United States
Department of
Agriculture

Forest
Service

**Southwestern
Region**

Environmental Assessment for Integrated Treatment of Noxious or Invasive Plants

Tonto National Forest

Gila, Maricopa, Pinal, and Yavapai Counties, Arizona

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Summary

The Tonto National Forest (Tonto NF) proposes to conduct control treatments for invasive plants throughout the area of the National Forest. The project area is located on approximately 2.9 million acres in central Arizona and is within the Tonto NF. This action is needed, because of the occurrence of noxious weeds on and adjacent to the Forest, whose populations are growing exponentially, and to meet the requirements of law, regulations, and policy.

The proposed action is to use the approach of Integrated Vegetation Management to manage invasive plant species on the Tonto NF. The Forest would use the complete range of methods associated with integrated vegetation management to eradicate or contain and control populations of invasive species. These control methods include manual/mechanical techniques, burning/flaming, cultural methods, biological control agents, and herbicides. Monitoring, prevention, education, and cooperation with other land managers are also incorporated into this proposal.

In addition to the proposed action, the Forest Service also evaluated the following alternatives:

Alternative 1: No Action (continue ongoing treatments). This alternative allows all previous decisions regarding treatment of noxious weeds on the Tonto NF to continue. There are: manual treatments forestwide, torching areas less than ten acres in size adjacent to roads, herbicide use in areas allowed by categorical exclusion (administrative & recreation sites), treatment of yellow starthistle and diffuse knapweed by prescribed fire and herbicide at the Pleasant Valley Ranger Station, continuation of a burn program for Malta starthistle along SR 188, and use of herbicides along federal and state highways as approved in a decision notice dated May 2004 (U.S.F.S.). No new weed treatments are proposed.

Alternative 2: Integrated Vegetation Management Excluding the Use of Herbicides. This alternative provides for use of mechanical, manual, prescribed burning/flaming, cultural and biological control agents to manage existing invasive plant populations and to control new infestations, as they occur.

Based upon the effects of the alternatives, the responsible official will decide

- Whether the proposed action would result in significant environmental effects that would require the preparation of an Environmental Impact Statement, or if there is a finding of no significant impact.
- If significant impacts are not anticipated, the Forest Supervisor will determine whether the proposed action will proceed as described above, as modified by an alternative, or not at all.
- Mitigation measures and monitoring requirements to be implemented by the Forest Service.
- If the project requires a Forest Plan amendment.

Chapter 1 – Purpose and Need

Document Structure

The Forest Service has prepared this Environmental Assessment in compliance with the *National Environmental Policy Act* (NEPA) and other relevant federal and state laws and regulations. This Environmental Assessment discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. The document is organized into four parts:

Introduction: The section includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for achieving that purpose and need. This section also details how the Forest Service has informed the public of the proposal and how the public responded.

Alternatives, including the Proposed Action: This section provides a more detailed description of the agency's proposed action, as well as alternative methods for achieving the stated purpose. These alternatives were developed based on significant issues raised by the public and other agencies. This discussion also includes possible mitigation measures. Finally, this section provides a summary table of the environmental consequences associated with each alternative.

Environmental Consequences: This section describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by resource area. Within each section, the affected environment is described first, followed by the effects of the No Action Alternative that provides a baseline for evaluation and comparison of the other alternatives that follow.

Agencies and Persons Consulted: This section provides a list of preparers and agencies consulted during development of the environmental assessment.

Appendices: The appendices provide more detailed information to support the analyses presented in the environmental assessment.

Additional documentation, including more detailed analyses of project-area resources, may be found in the project planning record located at the Tonto NF Supervisor's Office in Phoenix, Arizona.

Background

The National Invasive Species Council defines "invasive species" as a species that is 1) nonnative (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health (*Executive Order 13112*). A native species is a species that (other than one established as a result of an introduction) historically occurred or currently occurs in an ecosystem (*Federal Register*, 1999).

Arizona Administrative Codes R3-4-244 & R3-4-245 (Arizona Dept. of Agriculture, 2006) regulate certain invasive species in the state: "A noxious weed is defined as any species of plant that is detrimental or destructive and difficult to control or eradicate and includes plant organisms found injurious to any domesticated, cultivated, native or wild plant." The former director of Arizona's noxious weed program uses five categories to describe noxious weeds: 1) exotic, 2) invasive, 3) competitive, 4) persistent, and 5) aggressive (Northam, 2004).

Invasive weeds were first noticed on the Tonto NF in the mid-to-late 1980s with the discovery of yellow starthistle on private land in the community of Young by Francis Cline. Mr. Cline, family members, and others in the community formed the Tonto Weed Management Area. They have enlisted the help of various agencies and organizations as cooperators to provide resources for control of weed infestations that have appeared in Pleasant Valley and Gila County.

Invasive plant control projects on the Tonto NF up to the present time have involved only very limited manual grubbing projects and application of herbicides along state and federal highway rights-of-way by the Arizona Department of Transportation, until 2003. In the summer of 2003, a Noxious Weed Program Manager was hired by the Tonto National Forest. The first large-scale project by the Tonto NF was a prescribed burn of Malta starthistle along State Highway 188. This infestation was possibly introduced in the mid-1980s, and had already spread significantly beyond the right-of-way in 2003. Projects since that time have included a follow-up to this burn, additional prescribed burns, weed control projects in Forest campgrounds, use of herbicides along federal and state highway rights-of-way, and manual grubbing of weeds in many locations throughout the Tonto NF. Funding levels have been low and are not expected to increase in the near future, despite noxious weeds being one of the four major threats to National Grasslands and Forests recognized nationally by the Chief of the Forest Service. The Forest depends upon special funding sources and grants to accomplish weed control projects. Volunteers are an important part of the Tonto NF's invasive plant control program.

Control projects of the scale and type conducted by the Tonto NF have not been adequate to prevent weed infestations from increasing. The wet winter and spring of 2004 to 2005 resulted in a population explosion of Malta starthistle, Saharan mustard, and red brome at lower elevations; and yellow starthistle, bull thistle, and diffuse knapweed on the higher elevation ranger districts. Some wildfires have allowed the invasion of bull thistle (Rodeo-Chediski Fire of 2002), Siberian elm, tree of heaven, and Jerusalem thorn (Cave Creek Complex Fire of 2005), Malta starthistle (Edge Fire of 2005), and black mustard (Willow Fire of 2004).

The Tonto NF has not been intensively surveyed for noxious weeds. Populations of some noxious weeds have been known for nearly 30 years and have spread considerably, since they were first identified. Others are still being found in small infestations. Opportunities such as funding from post-wildfire, long-term rehabilitation projects have been used to complete more extensive surveys and control new infestations. Both long-term and Burned Area Emergency Rehabilitation (BAER) funds have been used to conduct weed surveys in the areas of the Rodeo-Chediski, Picture, Willow, Diamond, Webber, Edge, and Cave Creek fires. ADOT funding has been used to conduct surveys along state and federal highways in preparation for highway reconstruction or maintenance projects.

Much of the Tonto NF's efforts in the weed management program have been directed toward education and awareness of Forest Service employees, regional Incident Management Teams, special interest groups, and the public. The emphasis of these presentations has been prevention of weed spread and identification of invasive and noxious weeds on the Forest. The Forest is developing relationships with surrounding land managers and other agencies and organizations that operate within the boundaries of the National Forest to work cooperatively on weed control strategies and projects.

The Tonto NF works cooperatively with two Weed Management Areas on projects within and near the National Forest: the Tonto Weed Management Area, based in Young, Arizona, whose boundaries are defined by the Tonto Natural Resource Conservation District (NRCD); and the Central Arizona Weed Management Area, which encompasses all of Maricopa and some of Pinal

County. In 2004, the Tonto NF assisted in writing a grant for the Tonto Weed Management Area to receive an $85,000 Resource Advisory Committee grant to map weeds in Gila County. Activities with the Central Arizona Weed Management Area have included field trips, information sharing, public education, work on an invasive plant curriculum for elementary schools in central Arizona, and contribution of in-kind labor for start-up grants.

The Tonto NF has a close working relationship with the Arizona Department of Transportation (ADOT). Forest staff works together with ADOT and communicates regularly on routine roadside vegetation maintenance. In 2007, the Tonto NF, ADOT, and the Federal Highway Administration (FHWA) included noxious weed control specifications in two new highway construction contracts, which was a completely new concept according to Bonnie Harper Lore, former Restoration Ecologist for FHWA (Brady, 2007). Since 2007, noxious weed prevention and control clauses have become regular specifications in highway construction contracts that take place within the boundary of the Tonto NF.

Purpose and Need for Action

The purpose of the proposed action is to contain, control, or eliminate populations of noxious weeds and invasive plants occurring on the Tonto NF and to prevent new infestations from becoming established. A list of invasive species to be addressed by this action is included as table 1. This action is needed because populations of noxious weeds are growing rapidly on and adjacent to the Forest and the requirements of law, regulations, and policy for noxious weeds need to be met.

Existing Conditions

Invasive plants can have detrimental effects on the environment and particularly on other species. While most infestations on the Tonto NF are at low population levels now, in a short time they can grow beyond any control efforts, as evidenced repeatedly in many other places. For example, spotted knapweed was introduced into Montana in the 1920s – today it occupies over 7.2 million acres in nine states and two Canadian provinces (Beck, 1994). Bunchgrass sites invaded by spotted knapweed exhibit increases in soil erosion of 192 percent and higher (Lacey, et al., 1990). Invasive exotic species often replace preferred wildlife forage species, forming monocultures inhospitable to native wildlife. Plants such as Dalmatian toadflax, Scotch and bull thistles, and oxeye daisy are not typically used by any native wildlife species. These invasive plants replace native grasses and forbs, which are used by deer, turkey, elk, and many other native wildlife species. Leafy spurge produces a sap that causes a severe skin rash in humans and is poisonous to most grazing animals. Adverse effects of these and other invasive species are described later in this document. Control of these plants promotes ecosystem health of forest, range, and aquatic habitat by maintaining or improving cover of native forbs, grass, and woody species. This, in turn, will prevent loss of wildlife habitat and species diversity.

Several decades ago very few acres on the Tonto NF were infested by invasive plants; however, several invasive plant species have increased dramatically in abundance on the Forest and in surrounding areas over the last several years. About twenty years ago, yellow starthistle and diffuse knapweed were discovered on private land in the town of Young (Cline, 2004). Today, there are an estimated 5,000 acres of yellow starthistle in Gila County alone. Thirty years ago, there was no Malta starthistle growing along Highway 188. Today, rights-of-way along more than 25 miles of this highway are covered with this plant, and the infestation extends for approximately 38,000 acres in Tonto Basin on both sides of Roosevelt Lake. Smaller infestations are being found regularly on all lower elevation ranger districts. Malta starthistle has been identified growing throughout the Phoenix, Scottsdale, Cave Creek/Carefree, Tempe, Gisela, Superior, Apache Junction, Mesa, and Punkin Center, mainly in small localized infestations of less than an acre. Fountain grass has been used for ornamental plantings in the greater Phoenix metropolitan area, and has naturalized along highways throughout most of the lower elevation Districts of the Forest. Buffelgrass is aggressively invading from southern Arizona.

While most infestations of invasive plants on the Tonto NF are currently at relatively low population levels, they have the potential to increase beyond any reasonable efforts to control them, as evidenced repeatedly in many other places. For example, spotted knapweed was first introduced into Montana in the 1920s; but today it occupies over 7.2 million acres in nine states and two Canadian provinces (Beck, 1994). Although there are fewer acres of weeds on the Tonto NF as compared to many other western forests, weed populations are growing rapidly here. History has repeatedly demonstrated that most invasive weed populations do not remain small for long. Growth rates can be exponential with an apparent lag time between initial infestation and subsequent extensive infestations that are beyond control.

Desired Conditions

The following paragraph describes the desired condition for the Forest at the end of the ten-year term of the program:

Existing infestations of invasive exotic plants will be eradicated or controlled through a coordinated forestwide approach to Integrated Vegetation Management. New populations are detected and treated as they become established. A forestwide approach is effective in controlling the spread of noxious weeds and invasive exotic plants, and is coordinated with the efforts of municipal, county, state and federal agencies, and weed management areas. Treatment plans take into account the latest guidance regarding the protection of public health and ecosystem health, as well as the protection and recovery of federally-listed wildlife and plant species.

Noxious and Invasive Plant Species

Plant species that are invasive on the Tonto NF or those invasive species that grow nearby and are likely to infest the Forest over the next ten years are listed in table 1. This list should probably be expected to expand in upcoming years.

Nomenclature for these plant species follows Natural Resource Conservation Service, Plants National Database at http://plants.usda.gov, with the exception of sweet resinbush, nomenclature by Dr. Bertil Nordenstam of Sweden (Nordenstam, 1968; Global Compendium of Weeds, 2007).

For definitions of weed categories, refer to the explanation in the caption of table 1. A specific category, the Tonto category, has been included to describe management of invasive weeds that are common to the Tonto NF.

Descriptions, origins, locations in Arizona and adverse effects of each species are included in chapter 3.

Table 1. List of Noxious Plant Species for the Tonto NF

Latin name	Common name	AZ Dept. of Agriculture Weed List*	Animal & Plant Health Inspection Service (APHIS) Weed List	On neighboring states' weed lists?	Tonto NF category**	AZ-WIPWG class ***	Acres on the Tonto NF
Acroptilon repens	Russian knapweed	P, Res.		CA, CO, NM, NV,UT	A	H	2
Aegilops cylindrica	Jointed goatgrass	P, Res.		CA, CO, NM	B	L☐	10
Ailanthus altissima	Tree of heaven				B		100
Alhagi maurorum	Camelthorn	P, Res.		CA, CO, NM, NV,	A	M	1
Arundo donax	Giant reed				B	H	100
Asphodelus fistulosus	Onionweed		X	NM	A	L	0
Avena fatua	Wild oats			CO	C	M	20,000
Brassica nigra	Black mustard				B		75
Brassica tournefortii	Asian mustard				C	M ☐	3,000
Bromus catharticus	Rescuegrass				C		200
Bromus diandrus	Ripgut brome				C	M	5,000
Bromus japonicus	Japanese brome				C		3,000
Bromus rubens	Red brome				C	H	150,000
Bromus tectorum	Downy brome			CO	C	H	100,000
Cardaria draba	Globe-podded hoary cress	P, Res.		CA, CO, NM, NV UT	A	M	0
Cardaria pubescens	Hairy white-top	P		CA,	A	M	0
Carduus acanthoides	Plumeless thistle	P		CA, CO	A		0
Carduus nutans	Musk thistle			CA, CO, NM, NV, UT	A	M	10

Cenchrus echinatus	Southern sandbur	P, Reg.		CA,	A		0
Cenchrus spinifex	Field sandbur	P, Reg.		CA,	A		7
Centaurea biebersteinii	Spotted knapweed	P, Res.		CA, CO, NM, NV, UT	A	M □	5
Centaurea diffusa	Diffuse knapweed	P, Res.		CA, NM, NV, UT	B	M	250
Centaurea melitensis	Malta starthistle			NM, NV	C	M	65,000
Centaurea solstitialis	Yellow starthistle	P, Res.		CA, CO, NM, NV, UT	B	H	8000
Ceratocephala testiculata	Curveseed butterwort				A		5
Chondrilla juncea	Rush skeletonweed	P		CA, CO, NV	A	M	0
Chorispora tenella	Blue mustard			CA, CO	A		250
Cirsium arvense	Canada thistle	P		CA, CO, NM, NV, UT	A	M	8
Cirsium vulgare	Bull thistle			CO, NM	C		20,000
Convolvulus arvensis	Field bindweed	P, Reg.		CA, CO, NM, UT	C	M	3,000
Dimorphotheca cuneata	White bietou				A		40
Dipsacus fullonum	Common teasel			CO, NM	B		15
Elaeagnus angustifolia	Russian olive			CO, NM	A	H	2
Elymus repens	Quackgrass	P, Res.		CA, CO, UT	B	L	5
Eragrostis curvula	Weeping lovegrass				C	L, □	40,000
Eragrostis Lehmanniana	Lehmann’s lovegrass				C	H	50,000
Erysimum repandum	Spreading wallflower				A		2,000
Euphorbia esula	Leafy spurge	P		CA, CO, NM, NV, UT	A	H	0

Euryops subcarnosus	Sweet resinbush				A	H ☐	27
Isatis tinctoria	Dyer's woad	P		CA, CO, NM, NV, UT	A		0
Kochia scoparia	Kochia				A		0
Leucanthemum vulgare	Oxeye daisy			CO	A	L	3
Linaria dalmatica	Dalmatian toadflax	P, Res.		CA, CO, NM, NV	A	M ☐	35
Linaria vulgaris	Yellow toadflax			CO, NM, NV	A	M	0
Lythrum salicaria	Purple loosestrife	P		CA, CO, NM, NV, UT	A		0
Melilotus officinalis	Yellow sweetclover				C	M	10,000
Nerium oleander	Oleander				B		40
Oncosiphon piluliferum	Globe chamomile				B		5
Onopordum acanthium	Scotch thistle	P, Res.		CA, CO, NM, NV, UT	B	L	50
Parkinsonia aculeata	Jerusalem thorn				A		30
Peganum harmala	African rue	P		CA, CO, NM, NV	A		0
Pennisetum ciliare	Buffelgrass	P, Reg.			B	H ☐	6,000
Pennisetum setaceum	Fountain grass				B	H ☐	7,000
Pentzia incana	Karoo bush				A		3
Polygonum cuspidatum	Japanese knotweed			CA,	A		0
Potentilla recta	Sulfur cinquefoil			CO, NV	A		0
Pyracantha sp.	Pyracantha				B		
Rhus lancea	African sumac				B	M	

Salsola kali & S. tragus	Russian thistle				C		
Salvia aethiopis	Mediterranean sage			CA, CO, NV	A		
Schismus arabicus	Arabian schismus				C	M	
Schismus barbatus	Mediterranean grass				C	M	
Sinapis arvensis	Wild mustard			CO	B		
Tamarix chinensis	Five-stamen tamarisk			NM	C	H □	
Tamarix parviflora	Smallflower tamarisk			CO, NM, NV	C	H □	
Tamarix ramosissima	Saltcedar			CO, NM, NV	C	H □	
Ulmus pumila	Siberian elm			NM	A	M	
Vinca major	Periwinkle				B	M	

Definitions: *Arizona State Dept. of Agriculture Weed List: P= Prohibited. *These weeds are prohibited from entry into the state.*
Reg. = Regulated. These weeds **may** be controlled or quarantined if found within the state, to prevent further infestation.
Res. = Restricted. These weeds **shall** be controlled or quarantined if found within the state.
Tonto Weed List: Class A weeds are of limited distribution in Arizona, or unrecorded in the state. They pose a serious threat. Management goal is eradication. **Class B weeds** are of limited distribution in Arizona, common in some places in the state. Management goal is to contain their spread, decrease population size, then eliminate. **Class C weeds** have spread beyond our capability to eradicate them. Management goal is to contain spread to present size, then decrease the population, if possible.

