operating instructions.
- Make sure to set up the sprayer exactly as explained in the printed operating instructions, reminder tags and/or stickers.
- Wear protective clothing, respirator, gloves, eye protection, etc. Whenever using, filling, or cleaning sprayer.
- Periodically re-gresse lid gasket as well as lid vent and pump cylinder, where applicable.
- To ensure good performance, keep lid vent free of obstruction. Before and after each use, make sure all connections are well tightened.
- Service and replace worn parts as required.
- Read and follow all instructions of the chemical suppliers.
- As a rule, mix your chemicals in a separate container from which to fill the sprayer. Do not mix formulas inside the sprayer. Where an exception is made (e.g. with liquid fertilizers), fill sprayer with water BEFORE adding the active ingredient.
- Always sift formula through the screen. If there is no built-in strainer, use a screened funnel.
- Never fill the sprayer with hot liquids. Max. 30°C. or 85°F.
- This sprayer is made to hadle agrichemicals in their usual water or oil solutions. Do not use flammable, corrosive or caulstic solutions.
- Do not use chlorine or clorox.
- Do not use acids.
- Never use gasoline or other flammable materials.
- Before cleaning or servicing the sprayer, allow all pressure to escape. Do not store or transport sprayer under pressure.
- After each use, wash the sprayer--including hose, lance and shut-off valve--with plenty of fresh water. Unless spraying is to be continued within hours, drain chemical formula and thoroughly rinse the tank and all liquid ducts.
- Never store chemicals in your sprayer for any length of time.
- Use the sprayer only for the kind of jobs for which it was designed. When in doubt, ask your dealer.
- Do not leave the sprayer in reach of children or persons not qualified to handle it in proper fashion.
- When not in use--and specially during prolonged storage---keep your sprayer in a protected place away from direct solar heat.
- Make sure the spray hose loops freely without kinking or squeezing.
- Always use SP Systems original replacement part.

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VII. Data Collection

A. Forms

1. Invasive Plant Daily Documentation
    a. Assign an individual to complete the data sheet
    b. Complete the entire daily data sheet according to protocols
    c. Record weather in both AM and PM with Kestrel monitoring device
    d. File in Herbicide Binder
2. Spill Form
    a. Complete a spill form in the event of any size spill
    b. Report any spill to project manager.
    c. Project manager will call in major spills
    d. File in Herbicide Binder

B. Mapping Treated Area

1. Read and follow protocols for mapping treatment areas using computer/GPS unit
2. Follow all of the safety procedures previously mentioned

C. Post-processing Data – see Exotic Plant Geodatabase Manual

VIII. Chemicals

The chemicals discussed below are the primary components of the solution that will be used to treat invasive plants during the upcoming field seasons.

A. **Herbicide Active Ingredient**: Glyphosate

Brand name (examples): RoundupPro, Rodeo, KleenupPro, Aquamaster, and others

Behavior in Soil/Air: Glyphosate has an average half life in soil of 47 days. It is rapidly and readily adsorbed to soil, making its mobility/leaching/runoff potential low, therefore is not likely to move into ground water due to its strong absorptive characteristics. Since it is bound by the soil, it is generally not absorbed by non-target plants through their roots. Degradation of glyphosate in the soil occurs through microbial metabolism. Rainfall within six hours of application may reduce this herbicide's effectiveness. It does not volatilize.

Impact to Plants: A non-selective herbicide applied to leaves, green stems or cut-stumps, glyphosate inhibits amino acid and protein synthesis in plants, with toxic effects. The product is readily translocated to roots through the plant.

Impact to Non-Target Species: Glyphosate acts effectively on a wide range of plants; therefore care must be taken to limit adverse effects on non-target plants (overspray/drift being the primary concern during application). Since the same amino acid pathways are not present in animals, glyphosate is considered to be relatively non-toxic to them.

Riparian/Water Use/Concerns: Readily adsorbs to sediments of stream waterways situations and is relatively non-toxic to submersed plants. However, some adjuvents that are mixed with glyphosate in commercial formulations are highly toxic to aquatic plants and animals. It is suggested that a 10m buffer be given to aquatic areas. Formulations registered for aquatic use are available.

Impact to Human Health: EPA Toxicity level IV. Glyphosate is not classified as a carcinogen, teratogen, mutagen, or reproductive inhibitor. Impacts to humans involve skin or eye irritation while mixing and loading.

Re-entry time period: When spray solution has dried.

B. **Herbicide Active Ingredient**: Aminopyralid

Brand name: Milestone

General: Aminopyralid is a synthetic auxin analogue in the pyridine carboxylic acid class of herbicides. Auxins are plant hormones that regulate a number of plant activities. Cellular effects include alterations to the cell wall elasticity and gene expression. The predominant means of aminopyralid degredation in the environment is likely to be aerobic soil metabolism (half life of 103.5 days).

Riparian/Water Use/Concerns: It is highly mobile and should not be preceding rainfall. Once in the water it is extremely persistent.

Impact to Human Health: Effects on terrestrial fauna are expected to be limited since aminopyralid is a synthetic analogue of auxin, a plant growth hormone, which has no known action in animal metabolism.

C. **Water Conditioning Agent**: CHOICE
General: Hard water ions can bind with salts of certain herbicides and with some surfactants to form an insoluble salt. These insoluble salts then "fall out" of solution decreasing solution efficacy. The ideal pH for water used for spraying pesticides is slightly acidic (pH 4-6). CHOICE will be used to lower the pH and hardness of regional water (approx pH 8.0), thus increasing the mixability and/or solubility of the solution.
Riparian/Water Use/Concerns: Slightly toxic to fish and other aquatic life.
Impact to Human Health: EPA Toxicity level III-IV. CHOICE is not listed as a carcinogen.

D. **Adjuvant**: LI-700
General: LI-700 is a non-ionic, low foaming penetrant that works by opening up the natural pathways through the leaf surface or stem by re-aligning the protective waxy platelets to increase penetration. It is also a surfactant and an acidifier, and provides a more uniform coverage of spray solutions, lowers the pH of spray solutions, improves deposition and retards drift.
Riparian/Water Use/Concerns: Not recommended for use in aquatic areas.
Impact to Human Health: Liquid causes skin and eye injury on contact. Primary routes of entry are inhalation, eye contact and skin contact. Wear appropriate PPE. Respirators are available for use, but are not required by law. LI-700 is not listed as a carcinogen.

E. **Indicator Dye**
General: Indicator dye under various trade names will be added to the herbicide mixture. The blue or red dye is used to indicate where herbicide mixture has been applied.

F. Material Safety Data Sheets and Labels - "The Label is the Law"

1. Always read MSDS and herbicide label before purchase, mixing, application, storage, and disposal.
2. Documents will provide appropriate PPE recommendations, safety precautions, and 1st Aid instructions in case of an emergency.
3. MSDS and herbicide labels for all chemicals will be kept in spill kits and at mixing stations.

IX. Training

This document, the "Herbicide Training and Safety Manual" is required reading for all applicators and its contents will be discussed during formal training sessions, and acknowledgement of having read this plan will be recorded in the Saguaro NP Resource Management Safety Documentation notebook. You will be asked to sign that you have read and understand the contents of this document.
All personnel who handle herbicides for over 90 days will obtain a Pesticide Applicators License from either the Arizona Office of Integrated Pest Management or Arizona Department of Agriculture. All others will be supervised by a certified applicator. All applicators regardless of status, will receive formal and hands-on training.

A. Certified Applicators
Certified Applicators, will have read and be responsible for understanding the contents of the Herbicide Applicators Handbook. All Certified Applicators will be responsible for following the laws regarding herbicide label use.

B. Applicators
Non-NPS personnel or non-certified applicators, will work under the supervision of a certified applicator or a NPS crew leader with previous herbicide experience.

C. All Applicators
1. All applicators will receive formal training including (2-3 hours training):
    a. Read, review and understand contents of the "Herbicide Training and Safety Plan"
    b. Read and understand the hazards, appropriate uses, and safety measures described in the material safety data sheets (MSDS) and chemical labels (Appendix G)
    c. Understand that the **label is the law**
2. All applicators will receive hands-on training including (2-3 hours of training)
    a. Herbicide spraying equipment and proper use
    b. Personal protective equipment and proper use

c. Herbicide mixing and spills
d. Proper storage and transport of chemicals
e. Equipment maintenance and cleaning

D. Roles and Responsibilities
   1. Program Manager
      a. Develop Safety Plan
      b. Ensure Crew Leaders are certified applicators or have undergone extensive in-house training
      c. Develop training and training materials
      d. Ensure that all Crew Leaders comply with Safety Plan
      e. Develop field operations plan
      f. Procurement of supplies and equipment
   2. Crew Leaders
      Responsible for daily implementation of all aspects of safety outlined in the Herbicide Training and Safety Plan, including the following:
      a. Ensure that all crew members have undergone required training
      b. Ensure that all crew members are wearing proper PPE correctly
      c. Ensure that all mandatory equipment on checklist (Appendix F) is at the staging area
      d. Ensure daily Safety Circle, operational briefing and debriefing occurs and is documented and filed
      e. Ensure supplies and herbicide are stocked for the next day
      f. Ensure the Invasive Plant Daily Documentation is accurate, complete and filed
      g. Report any injuries, spills, or safety concerns to Program Manager
   3. Crew Members
      Responsible for daily implementation of all aspects of safety outlined in the Herbicide Training and Safety Plan, including the following:
      a. Completed all required training
      b. Wear proper PPE
      c. Participate in daily Safety Circle and stretching exercises
      d. Carry a minimum of two liters of water at the beginning of each shift and a snack
      e. Perform tasks as delegated by Crew Leader or Program Manager
      f. Report any injuries or safety concerns to Crew Leader
      g. Speak up when safety procedures are violated or if you have a safety concern

APPENDICES

Appendix A: Saguaro Invasive Plant Management Program 2009 – *to be updated annually*

Justification

Buffelgrass *(Pennisetum ciliare)*, a perennial bunchgrass from Africa, was introduced into Arizona in the early 1940s for livestock forage and to prevent erosion. The species is extremely invasive; and over time it has displaced native plants, increased the likelihood, intensity and size of wildfires in an ecosystem not adapted to fire, and degraded habitat for native wildlife. Today, buffelgrass directly and indirectly threatens the integrity of the Sonoran desert ecosystem, including the iconic saguaro cactus. Unlike some ecosystems, the Sonoran Desert is not fire-adapted; saguaros in particular, readily succumb to wildland fires fueled by buffelgrass. If buffelgrass is not controlled within the next decade, many scientists believe that local extinctions of saguaros will occur and the Sonoran Desert ecosystem may be irreversibly damaged. Due to these concerns, buffelgrass was listed by the State of Arizona as a noxious weed in 2005. National, state and local media have recently begun educating the public about the impacts of buffelgrass, including the potential for more wildfires, loss of saguaros, and overall habitat destruction; but more action is needed.

Buffelgrass is well established, and poses a threat to the ecosystems of both district of Saguaro National Park. If left untreated, this and other invasive plant species will impair park resources. GPRA goal Ia1B (Invasive Species) explicitly requires parks to control invasive species and the federal government has an Executive Order to prevent the introduction of invasive species, provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause (Executive Order 13112 of Feb. 3, 1999).

Project Description

In CY09, the park will continue to focus efforts on controlling buffelgrass and to a lesser extent fountain grass, African love grass, soft feather pappus grass, natal grass, and several invasive winter annual, via manual pulling and herbicides. Staff, interns, emergency hires, short-term crews from organizations (SWCC, CREC, ACE), and volunteers/groups will be used throughout the year to manually and/or chemically control buffelgrass. Crews are trained in the safe use and application of herbicides, and many crew members hold an Arizona Structural Pest Control Commission pesticide applicators license. When large groups (>20 people) are working, they will be divided into smaller groups to minimize any unnecessary impact. When possible, groups will stick to trails, washes and previously disturbed sites. If it is necessary to traverse undisturbed areas, individuals will spread out to keep from creating social trails. During herbicide application, crews work in a grid manner to avoid drift and increase efficiency.