****AZ-WIPWG = Arizona Wildland Invasive Plant Working Group rating. (SWEPIC 2005) H = High.** These species have severe ecological impacts on ecosystems; invasiveness attributes are conducive to moderate to high rates of dispersal and establishment; species are usually widely distributed. **M = Medium.** These species have substantial and apparent ecological impacts on ecosystems; invasiveness attributes are conducive to moderate to high rates of dispersal, often enhanced by disturbance; ecological amplitude and distribution range from limited to widespread. **L = Low.** These species have minor yet detectable ecological impacts; invasiveness attributes result in low to moderate rates of invasion; ecological amplitude and distribution are generally limited, but the species can be problematic locally.

□= Additional designation for some species whose current ecological amplitude and distribution are limited. Species are capable of invading unexploited natural communities, based on initial, localized observations or behavior in similar ecosystems/communities elsewhere.

Consistency with Forest Plan Goals and Objectives

The Tonto Land and Resource Management Plan (U.S.F.S., 1985b) was written prior to an awareness of the issue of noxious weeds on the Forest. Consequently, there is no language in the document that specifically addresses management of noxious weeds and other invasive exotic plants. There are, however, broad goals and objectives that directly and indirectly provide a basis for development of this project. This action responds to the following goals and objectives outlined in the Tonto NF Plan:

Hazard Protection: **"Through integrated pest management, manage resources to prevent or reduce serious, long lasting hazards."**

Noxious weed infestations can be a hazard to human and animal health. Some species increase fire occurrence in ecosystems that are otherwise unadapted to frequent fires thereby subjecting forest users in desert areas and residents who live nearby to increased hazard from wildfires. Other weeds, such as Russian knapweed and yellow and Malta starthistles, are toxic to horses.

Visual and recreation resource: "Maintain and enhance visual resource values by increasing opportunities for a variety of developed and dispersed experiences. Emphasize visual quality objectives in all resource planning and management activities."

Noxious weed infestations detract from visual quality of the landscape by turning diverse and interesting landscapes into monocultures of often spiny or poisonous plants. Noxious weeds can out-compete native wildflowers thereby eliminating photographic and viewing opportunities. Plants such as Malta starthistle can form dense groundcovers in recreation sites, rendering those sites inhospitable for camping and picnicking.

Wildlife habitat: "All resource planning and management activities will be coordinated to provide for species diversity and greater wildlife and fish populations through improvement of habitat. Ensure that fish and wildlife habitats are managed to maintain viable populations of existing native vertebrate species."

Uncontrolled infestation by noxious weeds reduces biodiversity, displaces plants that are used by wildlife for forage and cover, and ultimately causes deterioration of wildlife habitat.

Threatened & endangered species recovery: "Prevent destruction or adverse modification of critical habitats for Threatened and Endangered species and manage for a goal of increasing population levels that will remove them from federal lists."

Noxious weeds can devastate riparian and aquatic habitat for federally-listed fish and amphibians by increasing water runoff and soil erosion, inducing higher sediment loads in streams, rivers, and lakes. Upland species can be affected by changes in fire regime or other ecosystem function induced by noxious weeds.

Restore rangeland: "The goal of the Forest range management program is to bring the permitted grazing use in balance with the forage allocated for use by domestic livestock, and to have all allotments under appropriate levels of management during the third time period (2005 to 2015).

Improve range forage, watershed & wildlife habitat conditions."

Noxious weeds out-compete native plants and reduce the amount of forage available to grazing livestock. In addition, some noxious weed species contain toxins that can cause death or injury in grazing animals.

Erosion control, water quality & quantity: "Meet minimum air and water quality standards, emphasize improvement of soil productivity, air & water quality, augment water supplies when compatible with other resources, and enhance riparian ecosystems."

Soil stability and watershed values suffer when native plants that have fibrous root systems are replaced by noxious weeds with deep tap roots.

Wilderness: "Emphasize a wilderness management program which is interdisciplinary in approach, and which is directed towards achieving the intent of the *Wilderness Act of 1964* and FSH 2320."

When noxious weeds invade wilderness areas, they destroy the quality described in the *Wilderness Act* as "untrammeled by man." Congress also directed that wilderness areas be managed in such manner as will leave them "unimpaired for future use."

Consistency with Laws and Policies

Federal laws and policies have required resource management to prevent degradation of the land since the Forest Service was formed. As noxious weeds have become more of an issue nationwide, laws and regulations have become more specific to this emerging problem. Listed below are the most recent laws, regulations, and policies related to weed management.

The Forest Service is directed by the *Federal Land Policy and Management Act of 1976* to "take any action necessary to prevent unnecessary or undue degradation of the [public] lands. (*43 USC 1732, Section 302b*). Regulations for implementing the *National Forest Management Act of 1976* (*36 CFR Part 219.27 a.3*) provide direction for controlling noxious weeds.

36 CFR 222.8 states that Forest officers "shall cooperate fully with state, county, and federal officials in application and enforcement of all laws and regulations relating to … noxious farm weeds."

The *Public Rangelands Improvement Act of 1978* established a national policy and commitment to "manage, maintain, and improve the condition of public rangelands" (*43 USC 1711, Section 2(b)(2)*.

The *Federal Noxious Weed Act of 1974* was updated in 1990 with the passage of the *Food, Agriculture Conservation and Trade Act*, commonly known as the Farm Bill. This Bill directed federal agencies to coordinate with state and local governments to contain and control undesirable plant species by entering into Memoranda of Understanding and other agreements where appropriate. The Farm Bill also directed federal agencies to develop policy direction; Forest Service Manual 2080 was issued in November of 1995.

In 1998, the Forest Service issued a National Strategy for weed management entitled “Stemming the Invasive Tide: Forest Service Strategy for Noxious and Nonnative Invasive Plant Management” (U.S. Forest Service, 1998).

In February 1999, President Clinton signed *Executive Order 13112*, addressing invasive species. This order directs federal agencies to prevent introduction and spread of invasive species, to cooperate with a newly created Invasive Species Council, and to produce and follow direction given in an Invasive Species Management Plan. Federal agencies are directed to conduct programs to detect and respond rapidly to and control populations of invasive species in a cost-effective and environmentally sound manner. Further, agencies are to monitor invasive species, restore native plant communities, and promote public education regarding invasive species (*Federal Regulation*, 1999).

The *Federal Plant Protection Act* and implementing regulations and policies, require the Forest Service to cooperate with state, county, and other federal agencies in the application and enforcement of all laws and regulations relating to management and control of noxious weeds. Forest Service policy in FSM 2259.03 states: “Forest officers should place noxious weed management emphasis on those areas where cooperative efforts are underway, such as organized weed control districts. Within budgetary constraints, the Forest Service shall control, to the extent practical, noxious farm weeds on all National Forest System lands. Efforts should be directed to those infestations where management actions will be the most effective in preventing or reducing the spread of noxious weeds considered to be the greatest threat to economic, environmental, social and other values.

The Wilderness Act (*Public Law 88-577*) mandates that wilderness be managed so its community of life is untrammeled by man, its primeval character is retained and its natural conditions are preserved. Forest Service policy direction is to maintain wilderness in such a manner that ecosystems are unaffected by human manipulation and influences so that plants and animals develop and respond to natural forces (FSM 2320.2). *The Wilderness Act* and its implementing regulations (*36 CFR 293*) do not preclude the use of herbicides in wilderness to maintain the natural ecosystem, and the Manual anticipates such use by establishing approval standards at FSM 2323.04c. In order to preserve natural conditions and processes in wilderness, it may become necessary to remove invasive exotic vegetation. Herbicides are a potential tool for controlling invasive species and may represent the appropriate “minimum tool” for accomplishing this objective.

Federal Clean Water Act, including the *National Pollutant Discharge Elimination System* permitting program and its implementing regulations by Arizona Department of Environmental Quality. The requirement to obtain NPDES permits for point source discharges from pesticide applications to waters of the U.S. stems from a recent decision by the Sixth Circuit Court of Appeals, whose mandate goes into effect February 2012.

The proposed action is responsive to these laws and policies. Lack of action against invasive plant species is clearly a violation of these laws and policies.

Proposed Action

The Forest Service proposes eradication, containment, and/or control of noxious weed and invasive plant species on parts of the Cave Creek, Globe, Mesa, Payson, Pleasant Valley, and

Tonto Basin ranger districts. The Tonto NF is located within Gila, Maricopa, Pinal, and Yavapai counties, and comprises a total of 2,872,876 acres. Known noxious weed infestations cover only a small percentage of the total National Forest acres, but unknown infestations may be found anywhere within the nearly three million acres of the Forest.

Proposed noxious weed treatment measures in this Environmental Assessment are contained in the Forest Service's broad strategy of Integrated Vegetation Management (IVM) (FSM 2080.2), which is composed of five elements: prevention and detection, treatment of existing populations, monitoring, restoration, and coordination with the public and other management entities. Noxious weed treatment methods in this Integrated Vegetation Management approach include: manual, mechanical, prescribed burning, cultural, use of biological control agents, and use of herbicides.

Adaptive Management Strategy

Weed infestations are dynamic; even the most complete inventory can never cover all infested areas and will quickly be out of date. During the life of this project, invasive plants are likely to be introduced to new locations by vehicles, heavy equipment, livestock, wildlife, recreationists, and other vectors of spread. It is also likely that additional species of invasive plants not identified in table 1 may be discovered on the Forest over the term of the project. Therefore, an adaptive management strategy will be used in the proposed invasive plant management program to provide direction for noxious weed management activities on the Forest. An adaptive management strategy allows decision makers to take advantage of new information, as it becomes available for improvement of planning and management. The Forest will respond to new infestations of invasive weeds by completing site-specific reviews to determine impacts to proposed, threatened, endangered and sensitive plants, wildlife and fish, as well as the public, heritage resources, or plant species of significance to local tribes. New populations of invasive plants will be treated as they are found as long as the conditions of this analysis and decision are met. Likewise, if a new or improved treatment product is available, the new product may be considered for use. Analyses will be done to determine if the effects of new treatments are similar to effects disclosed herein. As long as the new treatment activity fits within the range of effects analyzed and disclosed in this EA, no further NEPA analysis will be performed. If monitoring determines that control beyond the scope of this analysis becomes necessary, further analysis under NEPA will be conducted.

Project Monitoring

Monitoring is the process of collecting information to determine the effectiveness of management actions in meeting prescribed objectives. Weed management monitoring on the Tonto NF focuses on the density and rate of spread of invasive exotic plant species and the effects these aggressive plants have on natural resources. Also of interest is effectiveness of prescribed actions on the target plant and responses of desirable vegetation. Monitoring will help determine if our prescriptions and activities are accomplishing the goals established for each species (see table 1, Tonto NF category column).

There will be three types of monitoring, described below:

Implementation Monitoring

Annual monitoring will be conducted by staff on the Tonto NF to verify that actions are taking place as described in this environmental document. Monitoring results will be input to the Forest Service's corporate database "FACTS" (*Forest Service ACtivity Tracking System*) which serves as the database of record for Forest Service invasive plant control activities. Monitoring will include target species, treatment type, location, acres, timing of actions, and mitigation. Monitoring will occur prior to and during each prescribed fire and herbicide project, and will include weather information and site conditions.

Monitoring reports will be part of all contracts, and contractors shall be required to report on such items as: method used, name and amount of herbicide used, dates sprayed, and situation and weather conditions during herbicide application. This information will be included in the Forest's annual reporting in the FACTS database.

Project Effectiveness Monitoring

Monitoring of weed spread and/or suppression will be aided by analysis of an existing Forest Service database and GIS layer called *National Resource Information System* (NRIS) *Terra Invasives*. Before treating any population, the perimeter of the affected area will be mapped and infested acres will be calculated. This baseline measurement will be used to document the effectiveness of each type of treatment by comparing infested acreages in successive years. Yearly treatment summaries will be used to assess weed spread. By tracking infested areas, we will be able to gauge if our objectives are being met by each treatment.

Mitigation measures for notification of the public and signing of herbicide-treated sites will be monitored by periodically contacting individuals or groups concerned with Multiple Chemical Sensitivity, those who have submitted comments on this proposal regarding MCS concerns, tribal representatives, and others who have expressed concern, to verify the notification program is working.

Monitoring techniques for success of biocontrol agents will be developed with qualified professionals from U.S.D.A., Animal and Plant Health Inspection Service (APHIS). Monitoring will determine insect establishment success, insect population trends, insect impact on target plants, and effects of these biocontrol agents on weed population and density.

Environmental Effects Monitoring

Effects on human health resulting from exposure to daily treatment operations, accidents, and long-term exposure will be monitored through documentation of project records, including worker and public health complaints. Risk to human health regarding use of herbicides has been evaluated in chapter 3 and in Risk Assessments listed in appendix F.

Effects on public access and plant collection will be assessed to determine if design features, best management practices, and mitigation measures outlined in chapter 3 and Appendices C, D, G, and H are working and effective.

Potential non-target or offsite effects, such as those that may occur from a prescribed fire expanding beyond the treatment area, leaching, runoff, or aerial drift in the case of herbicide treatments, will be analyzed prior to treatment. Best management practices (appendix D) will be applied to minimize predicted undesirable environmental effects. Projects will be monitored after completion for this type of unintended effect.

Monitoring will be used to determine if biocontrol agents are adversely impacting native plants and if biocontrol agents are able to survive and successfully reproduce under the environmental conditions of the project area.

Decision Framework

The Forest Supervisor of the Tonto NF will review the proposed action and alternatives in order to make the following decisions:

- Whether the proposed action would result in significant environmental effects that would require the preparation of an Environmental Impact Statement or there is a finding of no significant impact.
- If significant impacts are not anticipated, the Forest Supervisor will determine whether the proposed action will proceed as described above, as modified by an alternative, or not at all.
- Mitigation measures and monitoring requirements that will be implemented by the Forest Service.
- If the project requires a Forest Plan amendment.

The Environmental Assessment (EA) is not a decision document. The EA displays the results of an analysis of the proposed action and alternatives with respect to the key issues as well as the ability of those actions to meet the purpose and need. A Decision Notice signed by the Tonto NF Supervisor will document the decision and rationale for selection.

Public Involvement

The proposal has been listed in the *Schedule of Proposed Actions* (SOPA) since fall of 2001.

The proposal was first provided to the public and other agencies for comment in a scoping letter on November 26, 2001 (Doc # 1 in project record). Comments from this original scoping were retained and included in the current analysis. They were also used to revise the proposed action and description of existing conditions. A revised public scoping letter was mailed to 858 individuals, organizations and agencies, and also to legislative representatives on May 25, 2004 (Doc # 5 in project record). A total of 16 comments were received from scoping in 2001 and 2004.

Talks have been given to various groups regarding the Tonto NF’s proposal to use integrated vegetation management, including the Arizona Native Plant Society, Association of Four-Wheel-Drive Clubs, Arizona State Horseman’s Association, Superstition Horseman’s Association, Cave Creek Saddle Club, Trout Unlimited, Arizona Flycasters, Scottsdale Sportsman’s Club, Arizona State University Wildlife Habitat and Ecological Restoration Club, Tonto Weed Management Area, Cave Creek Town Council, officials of the Town of Payson, the town of Star Valley, and the Gila County Board of Supervisors. The Tonto NF’s Noxious Weed Program Manager also participates in meetings of Southwest Vegetation Management Association, Central Arizona Weed Management Area, Tonto Natural Resource Conservation District, the Southern Arizona

Buffelgrass Coordination Center, and the Southeastern Arizona Weed Management Area (formerly known as the Sweet Resinbush/Pentzia Weed Management Group).