Herbicide Treatments

Wherever it is feasible and cost effective, we will treat invasive plants with herbicides that have been approved for use in the park. The active ingredients of the herbicides include glyphosate (also in an aquatic approved formulation), imazapic, triclopyr, and aminopyralid. Brand name products such as RoundUp Pro, KleenUp Pro, RazorPro, Aquamaster, etc. which have glyphosate as the active ingredient, are the preferred herbicides for effective control of bufflegrass and fountain grass.

Herbicide application will be primarily by 4 gallon backpack sprayers. Other delivery mechanisms are battery powered pressurized truck mounted sprayer and swabs (cut stump method for tamarisk).

Herbicides are only effective on growing, green plants. Buffelgrass seeds germinate, and dormant mature plants begin to put on new growth in the summer in response to the monsoon rains; so the opportunity to spray buffelgrass is generally limited to July through September. However, if temperature and rainfall are favorable, there may also be times during the winter months when spraying can be effective. When buffelgrass is not green, manual removal is the most effective method of control. Once an area is treated, either manually or with herbicides, repeat treatments are necessary for 3-5 years, the period that seeds remain viable; otherwise, that effort is wasted.

Logistical considerations, particularly providing water to mix with the herbicide concentrate, for spraying remote sites can be very challenging. Water can be transported to remote sites by helicopter, mules or humans (crews). A programmatic pilot decision flowchart for determining the most efficient and least impact methods

for water transport has been developed (2008). This decision flowchart worked well in 2008 and we will continue to use it in 2009. It is used to provide guidance and is a dynamic flowchart because there are always unknown variables and there are situational or environmental factors which preclude strict adherence to a static framework.

Although helicopters are expensive, and may present Wilderness issues, they are preferred for delivering large amounts of water to remote sites, or to areas where mules may not be allowed. Mules are less expensive to use than helicopters, but are not nearly as efficient. A string of 6 mules can carry approximately 120 gallons of water compared to a helicopter which in the past has carried 2 blivets (approximately 100 gallons) in a single trip. Depending on where they are allowed to travel (on or off trail) mules may not be able to deliver water directly to staging sites, and thus people may still be required to carry water cross-country. In addition, mules, especially in a string, will impact the areas they travel, either on- or off-trail. It was observed in 2008, that the repeated use of crews hiking off trail to the staging areas was more of an impact than a single round trip by the mules. Humans are very inefficient transporters of water (5 gallons/person max). Carrying water cross-country also presents human safety issues. An alternative to transporting water from developed areas to staging sites, is to use "local" water from flowing streams in close proximity to bufflegrass infestations. This method may still require human transport of water to staging areas, but can significantly reduce the transport distance at some sites. In order to protect aquatic resources, the following criteria apply when removing water from any drainage in the Park.

Criteria for removing naturally flowing water

1) Source must be a stream or an actively flowing pool (i.e., overflowing or recharging).
2) The pool/water source will not be diminished by any more than 25% on any one day, so the pool is allowed to recharge/fill.
3) No more than 200 gallons will be taken from a given source.
4) Sediment will not be disturbed
5) Any pool with leopard frogs present will not be disturbed
6) Water would be strained, and any plant or animal (including invertebrates) filtered out would be returned to the water body.
7) Only herbicide-free containers and equipment will be used for collecting water
8) Employees will remove any PPE that may be contaminated with herbicide and would come into contact with the water (i.e., gloves), and be vigilant about any other sources of contamination.
9) Employees will minimize impact to surrounding area by staying on bedrock or rocks when collecting water.

The attached map outlines the proposed sites for caching water and the delivery method. Modifications from 2008 are minor and include 2 additional mule drop sites at TMD (Red Hill 2 – north of the visitor center and Kings Canyon). At RMD, one additional helicopter drop location is proposed and the relocation of one helicopter drop. Water for the remainder of the sites proposed for treatment will be carried in by crews.

Water can be transported to staging areas as time/resources permit, and stored onsite [in 5-gallon plastic containers (via mules) or 55-gallon blivets (via helicopter); both are blue in color] in the field until needed. When necessary, containers can be camouflaged with tarps and/or signed. We currently have water stored from last season at several sites in the park, and thus far, no problems or issues have arisen.

Manual Treatments

For hand-pulling, rock hammers, digging bars and pick mattocks are used. A French hoe is also used for winter annuals. Care is taken to completely remove the root crown of each plant, which generally lies within the top 2-3" of soil; therefore only the top 2-4" of soil will be disturbed when removing each plant. When pulling, it is best to concentrate on mature (reproductive) plants, and spray seedlings later, when they are actively growing (pulling seedlings is not a good use of people's time). Weed Free Trail Volunteers are instructed on how to properly remove the plant and disguise the disturbance.

Opportunistic Efforts
A common characteristic of invasive plants is that they start showing up anywhere and everywhere, and these satellite populations beget more starts in increasingly remote areas. Therefore, we would like to have the ability to opportunistically treat invasive plants anywhere in the park they are found.

Due to limited staff and resources, we have enlisted the help of volunteers, both groups and individuals. Volunteer groups are used to hand-pull both buffelgrass and fountain grass during the plants' dormant season. When working with volunteer groups, we target dense patches that are easily accessible and safe to work on (i.e., require minimal hiking and travel and have few natural hazards), and are not near sensitive resources. We propose to use trained staff and volunteers to pull scattered individual plants or small patches that are not feasible or cost effective to treat with herbicides. The Weed Free Trail program has been extremely successful.

Buffelgrass Strategic Plan
Saguaro's current strategy for treating buffelgrass with hand crews is based on the following priorities:

- Areas that have been previously treated (especially sites treated in 2007 and 2008)
- Sensitivity of habitat
- Accessibility
- Visitor viewshed (what it would look like after it burns)
- Pathway and vector corridors

Chemical Treatment Locations – Buffelgrass and other perennial invasive grasses
(See the attached power point for maps)

Areas for re-treatments:
Rincon Mountain District

1. Tanque Verde Ridge (south facing slope of Box Canyon); sites 1A, 1B, and 1C.
2. Javelina Hill and Picnic Area
3. Tanque Verde Ridge Trail from trail head to approximately 2.5 miles
4. Patches along and the interior of Cactus Forest Loop
5. Hope Camp Hills
6. All roadsides

Tucson Mountain District

7. Previously treated roads
8. Waterline Construction
9. Maintenance Hill, VC Wash, Boundary Gully, Borrow Pit, and Fruit Camp Washes

Areas for initial chemical treatments:
Rincon Mountain District

1. Freeman South (previously pulled)

Tucson Mountain District

2. All other roads at TMD – funded through WUI Fuel Reduction funds
3. Red Hills 1 and 2 north of TMD visitor center
4. Kings Canyon (previously pulled)

Other Species to be Treated
Other species that will be actively sought out and treated include salt cedar (*Tamarix* sp.), malta starthistle (*Centaurea melitensis),* Sahara mustard (*Brassica tournefortii),* soft feather pappus grass (*Enneapogon cenchroides)* our most recent invasive species, onion weed (*Asphodelus fistulosus*). In February 2008, dense stands of horehound (*Marrubrium vulgare*) were found in washes transecting the Cactus Forest Loop Road. These populations had not previously been recorded and it is questionable whether they were introduced by equipment and materials used in the construction and restoration associated with the road project.

The park has been treating any salt cedar found (so far less than 20 trees have been found in the park) for the past 15-20 years (by pulling seedlings, and cutting and applying herbicide (Garlon 4) to the stumps of trees), but

after the 2006 flood event, there has been an explosion of tamarisk seedlings in Rincon Creek. In the spring of 2007, onion weed was also found in Rincon Creek. As of now, these species (tamarisk seedlings and onionweed) can be hand pulled, and appear to be limited to Rincon Creek. Small patches of targeted species will be hand pulled, for more extensive patches herbicides will be used.

Other target invasive species include but not limited to:

Malta starthistle	*Centaurea melitensis*
Saharan mustard	*Brassica tournefortii*
African lovegrass	*Eragrostis echinochloidea*
kleberg bluestem	*Andropogon annulatus*
soft feather pappusgrass	*Enneapogon cenchroides*
onion weed	*Asphodelus fistulosus*
natal grass	*Melinis repens*
African sumac	*Rhus lancea*
tamarisk	*Tamarix sp.*
horehound	*Marrubium vulgare*
cow's tongue prickly pear	*Opuntia lindheimeri*
Russian thistle	*Salsola australis*
African daisy	*Dimorphotheca sinuata*
cheeseweed	*Malva parviflora*
pampas grass	*Cortaderia selloana*
sow thistle	*Sonchus* sp.
Wild oats	*Avena fatua*

Compliance

Invasive plant control work has been analyzed under an existing plan (*Exotic Plant Management Plan and Environmental Assessment, November 2004*) and a FONSI was signed by the Superintendent in 2005. A programmatic agreement has been written for cultural resource compliance for the *Exotic Plant Management Plan and Environmental Assessment* and has been signed by park, the AZ State Historic Preservation Office and the Advisory Council on Historic Preservation. Under this agreement, the park will work with a WACC archeologist (Sue Wells) to identify any areas of concern or preferred methods of control for the treatment sites.

Specific actions at specific sites still need to be reviewed annually by the interdisciplinary team to ensure that potentially adverse impacts from implementing the program are mitigated.

Alternatives

No action alternative – No exotic plant treatment efforts in 2008 would make the previous 5 ½ years work much less meaningful, and put us back to the starting point (or very near) for some revisit sites. No action would also mean non-compliance with Executive Order 13112, and that the Park would not meet GPRA goals for FY2008. Perhaps more importantly, no action would mean that we lose ground in removing two very invasive and disruptive species from the park.

Mitigation for Overall Project Work

See Mitigations List Form for further details.