On October 3, 2005, a letter was mailed to the Tonto NF's tribal mailing list, requesting their input in identifying plant species having traditional cultural or religious significance, and/or areas being used by tribal members for plant harvesting or collecting, or which would have other significance that would merit special consideration during project design and implementation. Three tribes responded: Fort McDowell Yavapai Nation, Yavapai-Prescott Indian Tribe, and White Mountain Apache Tribe. Fort McDowell Yavapai Nation stated that they supported the project providing there were no impacts to acorns and piñyon in the Forest. The Yavapai-Prescott Tribe was also supportive of the project, and requested more information on invasive plants and their locations. They are providing the Tonto NF a list of plants that are important to them for cultural purposes. The White Mountain Apache Tribe replied that the project posed no threat to their traditional cultural properties and/or religious sites. If a historical Apache site is located when planning a project, the project should cease until the proper authorities are notified.

In order to fully describe the proposed project and solicit input, we met with tribal members from the tribes' cultural resources offices on the following dates:

- March 1, 2006 – Yavapai-Prescott Indian Tribe
- June 21, 2006 – Four southern tribes: Tohono O'odham Nation, Salt River Pima-Maricopa Indian Community, Gila River Indian Community, and Ak-Chin Indian Community
- July 19, 2006 – Hopi Tribe

Using the comments from the public, other agencies, and tribes (see *Issues* section), the interdisciplinary team developed a list of issues to address.

Issues

All comments received were reviewed by the ID Team to develop a list of issues to address for this proposed project. The Team separated the issues into two groups: significant and non-significant. Significant issues were defined as those directly or indirectly caused by implementing the proposed action. Non-significant issues were identified as those: 1) outside the scope of the proposed action; 2) expressing agreement or support of the proposed project; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence.

The Council on Environmental Quality (CEQ) regulations for NEPA require this delineation in Section 1501.7, to "identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review." A list of non-significant issues and reasons regarding their categorization as non-significant may be found in the Project Record (Document # 17).

The following issues were classed as significant:

1. Toxicity of herbicides to the public and agency employees. Specific concerns included on-site posting of treated areas, notification of the public (especially those with multiple chemical sensitivity), toxicity of herbicides and surfactants, and use of herbicides other than those registered by the Environmental Protection Agency (EPA).

Human exposure risks have been evaluated in a series of Risk Assessments developed by Syracuse Environmental Research Associates under contract with the Forest Service, which are incorporated herein by reference. The evaluation criteria for these effects are the risks to human health of herbicide use, the predicted location and size of area to be treated, preferred treatment method, and identification of areas where no chemical treatments would be used. Two alternatives (No Action and No Herbicides) are responsive to this issue.

2. Toxicity of herbicides to non-target vegetation and wildlife. Effects are described in narrative and tabular form through a wildlife specialist's report, biological assessment and evaluation and analysis of effects on management indicator species (MIS) and other wildlife, fish and plants. Mitigation measures have been included in the design of all action alternatives to minimize exposure to non-target species. Wildlife exposure risks have been evaluated in the aforementioned series of Risk Assessments written by Syracuse Environmental Research Associates, which are incorporated by reference.

Issues and Concerns Addressed through Project Design

In response to scoping comments, the proposed action was modified and analysis broadened to address some of the issues identified. The Tonto NF's invasive species list was increased considerably to include species such as yellow sweetclover and Russian thistle, and also other species that are not currently on the Forest but are close to its boundaries. The request by a commenter to use species-specific management guidelines led to inclusion of a section on treatments discussed by individual weed species. The request to identify how infestations began led to the section on vectors. Another suggestion was to increase the number of acres that could be treated annually.

A comment that aerial application should be included in the proposed action was considered. The need to begin implementation of invasive plant management quickly, and the possibility of controversy and delays in a decision that aerial spray application of herbicide would bring, led the team to defer this to a separate future analysis. Most infestations do not currently occupy large contiguous areas, thereby generally precluding aerial herbicide application. If future weed infestations are extensive enough to make aerial herbicide application a feasible control technique, an EIS would need to be completed. A comment on the potential for weed-burning projects to adversely affect air quality was addressed by mitigative measures that are required for any prescribed burn. Comments on the possibility for heavy equipment to bring in additional weeds and create unwanted ground disturbance are addressed through mitigation. And finally, comments from a community in the Globe area were addressed by excluding herbicide use from a portion of the Forest surrounding that community.

Incorporation by Reference

Regulations implementing NEPA provide for the reduction of bulk and redundancy (*40 CFR 1502.21*) through incorporation by reference, when the effect will be to reduce the size of documents without impeding agency and public review of the action. The following documents are incorporated by reference and form the basis for the conclusions related to human health and effects to non-target species:

Risk Assessments for Aminopyralid, Chlorsulfuron, Clopyralid, Dicamba, Glyphosate, Imazapic, Imazapyr, Metsulfuron methyl, Picloram, Sethoxydim, Sulfometuron methyl, and Triclopyr are available on the website http://www.fs.fed.us/foresthealth/pesticide/risk.shtml.

Biological Assessment and Evaluation for Environmental Assessment for Management of Noxious Weeds and Hazardous Vegetation on Public Roadways on National Forest Service System Lands in Arizona (U.S. Forest Service, Southwestern Region, 2004).

Final Environmental Impact Statement for the Integrated Treatment of Noxious Invasive Weeds on the Coconino, Kaibab, and Prescott national forests (U.S. Forest Service, 2004, Feb.).

Environmental Assessment for the Invasive Exotic Plant Management Program. Coronado National Forest (U.S.F.S. Coronado NF, 2004).

Recommended Protection Measures for Pesticide Applications in Region 2 of the U.S. Fish and Wildlife Service (USFWS, 2007a).

Chapter 2 – Alternatives, Including the Proposed Action

The Proposed Action: Integrated Vegetation Management to Treat Weed Infestations

The Forest Service proposes eradication, containment, and/or control of noxious weed and invasive plant species on parts of the Cave Creek, Globe, Mesa, Payson, Pleasant Valley, and Tonto Basin ranger districts. The Tonto NF is within Gila, Maricopa, Pinal, and Yavapai counties, and comprises a total of 2,872,876 acres. Known noxious weed infestations cover only a small percentage of acreage on the Tonto National Forest; however, unknown infestations may be found anywhere within the nearly three million acres of the Forest thereby increasing the overall total of infested acreage.

This project will be reviewed after ten years. If weed control beyond the scope of this analysis becomes necessary, further analysis under NEPA will be conducted.

Proposed noxious weed treatment measures are a part of a broad strategy of Integrated Vegetation Management (IVM) (FSM 2080.2), which is composed of five elements:

Prevention and Detection

- Conduct fire management activities in such a manner that noxious weeds are not introduced or spread during fire suppression or prescribed burn projects.
- Educate the public, employees, and permittees to identify and report noxious weeds.
- Ensure all contractors and permittees operating on the National Forest understand and comply with the Forest's Noxious Weed Policy.
- Conduct weed surveys, as funding allows.

Treatment of existing populations

- Implement an integrated vegetation management strategy using cultural, physical, mechanical, biological, or chemical methods of control. New populations are treated as they are found, and as long as the conditions of this analysis and decision are met, no further NEPA analysis will be performed.

Monitoring

- Monitor effectiveness of control methods annually for five years following treatment.
- Monitor all known populations at least every three years, noting density and area of infestation.

Restoration

- In areas where there are large infestations of an invasive species, where treatment would result in expanses of bare ground, restore native vegetation following treatment. Restoration efforts would mainly involve erosion control and planting of native species. Restoration may also be needed after large disturbance events such as floods or fire, to prevent invasive plants from establishing.

Coordination, cooperation and education

- Continue ongoing cooperation efforts with other agencies and landowners, and encourage new cooperative efforts as appropriate. These efforts should include lands of all ownerships and jurisdictions to ensure overall weed control.
- Partner with the State of Arizona Department of Transportation and other road management agencies to cooperate on control of invasive exotic species and ensure

mulches and seed mixes are weed free, including coordination of this treatment plan with the ongoing statewide plan for treatment of invasive exotic plants in state and federal highway rights-of-way. Ensure invasive plant surveys are conducted for new highway construction early in the planning process. Work with ADOT and other road management agencies to ensure weeds found are treated to prevent spread during construction.

- Continue to develop and implement educational and public awareness materials.

Most of these elements require only administrative action to accomplish. This proposed action evaluates treatment and restoration of sites with noxious weed infestations. Noxious weed treatment methods in this Integrated Vegetation Management approach include:

Manual – hand pulling and using hand tools to selectively remove noxious weeds from native plant communities. These treatments are effective in controlling new infestations of many weeds; however, they are very labor-intensive and may be ineffective on some types of weeds such as deep-rooted species or ones with fibrous roots. This control method will be used on up to 400 acres each year.

Mechanical – Using motorized equipment to mow, clip, or till. Many mechanical treatments are expensive. This control method will be used on up to 500 acres each year.

Prescribed Burning – Burning is an inexpensive and often effective method to remove large quantities of seed of annual weeds. It can be used effectively, in combination with other treatments, as an integral part of multi-year strategy, especially for annual weeds. This control method will be used on up to 2,000 acres each year.

Cultural – Seeding with plants that prevent infestation by invasive plants. Establishment of desirable plants is essential to preventing areas of bare ground created by construction or other activities from being vulnerable to infestation of weeds. Fertilizers or mycorrhizal inoculants may be included in some revegetation projects to increase establishment success. This method will be used on up to 2,000 acres each year.

Biological – Use grazing animals, approved insects and pathogens to control weeds. Biological treatments are typically used when the objective is control and not eradication. The biological agent and the weed co-exist to the extent that spread of the weed is limited. Once biological control agents, such as insects or plant pathogens are released, they may cover a large number of acres, if there is a continuous infestation of their target weed plant. If grazing animals are used for biocontrol, impacts of the action will either be evaluated in a new analysis or authorized according to an existing grazing permit.

Herbicidal – Application of approved chemicals to noxious weeds. Herbicides would be used to treat up to 9,000 acres per year (about 0.3 percent of the National Forest. Actual acreage of treatment would probably be much less, as it would be limited by funding each year. Annual weed management efforts will be coordinated with treatment efforts undertaken by other federal, state and local governments, and Weed Management Areas. The majority of treatments will occur along roads and other travel corridors.

Twelve herbicides and carriers (or additives) are proposed for use: aminopyralid, chlorsulfuron, clopyralid, dicamba, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr. These herbicides have been approved for use on the three northern forests in Arizona (Coconino, Kaibab, and Prescott) and/or on rights-of-way on federal and state highways in all national forests in Arizona.

Plant Treatment by Species

Characteristics of each species are discussed in detail in appendix A. Refer to table 1 for classification of each species, in the following discussion.

Russian knapweed
Acroptilon repens

Cultural control/Use of prescribed fire:
Seeding competitive, perennial grass species after Russian knapweed has been stressed by other control measures is essential (Beck, 2012). Cultural control is most effective when combined with mechanical and/or chemical control techniques.

Mechanical/hand control:
This plant's perennial growth habit and deep-rooting system render hand or mechanical removal methods fairly useless, when not used in combination with herbicides.

Herbicidal control:
A single control strategy, such as mowing or herbicide application, usually is not sufficient. Russian knapweed is best controlled with a selective, post-emergent herbicide; however, herbicides alone will not control Russian knapweed. They should be used in combination with cultural or mechanical/hand controls, such as mowing and seeding with perennial grasses. Some tillage may be needed prior to seeding to overcome the allelopathic effects of the knapweed (Beck, 2012). Herbicides that could damage grasses should not be used, because competition from grasses is known to stress Russian knapweed (Beck, 2012). Chlorsulfuron and metsulfuron control this species, but only if applied during the bloom or post bloom stage. A surfactant should always be used.

Biological control:
In North America, Russian knapweed is relatively free of parasites and is not extensively attacked by generalist feeders (Carpenter & Murray, undated a). Only two biological control agents have been approved for release on Russian knapweed; *Subanguina picridis*, a gall-forming nematode, and *Aceria acroptiloni*, a gall-forming mite.

Tonto NF Goals & Strategy:
Russian knapweed occurs in very few locations on the Tonto NF. It is classified as an "A" species, one that poses a serious threat to ecosystems. Infestations will be eradicated when found, using combinations of the tools above. To date, Russian knapweed infestations have been removed manually. Since this species is a deep-rooted perennial plant, this method has been rather ineffective in permanently removing the infestation. One infestation at an old mill site was treated by scraping the surface soil to a depth of 2 feet and burying the displaced soil in a deep pit. This was extremely expensive and is only financially feasible for treating special status sites when extra funding is available. Also, this method of treatment would probably not be appropriate in most wildland situations where the goal is to retain as much native vegetation and ground cover as possible.

Jointed goatgrass

Aegilops cylindrica

Jointed goatgrass is often a weed of wheat fields; therefore, most control measures discussed in scientific literature are related to agronomic situations rather than control in wildland settings.

Cultural control/Use of prescribed fire: Cattle that have eaten jointed goatgrass-infested hay, or have grazed on this plant scatter viable seed on rangelands through their manure. Studies have found 75 percent of jointed goatgrass seed that has passed through a cow's rumen is still viable (Lyon, et al., 2007). Thus, using weed-free feed for livestock on the National Forest is important.

Burning during the soft boot stage, or after flowering, but prior to seed maturity, can be used to eliminate a season's seed crop. Burning often promotes germination of the following year's crop of goatgrass, creating the need for a follow-up plan the year after the burn (CDFA, 2005).

Mechanical/hand control: Mowing can be an effective method of reducing seed production of jointed goatgrass; however, timing is critical. Mowing should occur after flowering, but before goatgrass seeds reach the soft boot stage. Early mowing will result in new tiller growth and late mowing will only spread viable seed. Tillage may be utilized in certain situations. Hand pulling or hoeing small infestations is effective, if the roots are pulled and air-dried (CDFA, 2005).

Herbicidal control: No herbicides have been found that are selective for jointed goatgrass in cropland situations, including wheat. In rangeland, nonselective herbicides may be used on small infestations. Sethoxydim is an herbicide that controls annual and perennial grasses and may be effective for treating jointed goatgrass. Herbicide should be applied after tillering and prior to flowering (CDFA, 2005).

Biological control: There are no biological control methods available for jointed goatgrass (Callihan & Miller, 1999). Grazing is not an effective tool, since grazing animals serve to spread the infestation through survival of viable seed in their manure.

Tonto NF Goals & Strategy: This plant is classified as a "B" species. The goal is to contain its spread, reduce the population, and then eliminate it. Only one site has been treated on the Forest. In 2009, an ADOT contractor sprayed an infestation in the right-of-way of State Route 87 north of Payson. Monitoring conducted in 2010 determined this treatment was successful.

Tree of Heaven

Ailanthus altissima

Cultural control/Use of prescribed fire: Establishing a thick cover of trees (preferably native and non-invasive) or grass sod will help shade out and discourage establishment of *Ailanthus* seedlings. However, *Ailanthus* usually crowds out and replaces native trees, and fire serves only to increase sprouting.

Mechanical/manual control: Young seedlings may be pulled or dug up, preferably when soil is moist. Care must be taken to remove the entire plant including all roots and fragments, as these will almost certainly regrow. Root suckers appear similar to seedlings, but are connected to a pre-existing lateral root and may be nearly impossible to remove effectively by hand or with mechanical equipment (Swearingen & Pannill, 2005).

Cutting alone is usually counterproductive because *Ailanthus* responds by producing large numbers of stump sprouts and root suckers. However, for small infestations, repeated cutting of sprouts over time can exhaust the plants' reserves of carbohydrates and may be successful, if continued for many years or where heavy shade exists. Initial cutting should be in early summer in order to impact the tree when its root reserves are lowest.

Herbicidal control: The most effective method of *Ailanthus* control seems to be through the use of herbicides, which may be applied as a foliar (to the leaves), basal bark, cut stump, or hack and squirt treatment (Swearingen, 2005).

Biological control: There are currently no approved biological control methods for *Ailanthus.*

Tonto NF Goals & Strategy: Elimination of *Ailanthus* requires diligence due to its abundant seed production, high seed germination rate, and vegetative reproduction. Regardless of the method selected, treated areas should be rechecked one or more times a year and any new suckers or seedlings treated (cut, sprayed, or pulled) as soon as possible, especially before they are able to rebuild root reserves. Targeting large female trees for control will help reduce spread of *Ailanthus* by seed (Swearingen & Pannill, 2005). One infestation growing along U.S. Hwy. 60 between the towns of Superior and Miami was treated by cut stump herbicide application. This project met with limited success. Apparently either a stronger concentration of herbicide is needed, or repeated applications. While many trees were successfully treated, a number of them sprouted from the base and will need retreatment.

This is a "C" species – management strategy is to contain spread and decrease the population, if possible. The main reason for this classification is that it is a popular ornamental plant in communities within the Forest boundary, such as Globe/Miami, Superior, and Payson. Residents are unlikely to kill or remove these trees that provide shade for their houses and yards. Removal efforts on the Tonto NF will emphasize detection of outlier infestations--such as a small number of saplings near the confluence of Pinal Creek and the Salt River--and eliminating them.

Camelthorn
Alhagi maurorum

Cultural control/Use of prescribed fire: Cultural control methods that can be used to prevent introduction of this aggressive species include: use of weed-free hay on the National Forest, cleaning heavy equipment before it is brought in for any ground-disturbing type of work, and preventing livestock from eating the plant and transporting the seed to the Forest via manure.

Mechanical/hand control: Because of its deep and extensively branched root system, mechanical treatments do not control camelthorn (ADOT, 2005).

Herbicidal control: Herbicides provide the best means of control. When using herbicides, different chemicals should be used each year to prevent the establishment of an herbicide-resistant population (ADOT, 2005)

Biological control: There are currently no biological control agents approved for control of camelthorn (Coconino NF & San Francisco Peaks Weed Management Area, 2001)

Tonto NF Goals & Strategy: Camelthorn is an "A" species on the Tonto's list. Infestations will be treated quickly to eradicate them before they can establish. Once this plant establishes, it is extremely difficult to eradicate.

Several years ago, ADOT successfully treated a large infestation of camelthorn north of Globe. No follow-up has occurred for the last five years, and the camelthorn is beginning to come back. Owing to its extensive root system, this plant is persistent and will need repeated herbicide applications and monitoring. In 2010 a single camelthorn plant was discovered growing in the median of SR 260 near Christopher Creek. ADOT's contractor treated this plant with herbicide; monitoring over the next 6 months has detected no sprouting and the plant appears to be dead. Herbicide use can be limited by treating individual plants whenever they appear.

Giant reed
Arundo donax

Cultural control/Use of prescribed fire: Prescribed burning, either alone or combined with herbicide applications, may be effective if conducted after flowering.

Mechanical/hand control: Mechanical/hand control (e.g., repeated mowing) may be somewhat effective, but any small fragments of root left in the soil may lead to re-establishment.

Herbicidal control: Areas infested with giant reed are best restored through chemical means. The most effective timing is post-flowering and pre-dormancy, when plants are translocating nutrients into the root system (Hoshovsky, 1986). Systemic herbicides, such as glyphosate (e.g., Rodeo), or imazapyr (Habitat) may be applied to clumps of giant reed after flowering, either as a cut stump treatment or as a foliar spray (Benton, et al., 2005).

Biological Control: No biological control agents have been introduced for giant reed.

Tonto NF Goals & Strategy: Like tree of heaven, this species is commonly planted in some of the communities that lie within the boundaries of the Tonto NF. There are many established small populations of this plant in Camp Verde, Superior, and Globe. *Arundo* is not an extremely aggressive invader. It is possible that after a scouring flood that removes large amounts of *Phragmites* spp. from along the Verde River, *Arundo* may become established in its place. These species occupy similar niches in riparian communities; however, *Arundo* can live on drier sites. Forest Service river rangers working on the Coconino and Prescott NFs have been trained, so they are able to distinguish between the two species. They are currently working to remove several *Arundo* infestations on the Coconino and Prescott NFs along the Verde River upstream of the Tonto NF. They have mapped several infestations on the Tonto NF section of the Verde River. The Tonto NF will be participating in this program of *Arundo* control along the state's only two Wild and Scenic rivers: the Verde River and Fossil Creek

Onionweed
Asphodelus fistulosus

Cultural control/Use of prescribed fire: This plant is sometimes sold as an ornamental. An education outreach effort with partners to check local nurseries periodically and request the owner to remove it from sale would prevent potential infestations coming from private lands near the Forest.

Mechanical/hand control: Pulling the plant is usually not effective. The top breaks off, leaving the tuberous roots underground. Plants must be dug up by the roots (Arizona-Sonora Desert Museum, 2005).

Herbicidal control: Herbicides are the best method of control for onionweed.

Biological control: There are no approved biological control agents available for onionweed.

Tonto NF Goals & Strategy: Onionweed is an “A”species; management goal is to detect new infestations early and eradicate them. APHIS has an active program to educate landowners in areas that have had infestations in the past, and to conduct surveys for this plant. It will be the Tonto NF’s strategy to cooperate with APHIS in any survey or control efforts on or near the Forest.

Wild oats
Avena fatua

Cultural control/Use of prescribed fire: Appropriately timed (cool season) grazing by herbivores may provide control.

Mechanical/hand control: Mowing may be useful in certain circumstances in controlling wild oats. Researchers in annual grasslands in California used selective herbicides to remove annual weedy grasses, followed by mowing and seeding of native bunchgrasses along roadsides (Bugg, et al., 1991). They were successful in initial stages of replacing weedy annual grasses with native perennial bunchgrasses. Bugg and associated researchers projected that restoration of native vegetation along roadsides would greatly reduce maintenance and herbicide costs.

Herbicidal control: Some herbicides may be effective for control; however, herbicide-resistant strains of wild oats exist because of routine spraying under cropland conditions (Friesen, et al., 2000).

Biological control: Biocontrol of wild oats, one of the world's most serious weeds, is largely unexplored. One study investigated crown rust disease as a potential control agent for wild oats on San Clemente Island. The result showed that application of crown rust lowers the competitive ability of wild oats, while raising that of *Stipa*, a native grass. Crown rust may be an effective biocontrol agent when used in a suite of management tools (Sands, et al., 2000). Development of crown rust as a tool for control of wild oats is not likely to occur within the next several years.

Tonto NF Goals & Strategy: Wild oats are extremely widespread on the Tonto NF and neighboring forests. Our goal is to prevent new infestations by requiring any seed to be used for revegetation to be free of species on the Tonto NF’s weed list. Seed mixes for revegetation will emphasize native perennial grasses, including cool-season growers that should out-compete wild oats over the long term.

Black mustard
Brassica nigra

Cultural control/Use of prescribed fire: Prevention of new infestations by state lab testing of all seed mixes introduced on the Forest will be key to controlling spread of black mustard.

Mechanical/hand control: Manual methods are effective for small infestations.

Herbicidal control: Herbicides can be used for controlling black mustard. They are best used during the rosette stage.

Biological control: Biological control using microfauna is not an option, since there are several mustard crop plants that would probably also be susceptible. Biocontrol using livestock is a possible treatment option for the winter/early spring season when invasive mustards are growing.

Tonto NF Goals & Strategy: Most black mustard infestations on the Forest were planted with revegetation seed mixes that predate the Tonto NF's current seed testing policy. New infestations will be prevented by requiring lab-testing for all seed used in revegetation projects. Existing infestations, which are in disturbed areas, will be removed.

Asian mustard
Brassica tournefortii

Cultural control/Use of prescribed fire: Establishment of a dense cover of grasses appears to suppress growth of Asian mustard. Prescribed burning may reduce seed survival, but hard seed coats allow some seeds to escape harm from the fire. Prolonged seed longevity in the soil can bring stem densities up to pre-burn levels within one or two growing seasons, depending upon winter/spring rainfall.

Mechanical/hand control: Manual methods are effective for small infestations.

Herbicidal control: Early winter/spring growth of this annual allows effective herbicide control without affecting native plants that grow later in the season (Sanders & Minnich, 2005).

Biological control: As with black mustard, biological control using microfauna or disease is not a likely option, due to the relationship of this plant to numerous crop plants. Placement of livestock in areas with high densities of Asian mustard in the winter/early spring period when most other plants are not growing is a viable option.

Tonto NF Goals & Strategy: The Tonto NF's strategy for this species is to control it beginning from its farthest extent away from disturbed sites, limiting it to its previous habitat of disturbed roadsides. The Tonto NF will work cooperatively with the Arizona Department of Transportation to identify priority sites for treatment along state and federal highways on the Forest. New construction sites will be monitored closely, and new infestations of Asian mustard will be treated before they are allowed to go to seed. The long-term goal is to eliminate it from disturbed areas, such as roadsides. One site along State Route 188 has been reduced in density by using manual treatment by a Department of Corrections crew. Several full days were needed by the DOC crew to remove only a couple of acres of this plant.

Red brome, rescuegrass, downy brome, Japanese brome, ripgut brome
Bromus rubens, B. catharticus, B. tectorum, B. japonicus, B. diandrus

Cultural control/Use of prescribed fire: For higher elevations, maintaining good range condition, with a good groundcover of perennial grasses will prevent extensive infestations of brome grasses. Post-fire soil inoculation with local species of mycorrhizae is a promising experimental technique that could both stabilize soil and prevent germination of the large-seeded brome grasses (Warren, 2007).

Mechanical/hand control: Mowing along rights-of-way may be a practical treatment, if done prior to flowering and seed-set.

Herbicidal control: Some herbicides are effective on these brome grasses, which can be targeted without damage to many other plants, since they grow very early in the year when most other plants are still dormant.

Biological control: Grazing by domestic animals during winter and early spring may remove these grasses from the Sonoran Desert where they potentially can create a fire hazard. They are particularly abundant after wet winters – thus, livestock may be brought in during December through early to mid-February to graze. Some work is being done to investigate the use of naturally-occurring fungal and bacterial seed bank pathogens to control annual bromes. Development of technically and economically feasible harvesting and application techniques is the subject of research at the Shrub Sciences Laboratory of the Forest Service Rocky Mountain Research Station in Provo, Utah (Meyer, 2011).

Tonto NF Goals & Strategy: These annual grasses are extremely widespread on the Tonto NF and in Arizona. They are included in the Tonto NF noxious weed list, so populations can be selected for treatment when this will achieve a strategic objective.

Globe-podded hoary cress, hairy white-top
Cardaria draba, C. pubescens

Cultural control/Use of prescribed fire: Fire is not an effective treatment since *Cardaria* species are known to expand after fire. Fire appears to stimulate root budding of lateral roots.

Mechanical/hand control: Mechanical/hand control is not effective, since these plants are deeply rooted species. If it is pursued diligently over several years, so above-ground parts are not allowed to replenish root reserves, control of small infestations is possible.

Herbicidal control: Herbicides are the surest method of control but must be re-applied over several years to obtain results. The most effective timing of application is the bud to early flower stage. Chlorsulfuron, sulfometuron, and glyphosate have all been used with good results (CDFA, 2005).

Biological control: There are no biological controls approved for these species. Cattle and sheep may graze them with no ill effects.

Tonto NF Goals & Strategy: This plant is uncommon on the Tonto NF. Small infestations will be eradicated when they are discovered.

Plumeless thistle
Carduus acanthoides

Cultural control/Use of prescribed fire: Good range management is an effective tool to decrease the possibility of infestation by this thistle and most other thistles.

Mechanical/hand control: Well-timed mowing, during early flowering will prevent seed production, but re-sprouting from the base may occur. Control using hand tools is effective on very small populations prior to seed maturity (Remalay, 2005). Soil disturbance should be minimized to prevent seeds germinating in the soil.

Herbicidal control: Several herbicides are effective for control of plumeless thistle. Chlorsulfuron, dicamba, clopyralid, glyphosate, picloram, or combinations of these herbicides provide excellent control (CDFA, 2005).

Biological control: The thistle head weevil (*Rhinocyllus conicus*) infests a number of genera in the thistle tribe, including species of *Carduus*, *Cirsium* and *Onopordum*. The larvae of thistle crown weevil (*Trichosirocalus horridus*) feed on the growing tips of the thistle rosette, and adult weevils slightly defoliate plants. Larvae of thistle crown fly (*Cheilosia corydon*) damage leaves, stems and crowns of plumeless thistle. This insect can also lower total seed production and can kill the plant, if it infests the roots.

Goats seem to prefer thistle flowers to leaves. Seeds ingested by goats and other ruminants are nearly all digested and are not viable.

Tonto NF Goals & Strategy: Plumeless thistle is an "A" species on the Tonto NF. New infestations will be eradicated.

Musk thistle
Carduus nutans

Cultural control/Use of prescribed fire: Open areas are susceptible to infestation by thistles. Construction sites and roadsides should be checked for this and other thistle species. Good range management is also important, as for plumeless thistle.

Mechanical/hand control: Control using hand tools is effective on small populations, prior to seed maturity (Remalay, 2005). Soil disturbance should be minimized to prevent seeds on the soil from germinating.

Herbicidal control: Herbicides need to be applied during the rosette stage or prior to flowering (Remaley, 2005b). The same herbicides that are named above for plumeless thistle control are also effective on musk thistle (CDFA, 2005).

Biological control: Two weevils introduced from Europe (*Rhinocyllus conicus* and *Trichosirocalus horridus*) have been used to control musk thistle.

Tonto NF Goals & Strategy: Musk thistle is an "A" species – new infestations receive the highest priority for eradication. When musk thistle was first discovered on the Tonto NF, a large effort was expended to manually remove all plants that were found. Repeated surveys in Robert's Draw north of Payson have turned up additional small infestations. Robert's Draw is the only known site where musk thistle grows on the Tonto NF.

Southern & Field sandbur
Cenchrus echinatus, C. spinifex

Cultural control/Use of prescribed fire: Requirements for routine cleaning of equipment brought in for fire suppression or used for construction projects will prevent new infestations.

Flaming is effective, if done prior to seed set. Flaming is not necessarily total burning of the plant. Flaming is application of fire to green plants, effectively killing them by bursting cells. It is usually done with propane torches.

Mechanical/hand control: Tillage is effective only when plants are small. It may possibly increase seed germination by burying seeds on the soil surface that have not already germinated due to light-inhibition. Even relatively deep tillage is not effective in controlling sandbur, as seeds can germinate from a depth of four inches.

Repeated mowing prior to flowering will reduce, but not eliminate seed production. Mowing is most effective at the boot stage of development. Disturbance by road maintenance activities is liable to spread the bur-like seeds of these two grasses. Agencies who mow rights-of-way along SR 188, U.S. 60, and roads through Globe will be made aware of the location of field sandbur infestations known in these areas, in order to take measures to avoid spreading seeds with mowers and other heavy equipment.

Herbicidal control: Chemical control can be very effective. There are currently no known cases of herbicide resistance in *Cenchrus* species, even though they commonly grow near crop fields.

Biological control: There are no biological controls for sandbur.

Tonto NF Goals & Strategy: There is currently only one known sandbur infestation on the Tonto NF. It was found near extensive patches of sandbur on the Fort Apache Reservation, on State Route 188 north of Globe, shortly before a highway reconstruction project. It has not been found now that the highway project has been completed, but it very likely will show up somewhere in the general vicinity, since no measures were taken to prevent its spread. Treatment of this plant must be coordinated with our neighbors on the reservation before any treatment on the Forest would be effective. Our goal is to eliminate this plant from the right-of-way on Highway 188 and prevent new infestations.

Diffuse knapweed
Centaurea diffusa

Cultural control/Use of prescribed fire: The use of fire has demonstrated mixed results for managing diffuse knapweed. Fire followed by vigorous grass regrowth can reduce knapweed stands; however, crown resprouts and increased seedling germination may eliminate any benefits from burning.

Mechanical/hand control: Hand pulling of small infestations of diffuse knapweed has shown considerable success. Since resprouting from the crown can occur, the entire plant must be removed. Hand pulling must be repeated 2 to 4 times a year and is easiest when the plants have begun to bolt in the late spring and the soil is still moist. Hand pulling of large infestations is labor intensive and may not always be feasible.

Herbicidal control: Herbicides can be used to control existing stands of diffuse and spotted knapweeds and substantially reduce seed production; however, since the seed of both species is viable in the soil for up to seven years, retreatment will be necessary. Long-term reductions in the seed bank must be the goal for effective knapweed management with herbicides (CDFA, 2005). Applying the correct herbicide to newly emerged plants following a burn is an effective approach.

Biological control: There are 12 insects established in the western U.S. that attack diffuse knapweed. These insects are most effectively used in combinations that affect different life stages of the thistle.

The gall-forming flies *Urophora affinis* and *U. quadrifasciata* are seedhead feeders, but do not significantly adversely affect seed production of diffuse knapweed. *Chaetorellia acrolophi*, the peacock fly, three weevils, *Bangasternus fausti*, *Larinus obtusus*, and *Larinus minutus*, the fly *Terellia virens*, and the moth *Metzneria paucipunctella* feed on seedheads. *L. minutus* may be especially damaging, as one larva can destroy the entire contents of a seedhead, along with any other insects that are in that seedhead. *L. obtusus* prefers spotted knapweed. *L. minutus* is established in Arizona. Roots are damaged by the larvae of the buprestid beetle *Sphenoptera* *jugoslavica*, the weevil *Cyphocleonus achates*, and the moths *Pterolonche inspersa* and *Agapeta zoegana*.

Two fungal pathogens are not yet cleared as biocontrol agents, but show promise for effective control of diffuse knapweed: *Puccinia jaceae* attacks the leaves, and *Sclerotinia sclerotiorum* attacks the crowns (Piper & Story 2004).

Tonto NF Goals & Strategy: This plant is quite widespread in the community of Pleasant Valley and there are many patches of it on the National Forest on the Pleasant Valley Ranger District. Containment and eventual eradication are the goal for this species. The Tonto NF will work with the Tonto Weed Management Area and the community of Young to prevent spread of the infestation to new locations. Known patches on the Forest will be treated by one or more of the methods above each year, and employees will be educated to identify and report new infestations they find during the course of their duties. When possible, new areas will be surveyed.