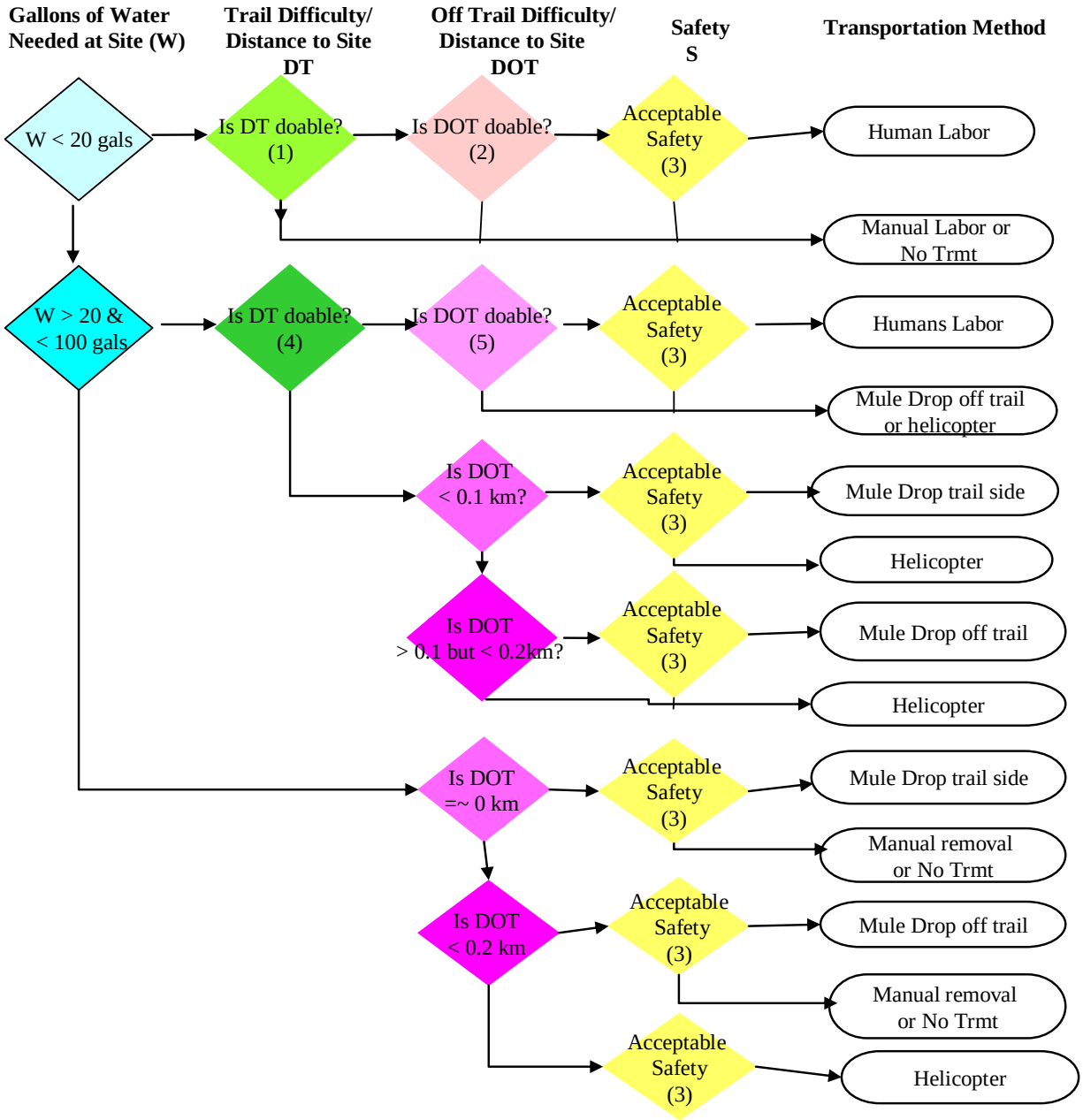
- Cultural- Archeological training for crews and volunteers will be administered by Sue Wells, from Western Archeological Coordination Center.
- Safety training will include review of JHAs, backcountry protocols, and communications.
- Daily safety circle and stretching will occur during the time crews are spraying.
- Land ethic training – Leave no Trace and Light on the Land principles.
- Remove signs of human disturbance, at the end of the season.

Appendix B

Pilot Decision Flowchart ("Flowchart") for Transporting Water to Treat Buffelgrass with Herbicide

Variables

1) Volume of water needed for treatment in the wilderness area (surrogate for buffelgrass density and area of infestation).
   W =Volume of water needed to treat site
2) Travel distance along trail and trail (terrain) difficulty; defined as doable, moderate, or difficult.
   DT = Distance on Trail (or wash)
3) Travel distance off trail and off trail (terrain) difficulty; defined as doable, moderate, or difficult.
   DOT = Distance off trail is the measure from the trail to the center of the infestation.
   *Assumption is that off trail difficulty is equivalent to trail difficulty; if no on trail travel is part of water delivery, than off trail difficulty will be evaluated in the same manner as trail difficulty.
4) Distance from staging area or water drop point and the size of the treatment area and slope/terrain. **S** is a measurement of distance, slope percent or terrain difficulty.



Area/Distance Equivalents
1 km = 1000m = 3280ft = 0.62mi
1 m = 3.3 ft
1 hc = 100m on a side (10,000m^2) = 2.47acres
1 ac = approx. 64m on a side (4046m^2)

Distance variables defined by difficulty or easiness of terrain factor (TF):
1 = Easy
2 = Moderate
3 = Difficult

Equation is Distance / terrain factor
Thresholds for terrain factor are variable depending on amount of water

Footnotes
1) Is it Doable?
DT < 3 km / TF
Doable is defined as
1 km for difficult terrain (3km/3) or 1000m
1.5 km for moderate terrain (3km/2) or 1500m
3 km for easy terrain (3km/1) or 3000m

2) Is it Doable?
DOT < 0.3 km / TF
Doable is defined as
0.1 km for difficult terrain (0.3km/3) or 100m
0.15 km for moderate terrain (0.3km/2) or 150m
0.3 km for easy terrain (0.3km/1) or 300m

3) Acceptable Safety
Yes – there no additional safety concerns related to wilderness, terrain, or vegetation
No - there are additional safety concerns related to wilderness, terrain, or vegetation (e.g. off trail terrain or slope is not the same as on trail which is frequent on ridge line trails)

4) Is it Doable?
DT < 1 km / TF
Doable is defined as
0.3 km for difficult terrain (1 km/3) or 300m
0.5 km for moderate terrain (1km/2) or 500m
1.0 km for easy terrain (1km/1) or 1000m

(5) Is it Doable?
DOT < 0.1 km / TF
Doable is defined as
0.03 km for difficult terrain (0.1km/3) or 33m
0.05 km for moderate terrain (0.1km/2) or 50m
0.1 km for easy terrain (0.1km/1) or 100m

Appendix C: Invasive Plant Management Program Mitigations Form

Park: Saguaro National Park
Project: Invasive Plant Management Program (CY09)
ProjectID/PIN: 25266

Mitigation(s):

CULTURAL RESOURCE PROTECTION

1. Park staff conducting exotic plant management work would be trained yearly in cultural site awareness to learn how to identify and avoid archeological and historical resources on the ground. This training has been very successful in the past in assuring protection of park cultural resources.
2. All workers would be informed of penalties for illegally collecting artifacts or intentionally damaging any archeological or historic property in the vicinity. Should any unusual treatment conditions or locations arise related to cultural resources, the park would contact the consulting archeologist and SHPO to determine how to proceed.
3. Should presently unidentified archeological resources be discovered during project implementation, work in that location would stop and the procedures of 36 CFR 800.13(c) followed. In the event that human remains, funerary objects, sacred objects, or objects of cultural patrimony are discovered the regulations implementing the Native American Graves Protection and Repatriation Act (43CFR Part 10) would be followed.

AQUATIC RESOURCE PROTECTION

The following criteria apply to removing water from any drainage in the Park:

1. Source must be a stream or an actively flowing pool (i.e., overflowing or recharging).
2. The pool/water source will not be diminished by any more than 25% on any one day, so the pool is allowed to recharge/fill.
3. No more than 200 gallons will be taken from a given source.
4. Sediment will not be disturbed.
5. Any pool with leopard frogs present will not be disturbed.
6. Water would be strained, and any plant or animal (including invertebrates)filtered out would be returned to the water body.
7. Only herbicide-free containers and equipment will be used for collecting water.
8. Employees will remove any PPE that may be contaminated with herbicide and would come into contact with the water (i.e., gloves), and be vigilant about any other sources of contamination.
9. Employees will minimize impact to surrounding area by staying on bedrock or rocks when collecting water.

T&E SPECIES PROTECTION

1. Workers will be advised of the sensitivity of the local threatened and endangered species and their habitats, and behave accordingly. Specifically: Time spent working near sites known to support threatened or endangered species will be minimized.
2. In circumstances when it is deemed necessary to conduct activities near sites known to support threatened or endangered species, such work will be performed in a way (specified by the T&E Biologist) to minimize impacts to the listed species.

3. Activities will have minimal impact on the T&E habitat features throughout the Park (i.e., trees greater than 4" basal diameter, at any elevation; and saguaros and agave plants).

WILDERNESS/VALUES PROTECTION

The MRA for this project, including the decision tree that determines the method of water transport to sites, will be adhered to. Per the MRA, where mules and humans go off trail, the entrance to where the mules/humans depart the trail, road, boundary will be signed to indicate the area is closed and describe the work taking place. Because crews will use the access points after the mules, the access points will not be disguised until the end of the herbicide treatment season but the signage will remain in place. At the end of the herbicide treatment season, the access point will be disguised with locally available materials. Degradation of the off trail route will be restored with locally available materials, by resource staff after eradication of the site.

STANDARD SAGU MITIGATIONS

1. Ground disturbance and removal or impact to native vegetation will be minimized as much as possible.
2. Wilderness-compatible techniques and tools (i.e., hand tools) will be used to conduct all backcountry maintenance, rehabilitation, and restoration work.
3. Impacted areas will be restored/revegetated per consultation with the Park's Restoration Ecologist after the site will no longer be visited
4. Trees over 4" diameter at their base shall not be removed.
5. Every attempt will be made to avoid impacting any saguaro. If saguaros less than four feet will be impacted, they must be transplanted.
6. Any cactus that must be removed will be salvaged and/or transplanted.
7. Whenever needed or requested, a park Biologist will provide personnel with an orientation/briefing that will appraise them of, and sensitize them to, threatened and endangered species and other relevant natural resource issues.
8. Care will be taken not to disturb any other sensitive wildlife species (reptiles, migratory birds, raptors, or bats) found nesting, hibernating, estivating, or otherwise living in, or immediately nearby, the worksites.
9. Resource Management personnel should be notified/consulted when these, or any other wildlife, must be disturbed or handled. They will be available to assist with moving/relocating Gila monsters, snakes or any other wildlife, when necessary; and/or to make recommendations for relocating any disturbed animals.
10. The Sonoran desert tortoise, a sensitive species, shelters in burrows which are usually found on rocky slopes below boulders and rocks. Thus, holes and crevices large enough to house an adult tortoise (>20cm wide at the opening) should not be disturbed. Any tortoise found, or known to be in a burrow must be relocated to the nearest appropriate alternative burrow or habitat (consult with RM staff). If desert tortoises are encountered at worksites (or elsewhere) care shall be taken not to disturb them, unless they are in a path of imminent danger; then they can and should be moved out of harm's way. They should be moved no further than necessary (certainly no more than 0.1 mile from their original location), and should be handled as little as possible. To move them, approach the tortoise from the front (giving it time to retract and prepare for an encounter) and grasp the tortoise firmly with both hands- one on either side of the tortoise, between their front and back legs, keeping the animal in its normal orientation at all times (e.g., do not turn them upside down!). These steps will minimize the potential for the tortoise to void its bladder and lose its precious water store. Tortoises should be moved in the direction

they were headed (on the other side of any nearby road it was headed towards), and placed in a shaded or protected site.

11. All sites where ground disturbance is to occur will be surveyed/cleared by a qualified archeologist and/or cultural resource specialist.
12. Workers will be advised of the sensitivity of any known relevant archeological sites or historic resources, and behave accordingly. If any cultural resources or objects are found/excavated, work must cease until an archeologist can assess the site.
13. All additional job analysis (e.g., JHA, MRA) identified for this project will be adhered to. All safety procedures and protocols specified in applicable JHAs or other safety documents for this project/work will be adhered to.

Appendix D: Roadside Signage

Always use appropriate signage.
Always wear safety vests (best if sprayer is wrapped with vest).
Always turn on yellow flashers of truck mounted sprayer vehicle.
Always place orange safety cones around vehicle.
Increased speed on the roadway warrants an increase of signage and distance placed between signs. To determine the distance between signs and distance from the roadside activity, refer to table 6H-3. Low speed is considered 30mph or less (as per John Connolly, Saguaro Safety Officer). After putting out signs on roads without direct line of sight, i.e. Picture Rocks, go back and drive the route to ensure operators of approaching vehicles can see them, in case of obstructing vegetation.

For high-volume roads or roads without a shoulder and high speed, a police patrol car and Ranger will be needed. This includes Picture Rocks Road and along Kinney Road just south of the junction with Mile Wide Road.