Spotted knapweed
Centaurea stoebe

Cultural control/Use of prescribed fire: Revegetation with desirable plants creates competition that stresses spotted knapweed. Together with other control methods, this can be part of an effective treatment program.

Mechanical/hand control: Small infestations of spotted knapweed can be controlled by persistent hand-pulling done prior to seed set. Care must be taken to remove the entire crown and taproot, as it can regrow from the base. Gloves should be worn when working with spotted knapweed.

Herbicidal control: Control of spotted knapweed infestations using three chemical herbicides (2,4-D, clopyralid, and picloram) has been reported effective (Carpinelli, 2005). This project proposes use of clopyralid and picloram, among others listed for use in the proposed action.

Biological control: A variety of natural enemies are used as biological control agents for large infestations of spotted knapweed. Most biocontrol techniques use insect larvae to damage the root, stem, leaf, or flower. Two species of seed head flies, *Urophora affinis* and *U. quadrifasciata*, are well-established on spotted knapweed in other areas. The larvae of these species reduce seed production by as much as 50 percent by feeding on spotted knapweed seed heads and causing the plant to form galls (Carpinelli, 2005). There are three species of weevils that are seedhead feeding agents. They are *Larinus minutus, Larinus obtusus* and *Bangasternus fausti*, which feed on spotted knapweed and have been released in Arizona. Three moth species (*Agapeta zoegana*, *Pelochrista medullana*, and *Pterolonche inspersa*) and a weevil (*Cyphocleonus achates*) that feed on spotted knapweed roots have also been released in the U.S. (Carpinelli, 2005). The collective stress on the plant caused by these insects reduces seed production and may lead to reduced competitiveness.

Long-term grazing by sheep and goats has been found to control spotted knapweed (Carpinelli, 2005).

Tonto NF Goals & Strategy: Spotted knapweed is an “A” species – any new infestations are to be eradicated before they have a chance to spread. The Payson Ranger District found this weed growing in their parking lot in 2009. They successfully treated it with application of the herbicide Milestone. Monitoring shows it has not returned. A very small infestation was identified at the

Payson materials pit at the north end of Payson, in 2008. Heavy equipment was used to dig a large deep hole, where topsoil scraped to a depth of 4 to 6 inches from the knapweed site was deposited and covered with clean soil. Subsequent monitoring of this site has not detected any recurrences (Fenner, 2011).

Malta starthistle
Centaurea melitensis

This species is currently not on the state's list of regulated plants. Creation and enforcement of a weed-free hay order will go a long way toward preventing new infestations. It is possible this weed is growing on agricultural fields on private lands within the Forest boundary. The Forest will attempt to work with these private landowners to treat Malta starthistle infestations on "both sides of the fence."

Cultural control/Use of prescribed fire: Managing for high quality range condition will prevent large areas of open space available for infestation by starthistle.

Burning, when used prior to herbicide application, serves three purposes – it eliminates a large number of seeds; stimulates seeds in the soil to germinate, and removes an overstory that would prevent herbicide from reaching newly germinated seedlings. DiTomaso recommends late spring/early summer flaming for yellow starthistle, before seed set (DiTomaso & Johnson, 2006). Yellow starthistle is a close relative of Malta starthistle; both are cool-season annual forbs. Managers should not be discouraged when there are still abundant Malta starthistle crops germinating after a few years of treatment. Seeds live for ten years in the soil and by encouraging germination; the seedbank is worn down more quickly. Any treatment methods are necessarily long term with this annual plant. DiTomaso reports that burning of yellow starthistle for one year reduced the seed crop by 75 percent, but this was not sufficient to reduce the infestation. Two consecutive years of burning further reduced the seed bank. After three consecutive years of prescribed burning, the yellow starthistle seedbank was reduced by 99 percent, and cover of yellow starthistle was reduced by 91 percent. DiTomaso also recommended use of herbicides the year following a prescribed burn for starthistle control.

Mechanical/hand control: Mechanical methods, including pulling, grazing, mowing, burning, and cultivation, can be used over a period of several years to deplete seed banks and manage infestations (Donaldson & Raffert, 1986).

Hand pulling is effective for small populations. Once plants have shed seed in a location, it must be revisited several times each year, for 7 to 10 years, to pull seedlings.

Mowing, if done at the correct time of year, can be a part of the integrated weed management plan for Malta starthistle. Roadsides with dense infestations should be mowed at early flowering, in order to avoid scattering seeds during the fruiting stage. Mowing should be used carefully, as it is likely to spread the infestation and make it much worse, if done during the time of year when seedheads are mature or if proper procedures to prevent spread are followed. These procedures include beginning mowing in uninfested areas and moving toward infested areas, and thoroughly washing equipment after running it through sites known to have Malta starthistle. Mowing is not an optimal treatment, as a Malta starthistle plant will produce a flower very near its base early in the plant's life. This flower is at ground level, below where mowers will cut; therefore even mown plants will produce at least some seed.

Herbicidal control: Herbicides selective for broadleaf weeds are desirable, since Malta starthistle often grows in rights-of-way in close association with native perennial grasses. ADOT has used clopyralid + chlorsulfuron along Highway 188 to control Malta starthistle; aminopyralid has also been used by ADOT and the Tonto NF. These are both very effective herbicides for the starthistles.

Biological control: Scientists are studying biological controls in the hopes of finding an insect or disease that will help reduce Malta starthistle populations. The beetle, *Lasioderma haemorrhoidale*, which feeds on seed heads, was introduced unintentionally from the Mediterranean region, but does not appear to adequately control the weed. Research completed in 2001 suggests that the rust, *Puccinia centaurea*, holds some promise for control. It is specific to Malta starthistle, and does not infect yellow starthistle or bachelor's button (*Centaurea cyanus*). The research suggests that heavy, early infection with the rust tends to suppress further growth and reproduction of Malta starthistle, although further research is needed to confirm these findings (Donaldson & Rafferty, 1986). *Eustenopus villosus* has been observed feeding on Malta starthistle. APHIS may want to investigate the utility of this weevil for helping to control the large Malta starthistle infestation in Tonto Basin.

Tonto NF Goals & Strategy: The Tonto NF, in partnership with ADOT, has used prescribed burning in the summer/early fall, combined with follow-up applications of herbicide in the winter and early spring to reduce infestations along Highway 188 on the Tonto Basin RD. Flaming and grubbing have been used on small infestations on the Payson, Cave Creek and Globe RDs, and in the town of Payson.

Many infestations of this plant are too large (hundreds of acres) to be treated manually. Some infestations that have been manually removed have returned even larger in successive years.

Partnering with neighboring landowners is essential for effective treatment of Malta starthistle, since it is an annual plant that spawns large numbers of easily dispersed seed. Strategy for this weed involves removal from heavy-traffic areas, such as along roads and highways, combined with locating the outer edge of the infestation and treating "from the outside in," and also finding and treating spot infestations, while they are still small. This strategy can be likened to that of fighting a large fire – containment, combined with special attention to "hot spots" scattered outside the perimeter of the main infestation.

Yellow starthistle
Centaurea solstitialis

Cultural control/Use of prescribed fire: Burning can provide control, if implemented before seed is produced (CDFA, 2005; DiTomaso & Johnson, 2006). See discussion above about use of prescribed fire for Malta starthistle.

Mechanical/hand control: Mowing is most effective when plants are cut below the lowest branches and 2 to 5 percent of the total population of seed heads is in bloom. Mowing too early can result in increased seed production (CDFA, 2005).

Herbicidal control: Clopyralid, picloram and aminopyralid are the most effective herbicides for fall season control of yellow starthistle. Unlike most post emergence herbicides, they provide both foliar and soil activity (DiTomaso, 2001). All starthistles are highly susceptible to the herbicide clopyralid (CDFA, 2005).

Biological control: Six biological control agents of yellow starthistle have been imported from Europe and are well established in the western United States. Of these, the most effective are the hairy weevil (*Eustenopus villosus*) and the false peacock fly (*Chaetorellia succinea*). These insects attack the flower/seed head, and directly or indirectly reduce seed production by 43 to 76 percent. They do not, by themselves, provide sustainable management of starthistle, but can be an important component of an integrated approach (DiTomaso, 2001). The hairy weevil has been introduced on the Coconino NF in 2006 and 2007. The weevil *Larinus curtis* was introduced to yellow starthistle infestations on the Coconino NF in 2006. APHIS is also working to establish the agent *Eustenopus villosus* in Arizona.

High intensity, short-duration grazing by sheep, goats, or cattle can be implemented during the period when plants have developed flowering stems, but not when spiny heads are present.

Tonto NF Goals & Strategy: Yellow starthistle is a "B" species, as it is very common on private lands and is becoming a common weed on the Payson and Pleasant Valley RDs. As such, our goal is to contain its spread, pushing it back toward the areas of oldest and densest infestation. New spots will be aggressively treated. It is also our strategy to partner with local landowners and towns in combating this prolific weed. This species has been successfully treated with the herbicide Milestone (active ingredient aminopyralid) in the Payson and Star Valley areas. Due to recent successes in treating infestations in the area of Star Valley and Houston Creek, the staff on the Tonto NF is cautiously optimistic this species may eventually be eliminated on the Forest, providing we are able to enlist private landowners to control their infestations.

Curveseed butterwort
Ceratocephala testiculata

Cultural control/Use of prescribed fire: This plant is an invader of open, disturbed areas, so maintenance of good ground cover is important. Effects of fire are unknown.

Mechanical/hand control: This is a very small plant, which makes manual control difficult. It grows close to the ground, which makes mechanical control measures such as mowing impractical.

Herbicidal control: Broadleaf herbicides with adjuvants to allow the herbicide to penetrate the hairy plant surface are effective.

Biological control: There are no known biocontrol agents for this plant.

Tonto NF Goals and Strategy: Curveseed butterwort is an "A" species, and should be controlled soon after it is found. Only very small infestations have been found to date (less than 0.01 acre) on the Payson Ranger District. Employees and volunteers should be educated to recognize this plant, so that new infestations can be quickly controlled.

Rush skeletonweed
Chondrilla juncea

Cultural control/Use of prescribed fire: Proper grazing management will prevent creation of large disturbed areas that are open to new infestations (CDFA, 2005).

Mechanical/hand control: Hand pulling can be effective, even though this plant has extensive carbohydrate reserves in its roots, if it is done a few times each growing season (Sheley, et al., 1999). However, rush skeletonweed seedlings may form shoot buds from root fragments as young as 2 weeks old, and 95 to 100 percent of 5 to 7 week-old seedlings can regenerate from root fragments (Cuthbertson, 1972).

Mowing reduces seed production, and over time, may reduce the plant’s ability to send up new rosettes from adventitious root buds (WSNWCB, 2007).

Herbicidal control: Once established, rush skeletonweed is extremely difficult to control using herbicides, primarily due to the difficulty of translocating herbicides into its extensive root system. Since 1944, trials have been conducted on rush skeletonweed with practically every new herbicide to come on the market. Of several herbicides tested for rush skeletonweed control in Washington in 1964, only picloram and dicamba were "acceptably effective." These herbicides provided most consistent results when applied in the fall (Zouhar, 2003a). Spring application of picloram and metsulfuron methyl have successfully treated rosettes and bolting plants. Glyphosate also works well, but is non-selective.

Biological control: Several organisms including insects, viral particles, and fungi, have been intensively studied as potential biological control agents for rush skeletonweed. The first effective biological control program for rush skeletonweed, involving several control agents, was established in Australia in the 1960s. These agents include the gall mite (*Eriophyes chondrillae*), the gall midge (*Cystiphora schmidti*), and the rust fungus (*Puccinia chondrillina*); the latter being the most effective (Zouhar, 2003a). The rust has multiple generations per year and has demonstrated success in California. This is the first example of an exotic fungus successfully used in biocontrol of a weedy plant (CDFA, 2005). Use of these biological agents is complex, and must fit in with an overall treatment program that includes other treatment methods.

Tonto NF Goals & Strategy: Chondrilla juncea is an “A” species – any plants observed will be documented and treated as quickly as possible.

Blue mustard
Chorispora tenella

Cultural control/Use of prescribed fire: Blue mustard is often dispersed as a seed contaminant. Following the protocol of having all seed lots checked for seeds on the TontoNF’s weed list by a state-approved lab prior to use could save much time and money later in removal of new infestations.

Mechanical/hand control: Cultivation is effective for control. Blue mustard can also be controlled by mowing, if done during early flowering. Small infestations can be hand pulled fairly easily, as it has a shallow taproot (CDFA, 2005).

Herbicidal control: Blue mustard is known primarily as a weed in grain crops. As such, it has evolved to become tolerant and somewhat resistant to typical 2,4-D use rates (CDFA, 2005). Herbicides that are effective against blue mustard include chlorsulfuron, dicamba, glyphosate, and sulfometuron. Most herbicide treatments work best when blue mustard is in the rosette stage.

Biological control: There are no approved biological controls for blue mustard at this time.

Tonto NF Goals & Strategy: This is an “A” species that has not yet been documented on the Tonto NF. Any new infestations are to be recorded, then eradicated.

Canada thistle
Cirsium arvense

Cultural control/Use of prescribed fire: Early season burning can stimulate its growth, so prescribed burns should be scheduled for late in the growing season.

Mechanical/hand control: Mechanical/hand control methods must be repeated often to wear out the carbohydrate root reserves. Small infestations can be eradicated with hand-pulling, if done repeatedly during over a growing season and over a period of several years.

Herbicidal control: Systemic herbicides that are translocated to the plants' roots are most effective. Repeated applications at a site are probably necessary, due to the long life of seeds in the soil (Thunhorst & Swearingen, 2005).

Biological control: The larvae of a native North American insect, the painted lady butterfly (*Cynthia cardui*) defoliates thistle (Moore, 1975). Three insects have been introduced and are available commercially: the Canada thistle stem weevil (*Ceutorhynchus litura*), whose larvae feed on new leaf, stem, root crown and root tissue; Canada thistle bud weevil (*Larinus planus*), whose larvae feed on the seed head while adults feed on the foliage; and the thistle stem gall fly (*Urophora cardui*), whose larvae develop within the stem, thereby interrupting nutrient flow in the plant (Morishita, 2003).

Two pathogenic rust fungi have been tested for Canada thistle control. *Sclerotinia sclerotiorum* affects the roots and crown; studies show it can cause death to 20 to 80 percent of new shoots (Graham, et al., 2003.). This fungus is not specific to Canada thistle. Another rust fungus that has been found to be specific to Canada thistle is *Puccinia punctiformis*, an obligate rust fungus parasite. It reduces flowering and vegetative reproduction (Morishita, 2003).

Tonto NF Goals & Strategy: Canada thistle is uncommon on the Tonto NF. All infestations should be controlled when found, using a combination of treatments listed above. In the summer of 2009, a newly discovered infestation of Canada thistle was treated with the herbicide Milestone. Follow-up monitoring in 2010 and 2011 showed some success, but continued control measures will be needed for several years.

Bull thistle
Cirsium vulgare

Cultural control/Use of prescribed fire: Since bull thistle is adapted to move into an area following burns, prescribed burns are not the best tool to use for control. Flaming of individual plants, with no soil surface disturbance may serve to kill plants and prevent them from maturing to produce seed. Ground disturbance, including heavy grazing by wildlife or domestic livestock increases vulnerability of a site to infestation by bull thistle and other thistles, as well. Competition by native perennial grasses is one deterrent to infestation by thistles.

Mechanical/hand control: Cutting and bagging flower and seed-heads prior to seed development, then using a spade to sever the taproot on the plant will kill the plant and remove any developing seeds.

Herbicidal control: Herbicides that are specific for broadleaved weeds are good tools for bull thistle control. When bull thistle is in the rosette stage, aminopyralid, clopyralid, dicamba, or picloram are good herbicide choices. After bolting begins, metsulfuron or chlorsulfuron are best.

For bull thistle that grows in floodplains and along streambanks, herbicides rated for aquatic application will be used.

Biological control: Using a combination of microfauna that attack different life stages of the plant, combined with seeding with native grasses, is a proven effective technique to control thistles. The seedhead weevil *Rhinocyllus conicus* prefers thistles of the genus *Carduus*, but will also attack other *Cirsium* species that are native species. The weevil *Trichosirocalus horridus* has larvae that feed on growing points of rosettes and developing shoots. Beck (1999) recommends integrating use of herbicides with insect biological control for the best results. This is best done by releasing insects into the center of an infestation, and using herbicides around the perimeter.

Tonto NF Goals & Strategy: Bull thistle is a "C" species on the Tonto NF. Forest strategy is to treat high priority sites first, such as meadows and streamsides of Canyon Creek, by removing flowers/seedheads and grubbing rosettes throughout the summer and fall. Many volunteer groups have been recruited for this project, and ranger district Youth Conservation Crews (YCC) crews have worked on Canyon Creek as one of their summer projects. Bull thistle growing in some campground areas has been effectively treated with glyphosate and aminopyralid herbicides.

In addition, disturbed areas, such as areas that have been burned, logged, or had pile burning will be surveyed for presence of bull thistle seedlings as soon as possible after the disturbance, in order to control bull thistle before it has a chance to produce seed. The Forest is doing trials of inoculating with mycorrhizae and/or seeding burn piles to find a cost-effective technique to prevent new bull thistle infestations in forest areas where thinning has been done.