Table 6H-3. Meaning of Letter Codes on Typical Application Diagrams

Road Type	Distance Between Signs**		
	A	B	C
Urban (low speed)*	30 (100)	30 (100)	30 (100)
Urban (high speed)*	100 (350)	100 (350)	100 (350)
Rural	150 (500)	150 (500)	150 (500)
Expressway / Freeway	300 (1,000)	450 (1,500)	800 (2,640)

* Speed category to be determined by highway agency

** Distances are shown in meters (feet). The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-46. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The third sign is the first one in a three-sign series encountered by a driver approaching a TTC zone.)

Situation A: Shoulder Work with Minor Encroachment
Signage = 2 "Road Work Ahead" is REQUIRED, 2 "End Road Work" is OPTIONAL (we will not be using "End Road Work" signs)
Other Equipment = Sign Stands, Safety Vests, Cones to place around vehicle (dots surrounding vehicle in diagram below)

Figure 6H-6. Shoulder Work with Minor Encroachment (TA-6)

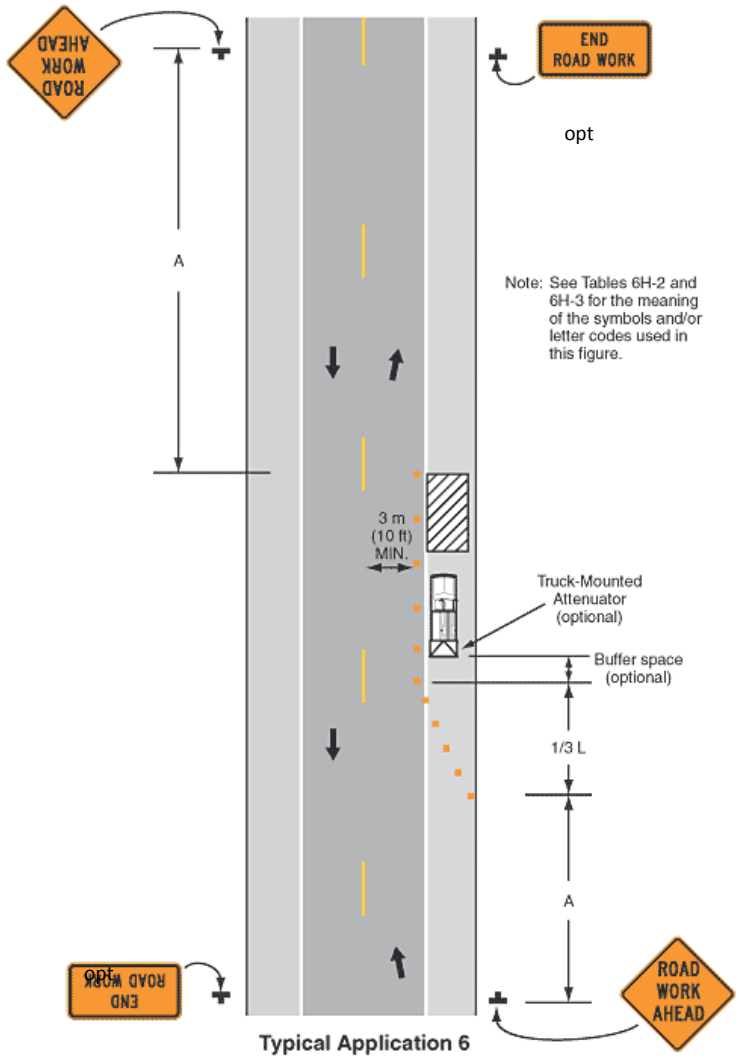
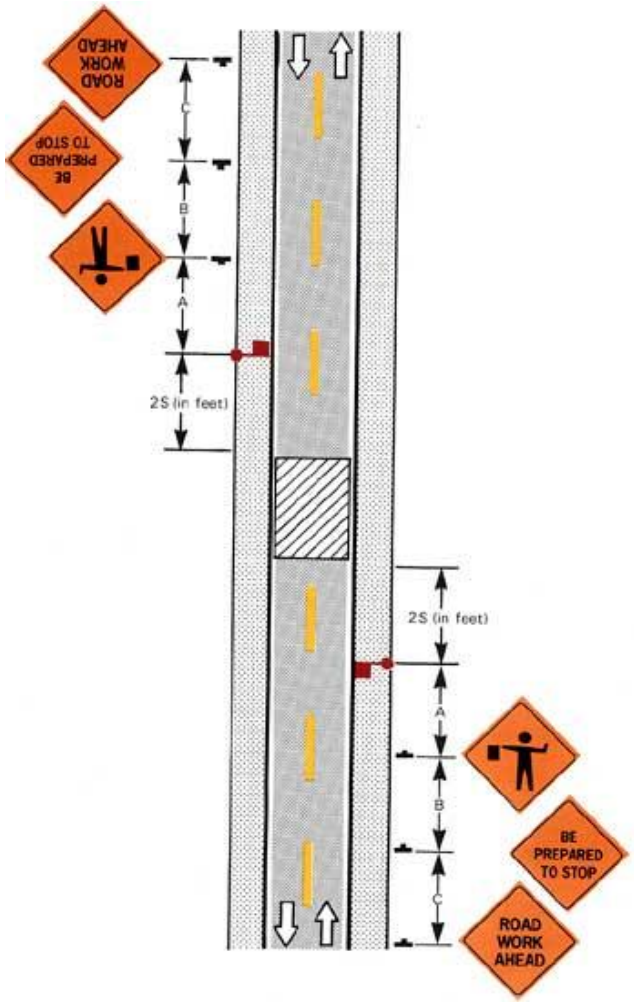


Figure 6H-6 shows a vertical two-lane roadway with one lane of traffic in each direction. Downward-pointing black arrows in the left lane and upward-pointing arrows in the right lane denote the direction of traffic. The opposing lanes are shown separated by a broken yellow line. A shoulder is shown to the right of each travel lane. The shoulders are shown separated from the travel lanes by a solid white line.
At the bottom of the figure and to the right of the shoulder of the right, northbound lane, a black inverted "T" is shown denoting a sign "**ROAD WORK AHEAD**". Beyond the sign, at a dimensioned distance A, a series of orange cones should be placed around the vehicle. This distance is shown as a dimensioned distance 1/3 L. Just beyond the vehicle and on the shoulder, a vertical rectangle is shown with diagonal black and white stripes, denoting a work space. At the

top-left of the figure and to the right of the shoulder of southbound roadway, a "**ROAD WORK AHEAD**" sign should be placed.

Situation B: Temporary Road Closure
Signage = 2 "Road Work Ahead", 2 "Be Prepared to Stop", 2 "Flag Person - Image", 2 "Stop" Paddles (Be sure to cover "Slow" if on reverse of "Stop").
Other Equipment = Sign Stands, Safety Vests, Cones to place around vehicle in same manner as diagram above



1. Conditions represented are for work that requires closings during daytime hours only.
2. This application is intended for a planned temporary closing not to exceed 15-20 minutes.
3. The flaggers shall stop the first vehicle from the position shown, then move to the centerline to stop approaching traffic.
4. For high-volume roads, a police patrol car and/or a changeable message sign may be added.
5. A changeable message sign may be used in place of the initial warning sign.

Appendix E

SAGUARO NATIONAL PARK
JOB HAZARD ANALYSIS

FACILITY:	**Saguaro National Park Service**	**ANALYSIS BY:**	**Danielle Foster**	**DATE:**	**06/30/2005**
			Modified by Drew Jackson		**07/09/2012**
DEPARTMENT:	**Resource Management**	**SUPERVISOR:**	**Dana Backer**	**FREQUENCY:**	
CATEGORY:	**Herbicide Spraying/Weed Control**	**APPROVED BY:**		**JHA NUMBER:**	
JOB TITLE:	**Herbicide Mixing and Application(Backpack Sprayer)**	**JOB PERFORMED BY:**			

Required Personal Protective Equipment:

- Tyvex suit or long pants and long sleeves, or overalls.
- Leather boots or water proof shoe covers.
- Chemical resistant gloves, safety glasses/goggles (closed sides) and/or face shield.
- Respiratory protection (NOISH) if stated on label.
- Sun protection such as hat with wide brim and sun screen lotion.

GENERAL NOTES:

- Read Material Safety Data Sheets and labels for all chemicals used prior to working with them.
- Follow guidelines outlined in the Hiking JHA for all work performed outside of developed areas (see Resources Safety Notebook).

JOB HAZARD Analysis:

Step	Description	Hazard	Controls
1	Dilution	Spills	Keep spill kit nearby.
		Splashing chemical in eyes or on skin	Wear protective eye wear and PPE as described on label. Keep eye wash on hand.
		Strain from lifting containers	Use proper lifting techniques. Get assistance when needed.
2	Transport of chemical	Spills, chemical contamination of skin, clothing, equipment and surfaces	Make sure container lids are tight. Secure containers in secondary containment at all times. Keep spill kit on hand. Do not transport herbicide container in same pack as your food and water. Wear appropriate PPE. Have adequate supply of potable water readily available for washing. Do not carry herbicide in personal compartment of vehicle.
3	Transport of equipment to work site	Back injury due to lifting/twisting	Employ proper body mechanics and proper lifting techniques when moving and lifting heavy objects. Fill water containers AFTER loaded on vehicle.
		Falling/sprains/strains	Use caution on wet surfaces (e.g. truck bed). Use step stool or block if necessary. Use handholds
		Crushing injury	Load heavy items carefully and secure well. Use caution when unloading-items in truck bed. They may have shifted in transit.
		Back strain from carrying sprayer	Use proper lifting techniques. Don't carry more weight than you can handle. Team lift if necessary.
4	Mix herbicide solution	Chemical contamination of skin, clothing and equipment surfaces	Wear appropriate PPE. Have adequate supply of potable water readily available for washing. Have second set of clothing or tyvex suit available.
		Spills	Mix on tarps or secondary containment. Have absorbent clothes and spill kit readily available. Secure lid immediately after finished with that chemical. Avoid having too many people in mixing area (2-5 people).
		Concentrated herbicides	More potent chemicals, ensure proper PPE for mixing (compared to application). Situational awareness
5	Fill sprayer tank	Chemical contamination of skin, clothing and equipment surfaces	Wear appropriate PPE. Have adequate supply of potable water readily available for flushing. Have second set of clothing or tyvex suit available.
		Splash	Ensure wearing safety goggles or face shield. Have non-participants avoid the mixing area.
6	Putting on and carrying	Chemical contamination of skin, clothing and	Wear appropriate PPE. Have adequate supply of potable water readily available for washing.

	back pack sprayer	equipment surfaces	Ensure tank cap is tightly sealed and sprayer is wiped clean of spilled herbicide solution. Have 2nd set of clothing/ tyvex suit available.
		Back or shoulder strain or injury.	Adjust straps to proper length and fit BEFORE filling. Employ proper body mechanics for lifting heavy objects. Have assistant lifting the sprayer onto back, or lift sprayer to platform such as truck bed then back into straps.
		Twisting and lifting	Balance before weight shifting. Employ proper body mechanics for lifting heavy objects.
7	Application	Chemical contamination of skin, clothing equipment	Wear appropriate PPE. Have adequate supply of potable water readily available for washing. Ensure tank cap is tightly sealed and sprayer is wiped clean of spilled herbicide solution. Have second set of clothing or tyvex suit available. Maintain control of nozzle at all times.
		Inhalation of chemical	Avoid drift. Do not spray if gusts greater than 10mph; spray intermittently when wind speeds between 5-10mph. Increase droplet size if breezy.
		Contamination	Consider anything you touch with your gloves on contaminated (pens, gps, water bottle, etc). Carry toilettes or hand sanitizer at all times. Avoid walking in previously sprayed areas where it is still wet. Wash gloves and hands before breaks.
		Back, neck and shoulder strain from carrying sprayer	Use proper lifting techniques. Do not carry more weight than you can handle. Take breaks to stretch when needed. Avoid quick twisting or jarring motions while wearing sprayer. Ensure all straps are secured and fastened.
8	Hiking over rough terrain with heavy load	See back country hiking JHA	For stability use waist and chest straps on backpack and sprayer at all times
9	Break for meals/rest	Ingestion of chemicals, chemical contamination of skin, clothing	If possible take breaks at supply base where there is a supply of potable water. If not possible, carry supply of potable water and or disposable cleaning cloths. Wash gloves and hands before eating, smoking, or using the restroom
10	Clean up	Body contact with chemical	Release pressure from tank first. Wear appropriate PPE. Have adequate supply of potable water readily available. Wear protective gear. Wash up after working with any chemicals.