Field bindweed
Convolvulus arvensis

Cultural control/Use of prescribed fire: Field bindweed is normally associated with old homesteads, roads, or other disturbed areas. Infestations that occur in these situations can be limited to the old disturbance by avoiding new ground disturbance in those sites, and good management practices to retain a good vegetative ground cover.

Mechanical/hand control: Hoeing or hand pulling may be helpful, but may also encourage the germination of dormant seeds or further promote vegetative growth by breaking up and spreading the plant (Morishita, et al., 1990).

Herbicidal control: Glyphosate is among the most effective herbicides for field bindweed. Most investigators recommend spraying during first bloom, when root carbohydrate reserves are at their lowest. Full-grown vines have a large leaf surface area to absorb the herbicide, and during vigorous above-ground growth, the plant is moving sugars to the roots and root buds. Dicamba and picloram have also been used for field bindweed control (Lyons, 1998).

Biological control: Two biocontrol agents, the bindweed gall mite (*Aceria malherbae*) and bindweed moth (*Tyta luctuosa*) are cleared for release in the U.S. It is unknown at this time, however, if related genera, such as *Calystegia* are susceptible to attack (CDFA, 2005). The bindweed moth has been released in Arizona (CDFA, 2005).

Tonto NF Goals & Strategy: Field bindweed is a "C" species on the Tonto NF. It has not been a problem weed in wildland situations, but may be locally abundant on disturbed sites, or historically disturbed sites. It has low priority for treatment, compared with other much more invasive weeds such as the starthistles and knapweeds. If it appears to be moving into undisturbed sites or is otherwise a local problem, it will be treated. Populations in disturbed areas will be treated as the opportunity arises.

Bride's bouquet, white bietou
Dimorphotheca cuneata

Cultural control/Use of prescribed fire: Since catclaw acacia is the most abundant perennial plant growing in the area of the white bietou, and it is a native invasive plant, planting of other desirable plants after removal of the white bietou is an important part of an integrated strategy to remove the bietou.

Flaming can be used to kill individual plants. It is not known if they resprout from the crown.

Mechanical/hand control: Removal using hand tools is a viable option for keeping this invasive plant in check.

Herbicidal control: Spot treatment with backpack herbicide sprayers will target this species and not affect other species growing in the area.

Biological control: There are no studies or records of biological control agents for this species.

Tonto NF Goals & Strategy: The one infestation on the Forest will be contained within an area of approximately 40 acres or less by working inward from the western edge. Treatment of this species is a low priority at this time.

Common teasel
Dipsacus fullonum

Cultural control/Use of prescribed fire: Spot burning or flaming of individual plants will provide effective control, when used with other tools.

Mechanical/hand control: Hand pulling or use of sharp spades are methods that work well when used in combination with other methods for small infestations, such as those on the Tonto NF. Areas that have been controlled using this method should be checked later in the year for sprouts. Near the end of the growing season, flowering stalks can be cut and removed from the site. If this is done after full bud stage, the plant does not send up more flowering stalks.

Herbicidal control: Glyphosate and triclopyr applied before bolting have been effective control measures (WDNR, 2004). In riparian areas, herbicides must be labeled for aquatic use.

Biological control: There are currently no approved biological control agents for teasel.

Tonto NF Goals & Strategy: There are few teasel infestations on the Forest that are known at this time. Eradication is a realistic goal. Isolated infestations will be treated as they are found. A combination of manual removal, burning and herbicides is an effective treatment for common teasel (WDNR, 2004).

Russian olive
Elaeagnus angustifolia

Cultural control/Use of prescribed fire: The recommended method of control is prescribed burning combined with chemical control (Tu, 2003).

Mechanical/hand control: Saplings and sprouts can be removed with hand tools when the soil is moist (Tu, 2003).

Herbicidal control: Foliar and basal bark applications of glyphosate, imazapyr, and triclopyr are effective, especially for young trees. For mature trees, recommended application methods are cut-stump, hacking and frilling (using an axe to make shallow cuts in a pattern around the entire trunk, then applying herbicide into the cuts), and girdling with injection of herbicide.

Biological control: No biocontrol agents are known for this species.

Tonto NF Goals & Strategy: Any plants found should be a high priority for treatment, as this species is not found on the Forest now.

Quackgrass
Elymus repens

Most of the literature about control methods for this species involves crop situations. There is little published material on its control in wildlands.

Cultural control/Use of prescribed fire: Burning combined with use of herbicides has been reported to be effective to control spread of quackgrass (Batcher, 2002). Burning on a repeated or biennial schedule for several years has been effective in eradicating quackgrass in some situations (Howe, 1995).

Mechanical/hand control: Tillage is used in cropland situations, and may be an option for heavily infested roadsides, when combined with other methods.

Herbicidal control: Haase reported that the use of herbicides was extremely effective in controlling quackgrass (Batcher, 2002). Chemicals he used were Roundup (glyphosate) and Fusilade (fluazifop), which is a grass-specific herbicide. He noted that spraying done early enough in the season (quackgrass is a cool-season grower), will not affect warm-season grasses.

Biological control: There is no information on approved biocontrol agents for quackgrass.

Tonto NF Goals & Strategy: Infestations along roads should be limited to a narrow zone, and then eliminated. Spot infestations away from major highways should be eradicated, if small (under one acre) and contained (work to remove plants from outer edges of the site toward the inside) if large (over one acre).

Weeping and Lehmann's lovegrass
Eragrostis curvula & E. Lehmanniana

Cultural control/Use of prescribed fire: Prevention of more introductions is the best method to manage infestation of these nonnative grasses. All seed that is to be used on National Forest land should be inspected by a certified seed-testing lab for both of these lovegrass species.

Mechanical/hand control: Treatments such as chopping or mowing only mimic grazing by animals, which lovegrasses are well-adapted to withstand.

Herbicidal control: Use of herbicides is probably the most effective method to remove extensive stands of lovegrasses. This must be balanced against possible damage to other vegetation and creation of open ground, open to colonization by other, possibly worse invasive species, or accelerated erosion. Herbicides that would control *Eragrostis* would also kill native grass species. Some off-target kill may be avoided by timing of herbicide application. *Eragrostis* is a cool-season grower, where most associated perennial grass species are not; however, spraying during the cool season could damage existing native cool-season grasses.

Biological control: There are no documented biological control agents for *Eragrostis.*

Tonto NF Goals & Strategy: Both *Eragrostis* species are "C" species on the Tonto NF. They are extremely widespread due to past practices of including them in revegetation seed mixes. Current strategy is to not introduce additional infestations by requiring all seed mixes used on the Forest, to be checked for presence of *Eragrostis* seeds. If it is accidentally introduced, immediate measures will be taken to eradicate new populations.

One pilot project on the Payson RD is using permitted cattle to concentrate grazing use on weeping lovegrass that was seeded after the Dude Fire, and encourage growth of native perennial grasses. Monitoring is ongoing.

Leafy spurge
Euphorbia esula

Because of its persistent nature and ability to regenerate from small pieces of root, leafy spurge is extremely difficult to eradicate.

Cultural control/Use of prescribed fire: Requirement for weed-free feed for all livestock brought onto the National Forest would help to prevent new infestations of leafy spurge (Lajeunesse, et al., 1999). There are no immediate plans in this Region for such an order. Requiring clean equipment brought in for fire suppression and other ground-disturbing activities will also prevent this weed from infesting the Tonto NF.

Burning prior to herbicide application allows easier visibility and better targeting of herbicide application, with removal of the overstory foliage.

Mechanical/hand control: Pulling by hand is ineffective, even for small patches, because of the extensive root system.

Herbicidal control: Several systemic herbicides have been found to be effective if applied when the flowers and seeds are developing, or later in the season, when the plants are moving nutrients downward into the roots. Preliminary research suggests that chemical treatment in the fall followed by a spring burn to reduce seed germination may be an effective strategy for reducing leafy spurge infestations (Thunhorst & Swearingen, 2005).

Biological control: The U.S. Department of Agriculture has shown success using six natural enemies of leafy spurge imported from Europe. These include a stem and root-boring beetle (*Oberea erythrocephala*), four root-mining flea beetles (*Aphthona* spp.) and a shoot-tip gall midge (*Spurgia esulae*) (Thunhorst & Swearingen, 2005).

Sheep will graze leafy spurge; the initial effect may be an increase in stem densities by removal of apical dominance and stimulation of growth of root buds, but continued summer-long grazing over three years may reduce leafy spurge density dramatically. Effects to associated species with this management technique should also be considered. Grazing of this intensity should be reserved for densely infested problem areas only.

A combination of sheep grazing with use of the flea beetle *Aphthona* has been successful when sheep are allowed to graze in the spring, removed during egg laying period of the beetle, and then put back into the pasture for grazing in the fall.

Fall grazing by goats, followed by application of herbicides allows the herbicide to work on newly growing sprouts of the plant that have been stimulated to grow by the grazing (Lajeunesse, et al., 1999).

Tonto NF Goals & Strategy: Any individuals or small infestations found are a very high priority for treatment, using herbicides.

Spreading wallflower
Erysimum repandum

Cultural control/Use of prescribed fire: This plant is adapted to invading disturbed sites in full sun; thus cultural vegetation management techniques that increase ground cover of native plants will serve to help prevent its invasion. There is no information on whether seeds of this plant are resistant to fire.

Mechanical/hand control: Small infestations of this small annual mustard can be easily hand-pulled. This should be done before seed set so that disturbance of the plant does not scatter seed.

Herbicidal control: A variety of herbicides will control this plant, but must be applied in the short time between when it germinates and when it flowers, in the winter/early spring.

Biological control: There are no known biocontrol agents for this plant.

Tonto NF Goals and Strategy: Spreading wallflower is common on the Agua Fria National Monument, which lies on the western boundary of the Tonto NF. The Tonto NF’s portion of the grassland should be managed for adequate groundcover to prevent invasion. Prescribed burning and grazing practices should be carefully applied to maintain native groundcover. Spreading wallflower is an “A” species on the Tonto NF.

Sweet resinbush
Euryops subcarnosus ssp. vulgaris

Cultural control/Use of prescribed fire: Prescribed burning has been tried to treat sweet resinbush. Burns were unsuccessful due to lack of fuels to carry the fire (Schalau, 2001).

Mechanical/hand control: Hand grubbing of very small infestations on the Tonto NF has completely controlled some of them. Hand removal of resinbush at Sabino Canyon has been effective at reducing the population to very low levels (Schewel, 2007). Manual removal of the Tonto NF’s infestation near the Miami cemetery often results in proliferation of seedlings the following season.

Herbicidal control: Recent aerial application of hexazinone to an infestation near Safford, Arizona has achieved some success (McReynolds, 2005). An infestation at the Santa Rita Experimental Range was treated with a combination of mechanical and herbicide treatments that greatly reduced sweet resinbush species composition and density (Howery, et al., 2003). An infestation at Cottonwood has been treated for five consecutive years with herbicides, and the population is declining.

Biological control: There are no biocontrol agents approved for use on sweet resinbush.

Tonto NF Goals & Strategy: Our goal is eradication for all infestations, using a combination of manual removal and herbicides. Sprouting of seedlings after either manual or herbicidal removal of mature plants is common. Monitoring and follow-up treatments are necessary for any type of resinbush treatment.

Dyer's woad
Isatis tinctoria

Cultural control/Use of prescribed fire: Prevention and early detection are very important, especially since this plant spreads very rapidly once it infests a site.

Mechanical/hand control: Mowing is not effective, since dyer's woad sprouts from the crown. Hand pulling may work well to reduce small infestations – it is most easily pulled after bolting and before seed set. It is necessary to follow up for several years, due to the seedbank in the soil. Longevity of seed in the soil is unclear, but experience has shown it is at least several years (CDFA, 2005). It is most easily visible before seed set, with distinctive bright yellow flowers. There is only a four-week window between flowering and seed set, so it is critical to have crews available at that specific time. The fleshy taproot must be removed, or plants will resprout. Pulling should be scheduled for two to three times each season, for several years.

Herbicidal control: Herbicides such as metsulfuron are economical, if used during the seedling to rosette stages. On roadsides, chlorsulfuron may be applied pre-emergence or post-emergence to seedlings and rosettes (CDFA, 2005).

Biological control: The native rust *Puccinia thlaspeos* is a recently discovered biocontrol agent (CDFA, 2005). This is a non-specific pathogen, but has been distributed to various states with dyer's woad. The rust is systemic in its activity. Severely infected plants produce few to no seeds; seedlings and rosettes are often killed.

Tonto NF Goals & Strategy: Our strategy is prevention, since this weed is currently not known to be on the Tonto NF. Dyer's woad is an "A" species, so Forest personnel should be trained to recognize this plant, immediately report it and eradicate it when located.

Kochia
Kochia scoparia

Cultural control/Use of prescribed fire: Kochia is a common invader of disturbed sites. Preventive measures include requirement of weed-free seed (inspected for the Tonto NF list, which includes Kochia), inspection of newly-disturbed sites such as road construction sites, and early removal.

Mechanical/hand control: Tillage of infested roadsides is an effective tool for treatment (Hager, 2001). Cutting plants before flower production is effective in reducing seed production.

Herbicidal control: Application of the herbicides glyphosate or dicamba is a recommended control method (Hager, 2001). There are many biotypes of Kochia resistant to triazine, 2,4-D or dicamba. If herbicides are used, different ones should be used each time in any given location.

Biological control: There are no known biological control agents for use on Kochia.

Tonto NF Goals & Strategy: Kochia is rare on the Tonto NF. Our goal is eradication.

Oxeye daisy
Leucanthemum vulgare

Cultural control/Use of prescribed fire: Areas that are cultivated should be revegetated with desirable native seed. Deep mulching (3 to 4 inches deep) with rice straw has eradicated oxeye infestations in California. This is a very intensive treatment - one straw bale covers approximately 100 square feet. Since bright seedheads can attract flower picking, it is necessary to post signs where people may be gathering the flowers. The seedheads shed seeds easily.

This plant is commonly sold as an ornamental for higher elevation gardens. Addition of this species to the Arizona Department of Agriculture Prohibited weed list would provide legislation to prevent it from being imported and sold in the state.

Mechanical/hand control: Hand removal can be effective, if the population is small (less than 0.25 acre). Shallow cultivation (less than six inches) only spreads roots. Deeper cultivation exposes roots to desiccation. Subsequent shallow cultivations can be used to kill seedlings. Cultivating large areas of soil leaves seedlings open to invasion by other invasive species.

Herbicidal control: Picloram, imazapyr, sulfometuron methyl, and dicamba are effective at label concentration when applied in the early flowering stages. These herbicides persist in the soil. Oxeye daisy is moderately resistant to 2,4-D and dicamba, and these herbicides can damage non-target species (Alvarez, n.d.).

Biological control: As of 1998, no biological control agents had been approved for oxeye daisy (Olson & Wallander, 1999).

Tonto NF Goals & Strategy: Complete eradication of a large population can be difficult because of the small size of the plant, abundant seed production, and longevity of seed in the soil. At this time, no large infestations have been documented on the Tonto NF; therefore, priority should be given to eradicating small infestations.

Dalmatian toadflax, Yellow toadflax
Linaria dalmatica, *Linaria vulgaris*

Cultural control/Use of prescribed fire: Education for identification of toadflax and routine requirement for clean equipment for wildfires and construction projects will help prevent infestations brought in from outside the National Forest.

Mechanical/hand control: Large, deep root systems of toadflax do not make it a candidate for burning or mowing. Hand pulling before seed set each year can be an effective control method. This must be repeated for up to ten years to completely eradicate an infestation (Carpenter & Murray, 1998).

Herbicidal control: Herbicide treatment is an important tool for controlling toadflax. Herbicides should be applied during flowering, when carbohydrate reserves in the roots are at their lowest (Carpenter & Murray, 1998). The herbicides glyphosate, dicamba, and picloram are effective for controlling toadflax.

Biological control: Six insect species have been approved by the USDA-APHIS-PPQ for release as biological control agents for both toadflax species. These are: *Brachypterolus pulicarius*, a shoot and flower-feeding beetle, *Calophasia lunula*, a defoliating moth, *Eteobalea serratella* and *E. intermediella*, small root-boring moths, and *Gymnaetron antirrhini*, a seed-eating weevil (Carpenter & Murray, 1998). APHIS has found *Mecinus janthinus*, the stem-mining weevil to be very successful in the Pacific Northwest. This agent has been released in Arizona for control of Dalmatian toadflax. The Coconino NF is currently experiencing some success with use of the stem-mining weevil.

Grazing does not control either species of toadflax, as they are not palatable (Carpenter & Murray, 1998).

Tonto NF Goals & Strategy: Our goal is eradication. Toadflax populations are mostly limited in size and extent at this time. Most known sites are in locations where herbicides can be used, such as in the median of State Route 87. This site is being treated with both RoundUp and Milestone herbicides. RoundUp appears very effective at treating this species. Manual removal of the Dalmatian toadflax infestation at the Payson District Ranger Station has been ongoing for many years and has been largely ineffective. More recent use of herbicides containing glyphosate and aminopyralid have been much more successful in reducing density of this infestation.

Purple loosestrife
Lythrum salicaria

Cultural control/Use of prescribed fire: Prevention and early detection are good tools, since this species is very visible and distinctive. River rangers should be trained to recognize this weed.

Mechanical/hand control: Hand-removal is recommended for small populations and isolated stems. The entire rootstock must be pulled out since regeneration from root fragments is possible (Bende, 2001).

Herbicidal control: Broadleaf chemicals are effective in treating this species. Spraying should be done after peak bloom. It is critical that this be followed up the same growing season and for several years since some plants will be missed, new seedlings may sprout from the seed bank, and a few plants may survive the herbicide application (Bender, 2001). Glyphosate and dicamba are recommended (Bender, 2001).

Biological control: Four insects have been approved and are being used by APHIS for control of purple loosestrife: a root-mining beetle (*Hylobius transversovittatus*), a flower-feeding beetle (*Nanophytes marmoratus*), and two leaf-eating weevils (*Galerucella calmariensis* and *G. pusilla*) (Crisp, 2000).

Tonto NF Goals & Strategy: Purple loosestrife is an “A” species on the Tonto NF. Our goal is prevention or eradication. Large populations extending over three acres or more are difficult if not impossible to completely eradicate using presently known methods (Bender, 2001); therefore any new sitings are a high priority for eradication.

Yellow sweetclover
Melilotus officinalis

Cultural control/Use of prescribed fire: Seed mixes should be checked for presence of sweetclover seed.

Mechanical/hand control: Pulling or grubbing with hand tools will remove this species.

Herbicidal control: Herbicides that control broadleaf species could work on sweetclover. Its use as a crop or cover plant for many years has probably lent it resistance to some herbicides.

Biological control: As this is a crop plant, there are no biological controls being developed for treatment.

Tonto NF Goals & Strategy: This plant is not a priority weed to control; only locally important infestations will be treated. Most effort will be to prevent introduction of more sweetclover in seed mixes and control it when the opportunity arises.

Oleander
Nerium oleander

Cultural control/Use of prescribed fire: Burning is definitely not recommended, as the smoke from burning oleander is toxic.

Mechanical/hand control: Plants may be mechanically removed, if care is taken to remove the crown.

Herbicidal control: A combination of mechanical trimming plus use of herbicide, either as a spray or cut stump for larger plants is probably the most effective control method. Heavy trimming over a period of time would serve to reduce root carbohydrate reserves and also reduce the amount of herbicide that is required.

Biological control: There are no known biocontrol agents that control oleander. Its common use as an ornamental plant will preclude development of this type of control.

Tonto NF Goals & Strategy: Our goal is eradication.

Globe chamomile
Oncosiphon piluliferum

Cultural control/Use of prescribed fire: It may be possible to discourage use of this plant as an ornamental, which seems to be how it has been introduced and subsequently naturalized into wildlands. There is very limited literature on control methods for globe chamomile. It grows densely along rights-of-way, lending it to control by burning or use of broad-leaf specific herbicides.

Mechanical/hand control: Globe chamomile normally grows in dense patches for long distances. Pulling would not be effective unless very small patches were found. Tilling along roadsides may be effective, but could also prepare the ground for infestation by other invasive weeds.

Herbicidal control: There is limited information on specific herbicides that control globe chamomile in the U.S. Various broadleaf herbicides would probably be effective. This plant is a pest in Western Australia, where herbicide trials have been conducted (Rayner, 2009).

Biological control: There is no information on biological control agents for globe chamomile.

Tonto NF Goals & Strategy: Our goal is to contain, with eradication possible. This weed is newly discovered, but has spread through the town of Cave Creek and along I-17 north to New

River extremely rapidly. In the near future it will be a serious invasive threat to the Tonto NF's southwest corner.

Jerusalem thorn
Parkinsonia aculeata

Cultural control/Use of prescribed fire: Jerusalem thorn appears to be well-adapted to fire, as a one or two-tree planting grew quickly to a few acres after the Cave Creek Complex Fire burned through a recreation residence where a single tree had been planted. As the plant usually grows in the Sonoran desert, fire is not a management option.

Mechanical/hand control: Very young trees may be removed using a tool called a weed wrench, which levers the tree out of the soil. Saplings quickly develop deep root systems, so this is not an option for trees more than one or two years old.

Herbicidal control: Jerusalem thorn is a good candidate for basal bark or cut stump herbicide control. This technique has been used successfully by Dr. Ed Northam in field trials (Northam, 2009).

Biological control: There are no known biocontrol agents for this species.

Tonto NF Goals and Strategy: Our goal is to eradicate this species on the Forest. This will be a continuing project, as there is a seedbank in the greater Phoenix area that continually disperses to the north. However, presence of this plant is uncommon and it could be completely removed from the Forest.

Scotch thistle
Onopordum acanthium

Cultural control/Use of prescribed fire: Good range management for a groundcover of perennial grasses provides competition that can stress thistles.

Mechanical/hand control: As with bull thistle, any method that severs the root and removes the flower/seed head will kill the plant and prevent it from reproducing or sprouting.

Herbicidal control: Aminopyralid, clopyralid, dicamba, and picloram are recommended herbicides for control of Scotch, bull, and musk thistles in the rosette stage. Metsulfuron and chlorsulfuron are most effective when plants have begun to bolt.

Biological control: The seedhead weevil *Rhinocyllus conicus* has been used in neighboring states to control a variety of introduced invasive thistles, including Scotch thistle. It is not host-specific, and will also feed on native thistles (Beck, 1999).

Tonto NF Goals & Strategy: Maintaining properly-grazed pastures is key to preventing infestations of this and other thistles from invading many acres of rangeland. Our goal is eradication upon discovery of new infestations.

African rue
Peganum harmala

Cultural control/Use of prescribed fire: Prevention by maintaining healthy native vegetation is the best cultural control method. Burning is not an option, since it sprouts vigorously following fire.

Mechanical/hand control: Hand pulling of small infestations can be effective, if it is repeated multiple times each year. Cultivation and mowing are not options, as the plant sprouts from its crown following disturbance.

Herbicidal control: Glyphosate and metsulfuron have been found to be effective herbicides for control of African rue (Peachey, 2007). Triclopyr or triclopyr + imazapyr were found to be 80 percent effective in New Mexico (Davison & Wargo, 2001). The Extension Service in Nevada recommends that any control effort needs to be planned for a minimum of 3 years and multiple applications to kill African rue (Davison & Wargo, 2001).

Biological control: There are no known biological control agents for African rue. Grazing is not an option, as this plant is poisonous to most species.

Tonto NF Goals & Strategy: Our goal is prevention. African rue is an “A” species, meaning any new infestation is high priority for eradication.

Buffelgrass
Pennisetum ciliare

Cultural control/Use of prescribed fire: Burning stimulates growth of buffelgrass, so prescribed burning is not recommended. Burning may be a good tool to use in combination with use of herbicides, to remove the bulk of decadent growth that could prevent good herbicide contact with growing leaves.

Mechanical/hand control: Most mechanical/hand control methods simulate grazing, a treatment to which buffelgrass is well adapted. A group in southern Arizona has had much success with removal by digging the plants out by the root and removing them, being careful to bag and remove all of the seeds and flowers.

Herbicidal control: Herbicides are an option, but buffelgrass has a history of developing resistance to herbicides (ADOT, 2005). Glyphosate-based herbicides have proven very effective.

Biological control: There is no known biological control agent for either buffelgrass or fountain grass.

Tonto NF Goals & Strategy: This species will be managed with a containment strategy, combined with working along rights-of-way to eliminate it. The Forest has been using Department of Correction’s crews, volunteers and force accounts to manually remove a large infestation north of Gonzales Pass, on the Mesa RD. The infestation is spreading rapidly despite this effort. Herbicides will be used in the interest of cost-effectiveness, with an eye to preventing resistance by varying herbicide active ingredient that is used.

Fountain grass
Pennisetum setaceum

Cultural control/Use of prescribed fire: As with buffelgrass, burning is not recommended, except in combination with use of herbicides.

Mechanical/hand control: Small infestations may be managed by uprooting plants by hand and destroying the inflorescences in order to prevent seed dispersal. Removal by hand may need to be repeated several times per year. Fountain grass is much more difficult to remove by hand than is buffelgrass.

Herbicidal control: The long-lived seeds of fountain grass make its control extremely difficult. Extensive infestations of fountain grass are probably best controlled with the help of herbicides, especially those with some systemic activity. Pre-emergent herbicides are necessary to control plants in areas with high seedling recruitment (Lovich, undated).

Biological control: There is no known biological control agent for either *Pennisetum* species.

Tonto NF Goals & Strategy: The management strategy for this species is the same as for buffelgrass. Manual removal is fairly effective, but expensive. Herbicide application on some sites along state highways resulted only in setting back mature plants for a year. The herbicide used was not a sufficiently concentrated solution of glyphosate. A combination of manual removal and/or burning, followed up with herbicides is an effective treatment method.

Karoo bush
Pentzia incana

One karoo bush infestation on the Forest is limited to one disturbed area north of Oak Flat. The other is in association with sweet resinbush near Miami. It is unlikely infestations will occur elsewhere on the Forest, as both populations were planted long ago and no others have been identified.

Cultural control/Use of prescribed fire: Good land management practices that limit bare ground in that area will prevent spread of the existing infestation.

Vegetation is sparse in the area where Pentzia grows, so that flaming individual plants during the non-fire season would not pose a hazard to other vegetation. It is not known if Pentzia sprouts from roots after it is burned.

Mechanical/hand control: Our existing infestations can be treated by hand pulling or grubbing with hand tools.

Herbicidal control: Spot herbicide applications using broadleaf herbicides would probably be effective.

Biological control: There is no known biological control agent for karoo bush.

Tonto NF Goals & Strategy: This plant is not very invasive. The only two documented infestations of Karoo bush on the Tonto NF are fairly small. They have hardly spread from where they were planted 70 years ago. Our goal is to contain populations to the small area where they now grow. These sites are a low priority for treatment.

Japanese knotweed
Polygonum cuspidatum

Cultural control/Use of prescribed fire: Education of nursery dealers and discouraging use of this plant as an ornamental would prevent infestations that would most likely come from naturalized plantings on private land.

Mechanical/hand control: Very small infestations can be controlled by thorough grubbing of all rhizomes and roots. The entire root system must be removed, since resprouting can occur from long rhizomes. A Pulaski or pick-mattock is useful for digging out mature clumps, while hand pulling works well for small plants in moist areas. The plant material should be removed, dried and burned, if possible. Mowing or cutting plant shoots is ineffective alone. However, mowing followed by herbicide treatments will provide some control (CDFA, 2005).

Herbicidal control: Established infestations are better controlled with either cut-stem or foliar-applied herbicides. Glyphosate (may need aquatic formulation, since this species is most likely to be found in riparian situations), or triclopyr have been found to kill Japanese knotweed. Imazapyr and dicamba are other herbicides that are effective.

Biological control: There are currently no registered biological control agents for use on Japanese knotweed. Grazing may be an effective strategy to prevent establishment. It has been observed that Japanese knotweed will not establish where grazing pressure is high; however, heavy grazing may also select for other undesirable weedy species (CDFA, 2005).

Tonto NF Goals & Strategy: This species will be eradicated where found. Prevention of infestations will be accomplished by education of nurseries and the public on northern ranger districts, where this plant would grow readily.

Sulfur cinquefoil
Potentilla recta

Cultural control/Use of prescribed fire: Prescribed burning alone is not recommended, but this could be effective when used in combination with herbicides and seeding of native species. Seeding with native perennial grasses helps to stress sulfur cinquefoil in an integrated vegetation management program that also uses other tools.

Mechanical/hand control: Manual control may remove small infestations, if care is taken to completely remove root crowns (Endress & Parks, 2004). Mowing is not an effective control method (Endress & Parks, 2004).

Herbicidal control: Selective herbicides are the most effective means to control large infestations. On dry land, picloram is preferred because its residual activity will inhibit new plants from establishing (Endress & Parks, 2004).

Biological control: There are no available biocontrol agents for sulfur cinquefoil.

Tonto NF Goals & Strategy: Sulfur cinquefoil is an “A” species – eradication of new infestations is our goal.

Pyracantha
Pyracantha sp.

Cultural control/Use of prescribed fire: Pyracantha seems to move into riparian communities from nearby ornamental plantings. The best way to prevent infestation is to prevent special use permittees with homes on the National Forest from planting it. Education of urban interface homeowners may also help prevent new infestations.

Mechanical/hand control: Pyracantha can be uprooted using a weed wrench or other tool that uses leverage to pull the roots out of the ground.

Herbicidal control: Some broadleaf herbicides would probably be effective to remove pyracantha.

Biological control: There are no available biocontrol agents for pyracantha.

Tonto NF Goals & Strategy: Our goal is eradication. There are very few known infestations.

African sumac
Rhus lancea

Cultural control/Use of prescribed fire: As is the case with pyracantha, African sumac seems to move into riparian communities from nearby ornamental plantings. The best way to prevent infestation is to prevent special use permittees with homes on the National Forest from planting it. Education of urban interface homeowners may also help prevent new infestations.

Mechanical/hand control: Saplings and small trees can be pulled with a weed wrench or similar tool. Even small saplings have deep taproots and can be very difficult to hand pull.

Herbicidal control: There is very little information on herbicides that would be effective for control of African sumac. Various broadleaf herbicides may need to be tested to find the most effective one.

Biological control: There are no available biocontrol agents for African sumac.

Tonto NF Goals & Strategy: Our goal is eradication. There are currently few known infestations.

Russian thistle
Salsola kali, *Salsola tragus*

Cultural control/Use of prescribed fire: Practices that will prevent large infestations include using clean fill dirt for projects, cleaning equipment for fire suppression and ground-disturbing projects, and inspection of staging areas and other work sites.

Mechanical/hand control: Small infestations can be hand pulled.

Herbicidal control: Control is usually with non-selective or broadleaf herbicides at the seedling stage. It must be repeated often through the summer, as new plants continually germinate.

Biological control: Research into a potential biological control agent for *S. tragus*, Salsola rust (*Uromyces salsolae*), has been conducted. Salsola rust appears to attack only *S. tragus* plants; it is not a threat to crops and has not yet been found on native plants (Hasan, et al., 2001).

Tonto NF Goals & Strategy: Our goal is to limit this plant to disturbed rights-of-way, and ensuring that maturing revegetation replaces these populations over time. When it is found early in new construction sites, it should be eradicated.

Mediterranean sage
Salvia aethiopis

Cultural control/Use of prescribed fire: Maintenance of a good cover of perennial plants will slow spread of this plant once it has established.

Mechanical/hand control: Small infestations can be dug out if the root is cut 2 to 3 inches below the ground to prevent sprouting (CDFA, 2005). Mowing is not an effective tool.

Herbicidal control: Dicamba has been reported to control Mediterranean sage. Plants should be treated after bolting but before seed are produced. The hairy nature of the leaf surface may reduce herbicide efficacy and a surfactant should be included (CDFA, 2005).

Biological control: Some biocontrol agents have been used in the northwest: the European crown boring weevil, *Phrydiuchus tau*, was introduced in 1969, and populations are established in Idaho, Oregon, and California (Graham & Johnson, 2004). Seed production was slowed and population density of Mediterranean sage was reduced, but the weevil populations were slow to establish, and they alone will not control the spread of Mediterranean sage. Another species, *Stagmatophora pomposella* has been tested, with limited success. The caterpillar stage of the moth is effective only on the first-year rosette, and there is no impact on mature plants (WA State, 1999).

Tonto NF Goals & Strategy: This plant is unknown on the Tonto NF at this time. Education on identification of this species will help us to practice early detection and eradicate any new infestations as they appear.

Mediterranean grass
Schismus arabicus, *S. barbatus*

Cultural control/Use of prescribed fire: Fire promotes growth of *Schismus* species. At elevations higher than the Sonoran Desert, encouragement of a good ground cover of perennial grasses or soil crust species would serve to limit spread of *Schismus* species.

Mechanical/hand control: Manual control is impractical, since the plants are so small. Removal of the extensive mat of roots near the surface results in significant surface disturbance during manual removal, which promotes additional weed establishment, and ultimately improves the site for *Schismus*.

Herbicidal control: Herbicides can provide some control, but the very small leaf and stem size do not absorb much herbicide, and often non-target species are affected more.

Biological control: As with mechanical treatments, removal by grazing animals at moderate to intense levels only tends to increase the relative presence of alien annual grasses. A black smut, *Ustilago aegyptica*, has been noted on *Schismus*. It destroys the spikelets. It is not abundant enough to actually provide any control of this annual grass, but it presents possibilities for further research.

Tonto NF Goals & Strategy: This is a “C” species. There may be some strategic locations where the Forest wishes to contain this species. Grazing focused during early spring or selective herbicides may help control this annual grass.

Wild mustard
Sinapis arvensis

Cultural control/Use of prescribed fire: Routine requirement for clean equipment for wildfires and construction projects, and testing of seed for revegetation projects will help prevent infestations brought in from outside the National Forest.

Mechanical/hand control: Pulling small infestations before seed set is an effective treatment.

Herbicidal control: Wild mustard is most commonly treated as a crop weed; thus it has become resistant to some herbicides. Those herbicides recommended for control are the sulfonylurea herbicides such as chlorsulfuron, sulfometuron methyl, and metsulfuron methyl.