Appendix F: Herbicide Equipment Kits

Spill Kit:	Mix Kit/ Spare PPE:
2 "Pig" Absorbent Socks	Shop Cloths
Shop Cloths (1 packet)	Small Bottle of Soap in bag
4-5 Absorbent Pads	Mixing Cups & Spoons
Kitty Litter	2 pr Protective Glasses
Dustpan and brush	Absorbent Pads
Trowel	4-5 Pair Green Nitrile Gloves
4-5 Multiple Large Trash Bags	Glove Liners
4-5 Multiple Small Ziplocs	4-5 Pair Disposable Blue Gloves
Wet Naps	2 Sharpie Markers and Flagging
1 Roll of Medical Tape	1 Large bag of Wet Naps (make sure wet!)
1 Pair of Leather Gloves	Trash Bags and Ziplocs
4-5 Pair Green Nitrile Gloves	Sprayer Spare Parts: 2 kits each-nozzle, o-ring, elbow, cotter key
4-5 Pair Disposable Blue Gloves	Wag Bags
2 Tyvex Suits	
1 Pair Protective Glasses	
2 Small Bottled Water	Crew Kit:
1 Bottle Eyewash	Large 1st Aid Kit w/ Field Injury Packet
1 Sharpie Marker & Flagging	Data Collection Forms & Clipboard
Spare Long Sleeve Shirt	Kestrel Weather Recording Device
MSDS & Labels	Field Signage & Outreach Packet
Herbicide Safety Plan	Emergency Contact Card
Copy of Current Applicator Licenses	Flagging and Sharpie
Spill Report Form	
	Herbicide Kit/Action Packer:
OTHER:	Herbicides and Dye
Communications (radio, cell phone, 2-ways)	Absorbent Pads & Shop Cloths
GPS	Secondary Containment & Padlocks
Trimble	Padlocks (w keys)
Chaps	Tarp
Trail Head Sign	

Herbicide Treatment Field Checklist

Crew Leader: _____ Date: _____

Comments:_____

_____

____ Safety Circle
____ Safety Documentation Filed
____ Briefing on Daily Operations
____ De-briefing on Daily Operations
____ Cool Down Stretches

Equipment
____ Spill Kit
____ Mix & PPE Kit
____ Cactus Chaps
____ Large First Aid Kit

Communications
____ Park radio & Battery
____ Cell phone (charged)
____ 2-way radios & Batteries
____ Emergency Contact Card
____ Small notepad & pencil/pen

Data Collection
____ ArcPad Unit
____ GPS Unit
____ Kestral
____ Invasive Plant Daily Documentation (Herbicide Log)

Outreach & Education
____ "Notification of Herbicide" Signage
____ Buffelgrass Brochures & Volunteer Cards

Other
____ Comb
____ Utility Tool ("Leatherman")
____ Camelback or water supply for all crew members

Appendix G. Material Safety Data Sheets (MSDS) & Labels for Chemicals (glyphosate herbicides, Milestone, LI-700, Choice water conditioner)

Appendix D. Minimum Requirements Decision Guide Analysis for Determination of Restoration Delivery Methods in Saguaro National Park

MINIMUM REQUIREMENTS DECISION GUIDE

WORKSHEETS

". . . except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act..."

– the Wilderness Act, 1964

Please refer to the accompanying MRDG *Instructions* for filling out this guide.
The spaces in the worksheets will expand as necessary as you enter your response.

Step 1: Determine if any administrative action is necessary.

Description: Briefly describe the situation that may prompt action.

Saguaro National Park is concerned about the threat to native plant communities from invasive plants, large scale fire, and unauthorized human activities within the park. There is an increased threat of large scale wildfire caused by invasive plants, past fire suppression management activities, and a climate favoring warmer and drier conditions.

The park currently has an extensive amount of invasive non-native perennial grasses throughout its desert community. These grasses are currently disrupting ecosystem processes by decreasing native plant diversity and cover, which in turn impacts wildlife habitat and forage. The grasses invade the interspaces between native plants, and ultimately displace them, forming a continuous source of fuel for wildfires.

At higher elevations, woody biomass has accumulated due to lack of fire in the pine forest community. Anthropogenic disturbances such as off-road vehicle use, unauthorized trails and campsites, abandoned roads and other disruptive land uses can occur throughout the park.

Large-scale disturbances, primarily in Wilderness, are often in remote and steep terrain which can be difficult to access and put ground crews at risk. With a favorable climate, invasive plants continue to spread at rates faster than ground crews can keep pace with. This can lead to more acres of fuel and potentially fire in an ecosystem not adapted to fire.

To determine if administrative action is necessary, answer the questions listed in A - F on the following pages.

A. Describe Options Outside of Wilderness

Is action necessary within wilderness?

Yes: ☒ **No:** ☐

Explain: Disturbances described above occur in Wilderness.

B. Describe Valid Existing Rights or Special Provisions of Wilderness Legislation

Is action necessary to satisfy valid existing rights or a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that allows consideration of the Section 4(c) prohibited uses? Cite law and section.

Yes: ☐ **No:** ☐ **Not Applicable:** ☒

Explain:

C. Describe Requirements of Other Legislation

Is action necessary to meet the requirements of other laws?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Federal Executive Order 13112, Federal Noxious Weed Act of 1974, as amended (7 U.S.C. 2801 *et seq*.), Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.), Clean Water Act of 1975 (33 U.S.C. 1251 *et seq.)*, National Historic Preservation Act of 1966 (89-665; 16 U.S.C. 470 *et seq.*), and Arizona Native Plant Law

D. Describe Other Guidance

Is action necessary to conform to direction contained in agency policy, unit and wilderness management plans, species recovery plans, or agreements with tribal, state and local

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: In accordance with the National Environmental Policy Act (NEPA), regulations of the Council on Environmental Policy Act (CEQ) (40 CFR 1508.9) and the National Park Service Director's Order #12 Conservation Planning, Environmental Impact Analysis, and Decision-making, NPS Management Policies, Chapter 4: Natural Resource Management (2006) Saguaro National Park General Management Plan and EIS (2008), Saguaro National Park Comprehensive Trails Management Plan and EA (2009), Saguaro National Park Fire Management Plan and EA, and Saguaro National Park Exotic Plant Management Plan and EA (2004).

E. Wilderness Character

Is action necessary to preserve one or more of the qualities of wilderness character including: untrammeled, undeveloped, natural, outstanding opportunities for solitude or a primitive and unconfined type of recreation, or unique components that reflect the character of this wilderness area?

Untrammeled: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain: No action is necessary to maintain the untrammeled wilderness character.

Undeveloped: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain: No action is necessary to maintain the undeveloped wilderness character.

Natural: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Disturbances including spread of invasive non-native plants degrade the natural character of the wilderness. Thus, actions are necessary to preserve and restore naturalness.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation:

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

Explain: No action is necessary to maintain the solitude or primitive wilderness character

Other unique components that reflect the character of this wilderness:

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Action is necessary to preserve the native vegetation community (enabling legislation) which also provides habitat and forage for wildlife.

F. Describe Effects to the Public Purposes of Wilderness

Is action necessary to support one or more of the public purposes for wilderness (as stated in Section 4(b) of the Wilderness Act) of recreation, scenic, scientific, education, conservation, and historical use?

Recreation: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Recreational use of trails and washes would be hindered if areas become unsafe after a large scale disturbance like fire or flooding, until areas are naturally stabilized. Additionally, trails may need to be closed to minimize the spread of invasive plant.

Scenic: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Visitor viewshed would be impacted by larger scale disturbances.

Scientific: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Continued degradation of the ecosystem could result in decrease future scientific study opportunities in the Sonoran Desert ecosystem.

Education: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain:

Conservation: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Actions are necessary to conserve the naturalness of Wilderness

Historical use: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain:

Step 1 Decision: Is any administrative action necessary in wilderness?

Yes: ☒ **No:** ☐ **More information needed:** ☐

Explain: Disturbances are occurring in Wilderness and are anticipated to continue and worsen. Thus, action is necessary to mitigate the disturbance to preserve and restore wilderness character.

If action is necessary, proceed to Step 2 to determine the minimum activity.

Step 2: Determine the minimum activity.

Please refer to the accompanying MRDG *Instructions* for an explanation of the effects criteria displayed below.

Description of Alternatives

For each alternative, describe what methods and techniques will be used, when the activity will take place, where the activity will take place, what mitigation measures are necessary, and the general effects to the wilderness resource and character.

Alternative #1 No Action (current management practices)

Description:

Continuation of current management practices using ground-based natural, prevention and outreach, manual, and mechanical treatments to implement restoration activities in response to small-scale disturbances. Tools currently used for revegetation include hand tools, wheel barrow, augers, punjars, and watering jugs. Current methods of invasive plant control include hand tools to manually remove plants and herbicides applied with backpack sprayers or brushes. Treatment areas for invasive plants are limited to accessibility, work efficiency and terrain (safety concern on steep, shale slopes). The furthest treatment areas are 1 mile (Euclidean distance) into Wilderness. Mules and helicopters are currently being used to delivery equipment, plants, supplies and water into Wilderness.

See attachment of the draft alternatives for more detailed description of the alternative.

Effects:

Wilderness Character

"Untrammeled"

Current restoration strategies and treatments will trammel Wilderness by: large numbers of staff working in Wilderness, setting up staging areas, applying herbicide, manually removing invasive plants, revegetation of disturbed sites such as social trails, seeding, post-fire mop-up such as felling trees, log check dams, see post disturbance restoration activities and treatment types table for actions proposed in Wilderness.

"Undeveloped"

Current restoration strategies and treatments will have temporary, short-term impacts on the undeveloped character of Wilderness by utilizing mules and helicopters to deliver water and supplies to staging areas, and temporary storage of supplies and equipment/tools and shade structure/staging areas, in Wilderness.

"Natural"

Current restoration strategies and treatments improve the naturalness of Wilderness by attempting to restore native vegetation/communities and natural ecosystem processes. Only a small portion of Wilderness disturbances are currently being addressed therefore naturalness in the remainder of Wilderness will continue to degrade.

"Outstanding opportunities for solitude or a primitive and unconfined type of recreation"

Current restoration strategies and treatments affect visitor solitude by the use of invasive plant crews and equipment staged in backcountry areas, some of which is deposited in the backcountry by helicopter. Recreational use of trails may have temporary closures if they fall within a project area and visitor safety would be compromised while restoration treatments are taking place.

"Other unique components that reflect the character of this wilderness"
Current restoration strategies and treatments enhance threatened and endangered species habitat and scientific opportunities to study the Sonoran desert by restoring and maintaining this ecosystem. However, much of the park and Wilderness areas will go untreated and restored.

Heritage and Cultural Resources
Current fuel reduction practices help reduce the risk of wildfire that may impact cultural resources.

Maintaining Traditional Skills
NA

Special Provisions
NA

Economic and Time Constraints
Economic and logistical issues of our current program prevent timely implementation of restoration treatments. For example, there are not enough personnel and resources during the short window of opportunity to treat invasive plant populations using the most effective treatment methods (i.e. herbicides).

Additional Wilderness-specific Comparison Criteria

Safety of Visitors, Personnel, and Contractors
Personnel safety prevents access to remote and difficult terrain disturbances on foot to implement ground-based restoration treatments.

Alternative # 2 Current management actions, with the addition of using aircraft as a delivery mechanism for large scale and remote disturbances

Description:

This alternative includes all activities and treatments listed under Alternative 1 and allows for actions beyond the scope of current management practices to accommodate implementing aerial application of restoration treatments on disturbed lands. It will also enable SNP to implement any scale (small or large) of restoration treatment, including in otherwise inaccessible areas of the Park. Under Alternative 2, aerial applications, in addition to ground-based restoration treatment types, would be available to aid in implementation of the treatments. This alternative includes using aircraft as a delivery method for restoration treatments including seeding, mulching, herbicide application, and site amelioration

See attachment of the draft alternatives for more detailed description of the alternative.

Effects:

Wilderness Character
"Untrammeled"
Current restoration strategies and treatments will trammel Wilderness by: large numbers of staff working in Wilderness, setting up staging areas, applying herbicide, manually removing invasive plants, revegetation of disturbed sites such as social trails, seeding, post-fire mop-up such as felling trees, log check dams, see post disturbance restoration activities and treatment types table for actions proposed in Wilderness. With the option of using aerial delivery as a mechanism for treatments more acres of would be trammeled.

"Undeveloped"
Current restoration strategies and treatments will have temporary, short-term impacts on the undeveloped character of Wilderness by utilizing helicopters to deliver water and supplies to

staging areas, and temporary storage of supplies and equipment (non-mechanized) and shade structure/staging areas, in Wilderness. Under alternative 2, more aircraft would be used to deliver treatments; however, that use would be offset by less ground activities such as staging areas.

"Natural"
Current restoration strategies and treatments improve the naturalness of Wilderness by restoring native vegetation/communities and natural ecosystem processes to limited areas. The use of aircraft to deliver treatments will allow for restoration treatments to be implemented over a much larger area. For example, invasive plant treatments would more than double current efforts.

"Outstanding opportunities for solitude or a primitive and unconfined type of recreation"
Current restoration strategies and treatments affect visitor solitude by the use of invasive plant management crews and equipment staged in backcountry areas, and aerial delivery of water and supplies. Under alternative 2, more aircraft would be used to deliver treatments; however, that use would be offset by less on the ground activity in Wilderness. Recreational use of trails may have temporary closures if they fall within a project area and visitor safety would be compromised while restoration treatments are taking place.

"Other unique components that reflect the character of this wilderness"
Current restoration strategies and treatments enhance threatened and endangered species habitat, and scientific opportunities to study the Sonoran desert by restoring and maintaining this ecosystem. Under alternative 2 we expect to restore more areas thus enhancing the benefits to threatened and endangered species habitat and scientific opportunities.

Heritage and Cultural Resources
Current fuel reduction practices help reduce the risk of wildfire that may impact cultural resources. With the option to use aerial application as a delivery mechanism for treatments, additional acres of fuel would be reduced.

Maintaining Traditional Skills
NA

Special Provisions
NA

Economic and Time Constraints
Economic and logistical issues of our current program prevent timely implementation of restoration treatments. For example, there are not enough personnel and resources during the short window of opportunity to treat invasive plant populations using the most effective treatment methods (i.e. herbicides) and for implementing post-fire restoration treatments pre-monsoon. Under alternative 2, aerial delivery mechanisms are more cost effective, can accomplish treatment activities in less time, and treat larger areas within the short window of opportunity.

Additional Wilderness-specific Comparison Criteria

Safety of Visitors, Personnel, and Contractors
Under alternative 2, fewer personnel would be exposed to hazardous conditions.

Comparison of Alternatives

It may be useful to compare each alternative's positive and negative effects to each of the criteria in tabular form, keeping in mind the law's mandate to "preserve wilderness character."

	Alternative A	Alternative B	Alternative C	No Action
Untrammeled	-	- -		
Undeveloped	-	-		
Natural	+	+ ++		
Solitude or Primitive Recreation	-	-		
Unique components	+	+ +		
WILDERNESS CHARACTER	-	+		

	Alternative A	Alternative B	Alternative C	No Action
Heritage & Cultural Resources	NA	NA		
Maintaining Traditional Skills	NA	NA		
Special Provisions	NA	NA		
Economics & Time	-	+		
Additional Wilderness Criteria	NA	NA		
OTHER CRITERIA SUMMARY	-	+		

	Alternative A	Alternative B	Alternative C	No Action
SAFETY	- -	-		

Safety Criterion

If safety issues override impacts to wilderness character or other criteria, provide documentation that the use of motorized equipment or other prohibited uses is necessary because to do otherwise would cause increased risks to workers or visitors that cannot be satisfactorily mitigated through training, use of personal protective equipment (PPE), or other requirements to alleviate the safety risk. (This documentation can take the form of agency accident-rate data tracking occurrences and severity; a project-specific job hazard analysis; research literature; or other specific agency guidelines.)

Documentation

For ground based activities job hazard analyses are in place for restoration, off-trail hiking, and herbicide application. For post-fire disturbances BAER teams may be available to implement some of the activities otherwise proper training would be required. There are inherent safety risks when work is performed off trail and in remote and difficult to access sites.

For aerial treatments, only certified and qualified pilots would implement the treatments. An aviation safety plan would be developed with the contractor.

Step 2 Decision: What is the Minimum Activity?

Please refer to the accompanying MRDG *Instructions* before describing the selected alternative and describing the rationale for selection.

Selected alternative:

Rationale for selecting this alternative (including documentation of safety criterion, if appropriate):

Monitoring and reporting requirements:

Check any Wilderness Act Section 4(c) uses approved in this alternative:

- ☐ mechanical transport
- ☐ motorized equipment
- ☐ motor vehicles
- ☐ motorboats
- ☐ landing of aircraft
- ☐ temporary road
- ☐ structure or installation

Record and report any authorizations of Wilderness Act Section 4(c) uses according to agency procedures.

Approvals	Signature	Name	Position	Date
Prepared by: (Project Manager)				
Recommended: (Division Chief)			Chief Ranger	
Recommended: (Division Chief)			Chief of Science and Resource Mgmt.	
Recommended: (Division Chief)			Chief of Facility Management	
Recommended: (Division Chief)			Fire Management Officer	
Recommended: (Division Chief)			Administrative Officer	
Approved: (Superintendent)			Superintendent	

Appendix E. Saguaro National Park Standard Mitigations for Field Activities to Protect Resources

General

Potential Impacts

Any and every time we go into the field we will impact *something*, much of it is unavoidable and negligible, but cumulatively people in the park impact resources, so we do our best to be aware of, and minimize, such impacts.

Mitigations

- Staff will use "leave no trace" practices, established "best management practices" and mitigations in the Herbicide Safety and Training Manual (Appendix C).
- Select equipment and techniques that are effective, but have minimal impacts to non-target resources and/or their impacts will be mitigated.
- Prevention, education and outreach programs for staff, volunteers and visitors.
- Depending on the type of project field personnel will be trained to:
    - identify non-native plants from native plants
    - identify sensitive plant and animal species
    - identify sensitive habitats (eg, riparian/surface water)
    - mitigate impacts to wildlife, especially sensitive species or places (riparian), or at sensitive times (ie nesting or during temperature extremes)
        - lesser long-nosed bat
            - Palmer's agave (4,000-6,500') specifically, must not be impacted or removed
        - southwestern willow flycatcher and other riparian species (lowland leopard frog, whiskbroom, yellow-billed cuckoo, gray hawk, common black-hawk, giant spotted whiptail)
        - cactus ferruginous pygmy-owl
        - High elevations (American peregrine falcon, buff-breasted flycatcher, northern goshawk)
        - Upland Sonoran desert (saguaro, organ pipe cactus, Tumamoc globeberry)
        - Nocturnal – many bats & groundsnake
        - Bears (camping; get handout)

Physical Resources – Soils & Water (Ground and Surface Water Quality & Quantity)

Potential Impacts

- Disturbance of surface organic matter by hiking/trampling, digging, planting, mechanical equipment, etc.
- Soil destabilization and/or compaction.
- Erosion and sedimentation from soil disturbance.
- Destruction of soil crusts, structure and chemistry by digging or introduction of soils.
- Contamination of soil and/or water from chemicals.

Mitigations

- Minimize number of people traveling cross-country.

- Use roads, trails, game trails or other impacted areas as routes when possible.
- When no trails exist, identify and use access route(s) that cause minimum disturbance to sensitive soils (microbiotic soil crusts) and vegetation.
- Determine whether single or multiple paths would cause least impact, and act accordingly.
- Avoid soil disturbing treatments on slopes >45° or on highly erodible soils.
- Refill any holes and other depressions created during restoration activities.
- Replace and tamp down removed and/or disturbed soils.
- Remove invasive non-native plants.
- Stabilize disturbed soils and/or recreate natural surface flow with mulch, wattles, channel treatments, etc.
- Select staging areas to minimize the potential of impacting soil or vegetation.
- For materials to be delivered by helicopter, the unloading zone in the field will be scouted ahead of time, cleared of vegetation, and be at least 20 feet in diameter. The unloading zone will be marked for visibility by the pilot and wind direction flags will be established.
- Select herbicides with Relative Aquifer Vulnerability Evaluation (RAVE) scores below 60 or develop and implement mitigations to prevent groundwater contamination.
- Wilderness-compatible techniques and tools (i.e., hand tools) will be used to conduct all backcountry maintenance, rehabilitation, and restoration work whenever possible.
- Use aquatic formulations of herbicides near water.
- The following criteria apply to removing water from any drainage in the park, and/or to working in or around drainages, or natural surface water:
    - The source must be a stream or actively flowing pool (i.e., overflowing or recharging).
    - The pool/water source must not be diminished by any more than 25% on any one day, so the pool is allowed to recharge/fill.
    - No more than 200 gallons may be taken from a given source.
    - Sediment must not be disturbed
    - Only contaminant-free containers and equipment may be used for collecting water.
    - Employees must remove any PPE (personal protective equipment) that may be contaminated with chemicals or other pollutants that may come into contact with the water (i.e., gloves). Employees should be vigilant about any other sources of contamination, and address them accordingly.
    - Water must be strained, and any plant or animal (including visible invertebrates) must be filtered out and returned to the water body.
    - Any pool with leopard frogs present must not be disturbed.

Biological Resources - Vegetation & Wildlife, including Special Status Species

Potential Impacts

- Trampling, damage and destruction of native vegetation (wildlife habitat), especially small cactus or herbaceous plants.
- Disturbing wildlife and damaging or destroying wildlife habitat (nests, burrows, middens, shelter sites, loafing areas, etc.) by ground crews or aircraft.
- Ensnaring wildlife, especially reptiles, in fencing or barriers.
- Spraying non-target native plants and animals (especially invertebrates) with herbicides.

Mitigations

- When needed or requested, a park biologist will provide project personnel with an orientation/briefing about relevant threatened and endangered species, and other applicable natural resource issues.
- Use aquatic formulations of herbicides near water.
- Removal or impact to native vegetation will be minimized to the greatest extent possible.
- Every attempt will be made to avoid impacting any saguaro (*Carnegiea gigantea*). If saguaros less than 4' will be affected, they must be transplanted. Impact to saguaros greater than 4' requires additional assessment and/or mitigation measures, including salvage if possible.
- Any cactus other than prickly pear and cholla (*Opuntia spp*.) that need to be removed will be salvaged and transplanted in a new location.
- The best methods of restoration for a particular disturbed area should be evaluated on a case-by-case basis.
    - Revegetate disturbed areas, or cover the bare soil with local litter and duff mulch as soon as possible (mulch provides a source of seeds to reestablish native vegetation, and it reduces the risk of invasive plant seeds from germinating). Ideally, the litter and duff should be collected from surrounding areas, but do not denude the collection area.
- Minimize the introduction of invasive plants from outside sources into the park, and the spread of invasive plants within the park.
    - Except in emergencies, all equipment originating outside the park (e.g, backhoes, tractors, loaders, excavators, dozers, bobcats, wheeled compressors, helicopter skids, trucks and trailers that have traveled off-road) will be pressure or steam-washed prior to entry into the park to remove invasive weed seeds and seed-containing soil/material that may adhere to the equipment.
    - Construction and restoration materials (i.e., boulders, soil, sand, gravel, road base, straw, and erosion control materials) must be inspected before bringing them into the park.
- Crews will be trained to minimize disturbance to local wildlife (eg, knowing potential on-ground or aircraft "disturbance zone" for various species), and caution will be exercised at worksites and vicinity to not disturb wildlife species (reptiles, migratory birds, raptors, or bats) found nesting, hibernating, estivating, or otherwise inhabiting the area.
- Resource Management personnel shall be notified/consulted when any wildlife must be disturbed or handled.
- For any projects involving trenching or digging holes, provisions (generally in the form of ramps with a slope < 45°) must be made every 20-50' to allow for the escape of animals that may fall into these recesses; or these areas must be covered in a manner that prevents animals (vertebrates) from falling into them.
- When possible use fencing, mesh and other materials that have holes smaller than the head of a native reptile or that will not attract cavity nesting birds (i.e., tubes).
- Always check for animals, especially reptiles, under vehicles after they have been parked for a while before moving them.
- Any tortoise encountered or known to be in a burrow, must not be disturbed. Tortoises seek shelter in burrows which are usually found on rocky slopes below boulders and rocks.

- If a tortoise's burrow is accidentally destroyed, the tortoise should be relocated to the nearest appropriate alternative burrow (consult with RM staff).
- If tortoises are encountered at worksites (or elsewhere), they should not be disturbed unless they are in the path of imminent danger.
- If in imminent danger, tortoises can and should be moved out of harm's way per protocols:
    - Desert tortoises should be moved no further than necessary (less than 0.5 mile from their original location), and should be handled as little as possible.
    - To move a tortoise, approach it from the front, giving it time to retract and prepare for an encounter. Grasp the tortoise gently but firmly with both hands: one on either side of the tortoise, between their front and back legs, and keep it in its normal orientation at all times. ***Do not turn a desert tortoise upside down!*** These steps will minimize the potential for the tortoise to void its bladder and lose its precious water store. Tortoises should be moved in the direction they were facing (on the other side of any nearby road it was headed towards), and placed in a shaded, protected site. Separate disposable gloves should be worn for each tortoise handled to avoid potential transfer of disease between tortoises. If a release site or alternate burrow is unavailable within this distance, and ambient air temperature exceeds 105° F, RM staff should be contacted.
- In circumstances when it is deemed necessary to conduct activities near sites known to support threatened or endangered species, work will be performed in a way (specified by the park's wildlife biologist) to minimize impacts to relevant listed species.
- When the breeding status of Mexican spotted owls (MSO) are unknown, it will be assumed that the owls are breeding, and appropriate action (or inaction) and/or conservation measures implemented.
- Work will not occur in Mexican spotted owl Protected Activity Centers (PACS) during their breeding season (March 1 – September 31), unless further analyzed/ assessed/mitigated.
- When it is necessary to work within MSO PACS during the breeding season (March 1 – September 31):
    - all work will be conducted from/along existing trail corridors.
    - no MSO habitat features [i.e., large (>18" dbh) trees and snags and large down logs, multi-storied vegetation and dense canopy] will be disturbed.
    - work will be conducted in groups of five or less.
    - crews will work in a given PAC no longer than three consecutive days without a week long break.
    - less than ¼ mile of new trail construction or trail reroute shall occur in (all) MSO PACs in a given year.
    - work is to be conducted with hand tools only (no motorized/power tools).
    - activities will have minimal impact on the environment (per evaluation of a trained biologist), especially with regard to cutting trees (especially above 6,000').

Appendix F. Herbicide Toxicity Information

Herbicide formulations (the active ingredient plus inert ingredients are evaluated by the Environmental Protection Agency (EPA) at the time of registration.

Each herbicide formulation (also referred to as the brand name product) is assigned a toxicity category and a signal word. Toxicity is the degree to which a substance or formulation can harm living things. A product's signal word ("Poison", "Danger", "Warning", "Caution" or "None Required" (however "Caution" is often used) is determined by the most severe toxicity category assigned (EPA 2012).

The active ingredients and inert or other ingredients are stated as a percent on the product label. Active ingredients are the chemicals that actively kill or damage the plant. The inert ingredients are not required by law to be listed on the label. The inert ingredients serve another purpose in the effectiveness of the herbicide. Inert ingredients do not mean that they are non-toxic (**National Pesticide Information Center** 2013).

The toxicity of an herbicide formulation depends on both the active and other ingredients. Several different types of toxicity are considered. .*Acute* toxicity involves harmful effects in an organism through a single or short-term exposure. *Chronic* toxicity is the ability of a substance or mixture of substances to cause harmful effects over an extended period, usually upon repeated or continuous exposure sometimes lasting for the entire life of the exposed organism. *Subchronic* toxicity is the ability of the substance to cause effects for more than one year but less than the lifetime of the exposed organism. Acute toxicity studies examine a product's toxicity as it relates to six different types of exposures (acute oral, acute dermal, acute inhalation, primary eye irritation, primary skin irritation, and dermal sensitization). The product is assigned a toxicity category (I–IV; high to low toxicity) for each type of exposure based on the experimental results (Table 1). The sixth study, for dermal sensitization, evaluates the potential for allergic contact dermatitis. Its results are either positive or negative, and do not affect the signal word; determined by the most severe toxicity category assigned to any of the five acute toxicity studies (EPA 2012). None of the herbicides proposed for use in the park, are categorized as danger or poison.

Table 2 summarizes the toxicity information for herbicides proposed for use in the park. It describes the overall herbicide toxicity and oral lethal doses or concentrations to rats, birds, and fish and dermal lethal dose to rabbits. Definitions are provided by EPA **(**http://www.epa.gov/pesticides/index.htm).

- **Lethal Dose 50 Definition** A statistically derived single dose that can be expected to cause death in 50% of the test animals when administered by the route indicated (oral, dermal, inhalation). It is expressed as a weight of substance per unit weight of animal, e.g., mg/kg
- **Lethal Concentration 50 Definition:** A statistically derived concentration of a substance that can be expected to cause death in 50% of test animals. It is usually expressed as the weight of substance per weight or volume of water, air or feed, e.g., mg/l, mg/kg or ppm.

EPA 2012. http://www.epa.gov/oppfead1/labeling/lrm/chap-07.pdf).
National Pesticide Information Center. 2013. Inert or "Other Ingredients Topic Fact Sheet.
http://npic.orst.edu/factsheets/inerts.html

Table 1. Toxicity studies, categories and signal words.

Toxicity Categories Study	**Category I**	**Category II**	**Category III**	**Category IV**
Acute Oral	Up to and including 50 mg/kg	> 50 thru 500 mg/kg	> 500 thru 5000 mg/kg	> 5000 mg/kg
Acute Dermal	Up to and including 200 mg/kg	> 200 thru 2000 mg/kg	> 2000 thru 5000 mg/kg	> 5000 mg/kg
Acute Inhalation	Up to and including 0.05 mg/liter	> 0.05 thru 0.5 mg/liter	> 0.5 thru 2 mg/liter	> 2 mg/liter
Primary Eye Irritation	Corrosive (irreversible destruction of ocular tissue) or corneal involvement or irritation persisting for more than 21 days	Corneal involvement or other eye irritation clearing in 8-21 days	Corneal involvement or other eye irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Primary Skin Irritation	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hours (moderate erythema)	Mild or slight irritation at 72 hours (no irritation or slight eythema)
SIGNAL WORD	DANGER	WARNING	CAUTION	NONE REQUIRED (often use CAUTION)

Table 2. Herbicide Toxicity

Active Ingredient (Brand Names)	EPA Toxicity Level & Signal Word	Oral LD50 - Mammals (Rats)	LD50 - Birds (BW - bobwhite quail, M - mallards)	LC50 - Fish (bluegill sunfish)	Dermal LD50 - Rabbit
2,4 D acid, salt, esters[1,2] **(Aqua-Kleen, Barrage, Weedone)**	III-IV Caution	764 mg/kg [low]	500 mg/kg (BW) [moderate]	263 mg/L [moderate]	>2000mg/kg
Aminopyralid (Milestone)	IV Caution	Oral LD50 has not been determined because aminopyralid does not cause any mortality at the dose limits set by the U.S. EPA for acute oral toxicity studies (>5000 mg/kg).	2250 mg/kg (BW) [moderate], > 5620 mg/kg (M)	> 100 mg/L	>5000 mg/kg
Clopyralid[1, 2] **(Curtail, Transline, Reclaim, Redeem)**	III Caution	4300 mg/kg [low]	> 4640 mg/kg (BW), 1465 mg/kg (M) [low]	125 mg/L [moderate]	>2000 mg/kg
Dicamba[1,2] Acid and salt formulations (Banvel, Vanquish)	III Caution	500 to >4600 mg/kg (dependent on formulation)	216 mg/kg (BW), 1373 mg/kg (M) more variablility depending on formulation	28-516 mg/L	>2000 mg/kg
***Triclopyr**[1] (Garlon4, Remedy); formulations bButoxyenthyl ester (BEE) and triethylamine salt (TEA)	III Caution	713 mg/kg [low]	2934 mg/kg (BW), 1,698 mg/kg (M) [low]	148 mg/L [moderate]	>2000 mg/kg
Glyphosate[1] (terrestrial formulations: Roundup Pro Kleenup Pro; aquatic formulations: Rodeo, Aquamaster)	IV Caution	5600 mg/kg [slight]	>4640 mg/kg (BW) [low]	120 mg/L (terrestrial) [moderate] and > 1000 mg/L (aquatic) [non toxic]	>5000 mg/kg
Imazapic[1] (Plateau, Cadre, Plateau Eco-Paks)	III Caution	> 5000 mg/kg [slight]	> 2150 mg/kg (BW/M) [low]	> 100 mg/L [moderate]	>5000 mg/kg
Imazapyr[2] (Arsenal, Chopper)	III Caution	> 5000 mg/kg [slight]	> 2150 mg/kg (BW) [low]	>100 mg/L [moderate]	>2000 mg/kg

[1] Herbicides approved for use under the Exotic Plant Management Plant and EA (2004).

[2] Not currently being used in the part however, potential future uses.

Appendix G. Herbicide Properties and Behavior in the Environment

Active ingredients in herbicides have physical properties which influence how the herbicide acts in the environment. The properties are indications of the herbicide behavior in soils, water and air. The properties are for the active ingredient, not for the formulated trade names. The table below list the properties for the herbicides that will be used at Saguaro National Park. The references used to compile the table were not always consistent. Therefore, either the maximum value or a range of values was listed.

The behavior of herbicides in soil is dependent on herbicide chemistry, soil texture, soil moisture, pH, soil temperature, herbicide dose, amount of organic matter in the soil, and clay content of the soil. The fate of herbicides in soils depends on factors such as the ability of the herbicide to attach to soil molecules or organic matter in the soil (sorption), chemical transformation, persistence, mobility, and conversion to a gas phase (volatilization).

Herbicides in soil can undergo transformation by different types of degradation including by light (photodegradation), and degradation by biological and chemical processes (Senseman 2007). Herbicide persistence is measured in half-life which is the measure of how long it takes for half of the chemical to degrade. Herbicides are typically considered non persistent if soil half-life is less than 30 days, moderately persistent if typical soil half-life is 30 to 100 days and persistent if typical soil half-life is greater than 100 days (Kerle and others 2007). Warm temperatures and moist soil usually accelerate herbicide degradation (Kerle and others 2007).

Soils high in clay content and organic matter have many sites where herbicide can be bound, but soils high in sand content and low in clay content and organic matter do not. Soil sorption coefficient (Kd) and soil organic carbon sorption coefficient (Koc) provide an average or typical Koc, which can vary with different soil properties. Kd and Koc are most often used for general trends, and the values tend to increase with an increase in the percent of clay and organic matter (Senseman 2007). Abundance of tiny soil and organic matter particles (soil colloids), and the solubility and ionization properties of a herbicide determine its sorption value in that type of soil. In general, the lower the soil sorption, the greater the herbicide's water solubility, and the greater the mobility of the herbicide in and through the soil (Ross and Lembe 2009). Water is a significant factor in the movement of herbicides into and on soils through runoff potential and leaching.

Volatilization occurs as the herbicide moves into a gaseous phase during application or after the herbicides is deposited on the plants or soil surface. Herbicides with high vapor pressures are likely to escape from the soil and volatilize into the atmosphere. Volatilization of an herbicide from moist soil is determined by the moisture content of the soil and by the herbicide vapor pressure, sorption and water solubility. For dry soil, volatilization is determined by sorption and vapor pressure (Kerle and others 2007).

The behavior of herbicides in water is dependent the solubility of the herbicide in water. The lower the solutility the greater the potential for leaching. Leaching potential can be influenced by the half-live of active ingredient in water and how quickly the herbicide degradates. One guide to help evaluate the leaching potential and groundwater contamination potential is the Relative Aquifer Vulnerability Evaluation (RAVE). The RAVE guidence Saguaro National Park used was adapted from the Users Guide for the Vegetation Management Risk Assessment - Risk Assessment for Herbicide Use in Forest Service, Regions 1,2,3,4, and 10 and on Bonneville Power Administration Sites (1992). The USFS adapted their

Kerle, E.A., J.J. Jenking, and P.A. Vogue. 2007 Understanding pesticide persistence and mobility for groundwater and surgace water protection. Oregon State University Extension Service. EM8561-E.
Senseman, S.A. 2007. Herbicide Handbook, 9th ed. Lawrence, KS.: Weed Science Society of America. 458 p.

RAVE from the Montana Department of Agriculture, Environmental Management Division. RAVE is designed only as a guidance system and does not replace the need for safe and judicious herbicide application required in all situations.

Wetlands, streams, and areas of the park where groundwater is within 20 feet of the surface are particularly vulnerable to herbicide contamination and thus require special consideration prior to any herbicide application. The use of the score card may indicate whether an alternative herbicide should be used within a given area or if the area is not suited to herbicide applications and other control methods should be used.

Several major factors determine the relative vulnerability of groundwater to herbicide contamination. Nine of these factors have been incorporated into the RAVE score card and are defined below. A value for most of these factors can be determined by a simple on-site inspection.

Factor Definitions

Depth to Groundwater:	Distance in vertical feet below the soil surface to the water table.
Soil Texture:	Soils predominately gravelly, sandy, loamy, or clayey.
Percent Organic Matter:	The relative amount of decayed plant residue in the soil may be estimated by soil color; darker soil generally indicates higher organic matter. At the Tucson Mtn. District, the soils have less than 1% organic matter. At the Rincon Mtn. District, the soils have less than 3% organic matter.
Topographic Position:	Physical surroundings of the field to which the herbicide application is to be made. *Flood Plain* = within a river or adjacent to a spring such as Rincon Creek, Italian Spring (vegetation is composed of wetland species such as sedges and willow); *Alluvial Fan or Bench* = lands immediately above a river or stream but may still have some riparian vegetation such as a mesquite bosque; *Foot Hills* = rolling uplands near mountains; *Upland Plains* = high plains not immediately affected by open water or mountains.
Distance to Surface Water:	Distance in feet from treatment boundary to the nearest flowing or stationary surface water.
Annual Precipitation:	Over 60” annual precipitation, 30-60” annual precipitation, less than 30” annual precipitation on the treatment site. All of the park is less than 30" annual precipitation.
Herbicide Application Frequency:	Number of times the particular pesticide is applied during one growing season.
Herbicide Application Method:	Whether the herbicide is applied to the soil or to the plant.
Herbicide Leachability:	A relative ranking of the potential for an herbicide to move downward in soil and ultimately contaminate groundwater based upon the persistence and mobility of the herbicide.

THE RAVE SCORE CARD

Depth to Groundwater:
*2-10 ft. 20
10-25 ft. 12
25-50 ft. 5
>50 ft. 0

Annual Precipitation:
> 60" 5
30-60" 2
<30" 0

Soil Texture:
Gravelly 15
Sandy 15
Loamy 10

Herbicide Application Frequency:
> 1/year 5
1/year 2
< 1/year 1

Percent Soil Organic Matter
0-1% 5
** 1-3% 3
>3% 2

Herbicide Application Method:
Applied to Soil 5
Applied to Foliage 2

Topographic Position:
Flood Plain 15
Alluvial Bench 10
Upland Habitat 5
Transition zone 2

Herbicide Leaching Potential
Large 20
Medium 10
Small 5

Distance to Surface Water:
0-100 ft. 5
100-500 ft. 3
>500 ft. 2

Total all Rankings for the Site and Herbicide in Question here: _____ = RAVE Score

* If water table is less than 2 feet deep then applications should not be made or possibly done with a wick or wand applicator, but only for a herbicide that can be used with that method in wetland habitat.
** If unknown, use this value.
Note: Some products are used in very small quantities. In cases where less than ½ pound AI per acre is applied, it would be reasonable to reduce the final RAVE score by 2-5 points.

Higher numbers indicate high vulnerability of groundwater to contamination by the herbicide used in the evaluation. RAVE scores greater than or equal to 65 indicate a potential for groundwater contamination. Saguaro NP will always be evaluating information to determine herbicides that maybe appropriate. A RAVE score of 80 or greater indicate that herbicide applications should not be made at this location with the proposed product. Scores between 45 and 65 indicate a moderate to low potential for groundwater contamination and scores less than 45 indicate a low potential for groundwater contamination by the herbicide in questions. Even in such cases, careful use of herbicides and following label instructions is imperative to protect groundwater.

Table 1. Herbicide RAVE Scores

Herbicide	Soils		Water					Air
Active ingredient , formulation and suggested brand names	**Average Soil Half-life**	**Soil Sorption (Koc)**	**Water Solubility**	**Average Half-life in Water**	**Potential for Leaching**	**Relative Aquifer Vulnerability Evaluation Score**	**Degradation Mechanism**	**Volitization (mm Hg at 25° C)**
HERBICIDES FOR GROUND-BASED APPLICATION ONLY								
*** 2,4 D acid, salt, esters**[1,2] (Aqua-Kleen, Barrage, Weedone)	10 days	20 mL/g (acid and salt); 100 mL/g for esters	900 mg/L (acid); 796 g/L water (salt); 100 mg/L (ester)	Varies from hours to months.	High[a]; potentially mobile but rapid degradation in soil and removal from soil by plant uptake minimizes leaching.[b]	45	microbial and photo	negligible to minor 1.47×10^{-7} (acid), 3.98×10^{-8} (salt), 1.02×10^{-5} to 5.29×10^{-6} (ester).
*** Aminopyralid** (Milestone)	103.5 days	weakly adsorbed; 1.05 to 24.3 mL/g	2480 mg/L	Surface water breakdown in less than 24 hours.	NA [a]; Moderate leaching potential. Field experiments showed limited movement in the soil profile[b]; High [c]	39 (uplands) and 64 (drainages)	microbial and photo	extremely low; 1.92×10^{-10}
***Clopyralid**[1, 2] (Curtail, Transline, Reclaim, Redeem)	40 days	6 mL/g ranges to 60 mg/L because of increased soil sorption with time	1,000 mg/L (acid)	8-40 days	High[a]; Moderate leaching potential[b]	39 (uplands) and 49 (drainages)	microbial	Insignificant; 1×10^{-5}
***Dicamba**[1,2] Acid and salt formulations (Banvel, Vanquish)	Less than 14 days but may persist longer under conditions of low moisture and rainfall and soil types.	Weakly adsorbed 2 mL/g	4,500 mg/L (acid)		High[a]; Low to medium leaching potental. Low potential for runff due to rapid degradation[b]	35	Metabolized to CO2 in aerobic soils and degrades more slowly in anaerobic soils	9.2×10^{-6}

Herbicide	Soils		Water					Air
Active ingredient , formulation and suggested brand names	**Average Soil Half-life**	**Soil Sorption (Koc)**	**Water Solubility**	**Average Half-life in Water**	**Potential for Leaching**	**Relative Aquifer Vulnerability Evaluation Score**	**Degradation Mechanism**	**Volitization (mm Hg at 25° C)**
***Triclopyr**[1] (Garlon4, Remedy); formulations bButoxyenthyl ester (BEE) and triethylamine salt (TEA)	30 days; ranging from 10-46 days depending on soil type, moisture and temperature	20 mL/g (salt) and 780 mL/g (ester)	430 mg/L (acid): 23 mg/L (ester); 2,100,000 mg/L (salt)	2.8 – 14.1 hrs (acid); 16.7 – 83.4 hrs (ester)	Medium[a]; NA[b]	39 (uplands) and 71 (drainages)	microbial and photo	Negligible; 1.26×10^{-6}
HERBICIDES FOR GROUND-BASED AND AERIAL APPLICATION								
Glyphosate[1] (terrestrial formulations: Roundup Pro Kleenup Pro; aquatic formulations: Rodeo, Aquamaster)	60 days, depends on soil and climate conditions	24,000 mL/g	15,700 mg/L (acid), 900,000 mg/L (ipa salt)	12 days to 10 weeks	Low[a]; Low mobility in most soils[b]	42 (uplands) and 50 (drainages)	microbial in soils and water	Negligible losses 1.84 $\times 10^{-7}$ (acid) to 6.75×10^{-8} mmHg
Imazapic[1] (Plateau, Cadre, Plateau Eco-Paks)	120 days	206 mL/g	2200 mg/L	<8 hours	High[a]; Retained in top 30-45 cm of soil. Field studies do not indicate potential to move with surface water[b]	50 (pre-emergent) and 52 (post-emergent)	microbial and photo	Negligible; $<1 \times 10^{-7}$

Herbicide	Soils		Water					Air
Active ingredient , formulation and suggested brand names	**Average Soil Half-life**	**Soil Sorption (Koc)**	**Water Solubility**	**Average Half-life in Water**	**Potential for Leaching**	**Relative Aquifer Vulnerability Evaluation Score**	**Degradation Mechanism**	**Volitization (mm Hg at 25° C)**
Imazapyr[2] (Arsenal, Chopper)	25-142 days depending on soil type and environmental conditions	30.6-100 mL/g	11,100 mg/L	3-5 days	High[a]; Generally remains within the top 50 cm of soil in field dissipation studies[b]	50	microbial and photo	Insignificant; $<1 \times 10^{-7}$

[a] Montana State University Extension Service . 1990. RAVE: Relative Aquifer Vulnerability Evaluation. An on-farm scoring system to evaluate aquifer vulnerability to pesticide contamination. 2nd Ed. (Appendix RAVE)
[b] Senseman. S.A. ed. 2007. Herbicide Handbook ninth edition. Weed Science Society of America. Lawrence, KS.
[c] Thurston County Washington Public Health and Social Services (http://www.co.thurston.wa.us/health/ehipm/terrestrialreviewhtml accessed October 2012)
[1] Herbicides approved for use under the Exotic Plant Management Plant and EA (2004).
[2] Not currently being used in the part however, potential future uses.

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