Biological control: There are no known biological control agents for wild mustard. Their development is unlikely, since wild mustard is closely related to many crop plants.

Tonto NF Goals & Strategy: Our goal is to limit this plant to the immediate roadside and work to eradicate it from wildlands. Its main habitat is agricultural sites on private lands.

Saltcedar

Tamarix parviflora, *Tamarix chinensis, T. ramosissima*

Management of saltcedar (also known as tamarisk or tamarix) requires a long-term commitment to prevent reinfestation. Removal or destruction of the root crown is critical in saltcedar control. A variety of methods have been used in the management of saltcedar, including mechanical, chemical, and biological. The most effective management probably involves a combination of these.

Cultural control/Use of prescribed fire: Fire has been used with some success with saltcedar; however, resprouting normally occurs after fire since it is fire-adapted. Flooding can be used to control saltcedar if root crowns remain submerged for at least three months (Muzika & Swearingen, 2005b).

Mechanical/hand control: Mechanical techniques include hand-pulling, digging, root-cutting, use of weed eaters, axes, machetes, and bulldozers. Removal by hand tools is generally recommended for small infestations of saplings under one-inch basal diameter. Root-cutting and bulldozing may be effective but are costly, labor intensive, and may cause extensive damage to soils and lead to resprouting, or invasion by other undesirable invasive species.

Herbicidal control: For extensive infestations of saltcedar, chemical control has been shown to be the most effective method. Cautious use of herbicides aids in restoration of saltcedar-infested sites by allowing repopulation by native plant species. Systemic herbicides are recommended for saltcedar management and application methods include foliar sprays, cut stump treatments, basal bark treatments, and aerial sprays. Because tamarisk (saltcedar) usually grows in or adjacent to streams, wetlands, and other waterways; it is important to use products registered for aquatic application.

Biological control: No biological control of saltcedar is proposed. Various biocontrol agents are being used in other states; these agents may find their own way to saltcedar infestations in Arizona. In 2005, the U.S. Fish and Wildlife Service agreed that releases of the saltcedar leaf beetle *Diorhabda elongata* could be made at sites in Texas, New Mexico, Colorado, Wyoming, Utah, Nevada, and California, with the proviso that releases were located more than 200 miles from where Southwestern willow flycatchers nest in saltcedar trees, and certain other conditions (USDA/APHIS, 2005).

Tonto NF Goals & Strategy: Management goals are to contain the infestation on the upper Salt River to the main channel, limiting its spread up tributaries; over the long term to eradicate saltcedar from the Verde River, and remove it from the many small tributaries across the Forest where it grows in small populations. Preserves along the reach of Cave Creek below the National Forest are being treated intensively for eradication of saltcedar. Saltcedar is rare along upper

Cave Creek and does not grow in dense stands on the lower part of Cave Creek on the National Forest. Removal efforts on County and private preserves downstream will be futile unless the National Forest also acts to control our populations. Our long-term goal is to eradicate saltcedar from the Cave Creek drainage and its tributaries. Achieving this goal will require continual maintenance, as saltcedar seed sources are common throughout central Arizona.

Southwestern willow flycatchers currently use the thickets of saltcedar at the inflows of the Salt River and Tonto Creek into Roosevelt Lake. Rising lake levels as a result of the raising of Roosevelt Dam may cause these thickets to die off, or cause them to shift upstream. It is doubtful if native riparian tree species could survive with the greatly fluctuating water levels that result from operations of the dam. Thus, the Tonto NF does not propose to conduct saltcedar control projects within the flood pool of Roosevelt Lake, or below 2,151 feet in elevation around the perimeter of the lake. Management of these saltcedar populations will be to limit their spread upstream beyond the area influenced by changing lake levels.

The Tonto NF will refrain from removing saltcedar from the Gleason Flat area on the Upper Salt River, a site considered suitable for nesting Southwestern willow flycatchers (Beatty, 2009). The upstream end of Horseshoe Reservoir is also habitat for the Southwestern willow flycatcher. With radically fluctuating lake levels, saltcedar has become established in the same area as cottonwood and willow, and in recent years the Southwestern willow flycatcher has nested in saltcedar (Todd Willard, 2006). In the long term, the flycatcher may possibly benefit from removal of saltcedar, if a sustainable cottonwood/willow vegetation community is still possible, due to the high flammability of saltcedar thickets. Since flycatchers are nesting in saltcedar that has become established within the flood pool of Horseshoe Lake, this project does not propose control of saltcedar within that flood pool or below 2,026 feet in elevation around the perimeter of the lake.

As with the Salt River saltcedar infestations, management of saltcedar on the Verde River will be to limit its spread upstream beyond the area influenced by changing lake levels.

Siberian elm
Ulmus pumila

Cultural control/Use of prescribed fire: Fire will kill seedlings, but not mature trees (Wieseler, 2005).

Mechanical/hand control: Seedlings can be controlled mechanically or by hand. Shallow girdling will starve the tree for food from the top to the roots. The tree will die slowly over a period of years. If the tree is girdled too deeply, cutting into the xylem, the top of the tree will die and the roots will react by producing numerous sprouts (Wieseler, 2005).

Herbicidal control: Larger trees are better controlled using cut stump herbicide applications (Wieseler, 2005). Glyphosate and triclopyr are recommended (Wieseler, 2005).

Biological control: There are no methods for biological control of Siberian elm.

Tonto NF Goals & Strategy: This is an “A” species – any new infestation should be treated aggressively.

Periwinkle
Vinca major

Cultural control/Use of prescribed fire: As periwinkle acts to crowd out native riparian species, it should be controlled and replaced with native plants where feasible.

Mechanical/hand control: Hand removal is labor-intensive, but can be effective if all roots and stolons are carefully removed. This is best accomplished by working from the outer edges, pulling the periwinkle back in on itself to prevent further spread between removal sessions. This also allows native vegetation to recolonize where periwinkle has been removed. This removal method requires many repeated treatments in order to permanently remove the *Vinca*. Mowing or cutting is not recommended, as it encourages sprouting.

Herbicidal control: Glyphosate works well if plants are first cut then sprayed immediately afterward. Cutting with a weed whip breaks through the waxy cuticle, allowing better penetration of the herbicide. In Ramsey Canyon, a five percent glyphosate solution provided 100 percent control. A surfactant is recommended (Drewitz, undated).

Biological control: Biocontrol agents have not been tested for Vinca.

Tonto NF Goals & Strategy: This plant is not extremely invasive, and it does not occur in many locations on the Tonto NF. Strategy is to remove it where opportunities exist, normally on or near old homesteads. Time should not be spent controlling this species, unless it is spreading to undisturbed lands or replacing native riparian species. Where Vinca populations are so extensive that removal would leave areas of bare ground, vegetation will be treated with herbicide while leaving roots intact to hold the soil in place. Revegetate the site as practicable, or include erosion control structures/devices as part of the project if needed.

Biocontrol Agents Proposed for use

Table 2. Biocontrol agents' names and target species

Scientific Name of Biocontrol Agent	Common Name of Biocontrol Agent	Target Species Common Name	Target Species Scientific Name	Notes
Agapeta zoegana	moth	Spotted knapweed	*Centaurea biebersteinii*	First released in the United States in 1984. Has been released in Arizona, California, Colorado, Idaho, Minnesota, Montana, Nebraska, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, Wisconsin, and Wyoming. The moth has established in these states. Determined to be host-specific to mainly *Centaurea stoebe* and a few closely related *Centaurea* species (Muller, et al., undated).

Scientific Name of Biocontrol Agent	Common Name of Biocontrol Agent	Target Species Common Name	Target Species Scientific Name	Notes
Bangasternus fausti	Flower weevil	Spotted knapweed, diffuse knapweed	*Centaurea biebersteinii, Centaurea diffusa*	First released in the United States in 1991. The weevil has been released in California, Colorado, Idaho, Minnesota, Montana (established), Nebraska (established), Oregon (established), South Dakota, Washington, and Wyoming. Also released in Arizona. Studies conducted on host specificity determined that this weevil feeds only on a small number of species restricted to the genus Centaurea (Maddox and Sobhian, 1987).
Bangasternus orientalis	Yellow starthistle bud weevil	Yellow and Malta starthistles	*Centaurea solstitialis, C. melitensis*	Releases were made in California. Washington. Idaho, and Oregon in 1985 and it became established in all states in 1989. Widely distributed in starthistle-infested areas of the western United States, particularly California, Oregon, Washington and Idaho (Wilson, et al., 2003). Studies conducted on host specificity determined that this weevil feeds only on a small number of species restricted to the genus Centaurea (Maddox and Sobhian, 1987).
Cyphocleonus achates	weevil	Spotted knapweed, diffuse knapweed	*Centaurea biebersteinii, Centaurea diffusa*	First released in the United States in 1987. Has been released in Arizona, California, Colorado, Idaho, Minnesota, Montana, Nebraska, Nevada, Oregon, South Dakota, Utah, Washington, and Wyoming as part of a program to control spotted and diffuse knapweed. Populations are established in Colorado, Montana, and Wyoming, and individuals have been recovered in Oregon. It has also become established in Minnesota. The final report on testing of this agent for host specificity determined that *C. achates* is restricted to a few species of closely related Centaurea and all possible hosts that occur in North America are introduced weeds (Stinson, 1987).

Scientific Name of Biocontrol Agent	**Common Name of Biocontrol Agent**	**Target Species Common Name**	**Target Species Scientific Name**	**Notes**
Eustenopus villosus	Yellow starthistle hairy weevil	Yellow and Malta starthistles	*Centaurea solstitialis, C. melitensis*	Widely distributed in starthistle-infested areas of the western United States, particularly California, Oregon, Washington, and Idaho. (Wilson, et al., 2003), Introduced on Coconino NF 2008, 2009.
Larinus minutus	weevil	Spotted knapweed, diffuse knapweed	*Centaurea biebersteinii, Centaurea diffusa*	Cleared and first released in the United States in 1991. The weevil has been released in Arizona, California, Colorado, Idaho, Minnesota, Montana (established), Nebraska, Oregon (established), South Dakota, Utah, Washington (established), and Wyoming (estab.). L.minutus has been demonstrated to have a limited host range with a preference for Centaurea species in the subgenera which occur naturally in Europe (Jordan, 1995). A study in 1990 determined that L. minutus would be an effective control for diffuse and spotted knapweed, would be target-specific, and would have no adverse effects on other organisms or the environment (Groppe, 1990).
Larinus obtusus	weevil	Spotted knapweed, diffuse knapweed	*Centaurea biebersteinii, Centaurea diffusa*	Approved and first released in 1993 in the United States. This weevil has been released in Idaho, Minnesota, Montana (established), Nebraska, Oregon, and Washington Also released in Arizona. The testing report that recommended introduction of L. obtusus to North America found that this biocontrol agent had a host plant range limited to species in the subgenera Acrolophus and Jacea, and no native plants were at risk (Groppe, 1992).

Scientific Name of Biocontrol Agent	**Common Name of Biocontrol Agent**	**Target Species Common Name**	**Target Species Scientific Name**	**Notes**
Mecinus janthinus	Stem-mining weevil	Dalmatian toadflax	*Linaria dalmatica*	Approved for release in the U.S. in 1995. An EA completed for release of this weevil in 1996 (Hennessey, 1996). Introduced on Coconino NF in 2008 & 2009. Studies of this agent in the Rocky Mtn. area demonstrated no evidence of nontarget herbivory at any site (Breiter, et al., 2007).
Sphenoptera jugoslavica	buprestid beetle	Diffuse knapweed	*Centaurea diffusa*	First released in the U.S. in 1979. Also released in Arizona, Colorado, Idaho, Montana, Nebraska, Nevada, Oregon, South Dakota, Utah, Washington, and Wyoming. Established in Colorado, Idaho, Montana, Oregon, South Dakota, Washington, and Wyoming, and is being collected for redistribution in Colorado, Montana, Oregon, and Washington.
Urophora affinis	seed head flies	Spotted knapweed, diffuse knapweed	*Centaurea biebersteinii, Centaurea diffusa*	First released in the United States in 1971. Released in Arizona, California, Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, Wisconsin, and Wyoming. Populations are established in all of these states but Nevada.
Urophora quadrifasciata	seed head flies	Spotted knapweed, diffuse knapweed	*Centaurea biebersteinii, Centaurea diffusa*	Approved for release in 1988. Has been released and established in Arizona, California, Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, South Dakota, Utah, Washington, Wisconsin, and Wyoming. Establishment has been confirmed in Indiana, Maryland, New York, Pennsylvania, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, and New Jersey

Scientific Name of Biocontrol Agent	Common Name of Biocontrol Agent	Target Species Common Name	Target Species Scientific Name	Notes
Urophora stylata	Seedhead gall fly	Bull thistle	*Cirsium vulgaris*	First released in Maryland and Washington in 1983. This was followed by releases in Colorado, Oregon, Montana, and California. Now established in the western United States, with 60 to 90% of bull thistle seed heads infested in some areas (Kok & Gassmann, 2002).

Herbicide Descriptions

The following herbicides are proposed for use on the Tonto NF. In addition to extensive testing and approval by Environmental Protection Agency (EPA), risk assessments have been prepared by the Forest Service for all of these proposed herbicides. The Forest Service risk assessments may be found at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml**.** These human health and ecological risk assessments evaluate the probability that a given pesticide use might impose harm on humans or other species in the environment. It is the same process used for regulation of food, medicine, cosmetics, and other chemicals (U.S.F.S., 2005, Oct.).

The Environmental Protection Agency (EPA) is responsible for regulating the sale and use of pesticides, including herbicides, in the United States and ensuring that all pesticides can be used without causing adverse effects to humans or the environment.

In carrying out its responsibility, the EPA requires and reviews an extensive set of scientifically sound (80 to 120 chemistry, toxicology, exposure, and environmental) studies for each pesticide prior to marketing and use. EPA scientists review these studies to determine if the pesticide, when used according to the proposed pesticide's use directions and restrictions, would cause potential adverse effects to humans or the environment, including wildlife, plants and animals.

Aminopyralid is a new chemical registered for control of broadleaf weeds on rangeland. It was developed specifically for the control of noxious and invasive weed species in rangeland, pastures, and industrial vegetation management sites. It is a new active ingredient that is effective at low rates as compared to currently registered herbicides with the same mode of action, including 2,4-D, clopyralid, triclopyr, picloram and dicamba. It was accepted for evaluation under the EPA's Reduced Risk Pesticide program in October 2004, based upon data and risk assessments presented for toxicological, ecotoxicological, and environmental fate effects. Aminopyralid is a broadleaf weed herbicide that provides systemic, post-emergence control of noxious and invasive annual, biennial, and perennial weed species. It can provide residual control, thus reducing the need for re-treatment. Aminopyralid works by moving systemically throughout the plant to deregulate plant growth metabolic pathways affecting the growth process of the plant (Durkin, 2007). This disruption of plant growth processes, by binding of aminopyralid at receptor sites normally used by the plant's natural growth hormones, results in control and death of susceptible plant species. Half-life in the soil averages 34.5 days. (The half-life of an herbicide is the period of time required for the active ingredient to decompose to one-half of that which was applied.) Field tests demonstrate limited movement in the soil profile. No degradation metabolites of concern have been produced in any studies. This herbicide is dissipated in the soil by aerobic microbial degradation. The rate of breakdown depends upon soil moisture and soil temperature. Aminopyralid may be used to treat starthistles, Canada thistle, biennial thistles, knapweeds, teasel, and oxeye daisy. It is approved for use along state and federal highways through the Tonto NF (U.S.F.S., May 2004, Section 18 amendment).

Chlorsulfuron is registered for general use and is used to control many broadleaf weeds and some annual grasses. Some weeds might become resistant to chlorsulfuron after extended use. This herbicide prevents the target plant from producing an essential amino acid that controls cell division and has a half-life in the soil of 30 to 90 days depending on pH (Klotzbach & Durkin, 2004a). Chlorsulfuron tends to leach into soils with a textural range from sand to silt loam and degrades more rapidly at higher temperatures with adequate moisture contents. It is broken down to smaller compounds by soil microorganisms. This herbicide is being used by ADOT to manage weeds along state and federal highways on the Tonto NF. Chlorsulfuron may be used to treat bull, musk and Scotch thistles, and dyer's woad.

Clopyralid is a selective post-emergence herbicide controlling broadleaf species in the sunflower, legume, and smartweed family. This herbicide affects the target weed by mimicking the plant hormone auxin and causes uncontrolled plant growth and eventual death. It has an average half-life in the soil of 20 days, ranging from 15 to 287 days depending upon soil type and climatic conditions (Infoventures, 1995a). It is degraded primarily by microbial metabolism. Once applied to the ground, it rapidly disassociates and does not bind strongly with soil particles, which results in clopyralid having a high potential to contaminate ground or surface water. Commercial formulations of clopyralid are approximately 41 percent clopyralid and 59 percent inert ingredients (water, isopropyl alcohol, and a surfactant). This herbicide is being used by ADOT to manage weeds along state and federal highways on the Tonto NF. Clopyralid has also been used by the Prescott NF to treat resin bush in 2003 and 2004 near the town of Cottonwood. It may also be used to treat biennial thistles, Canada thistle, diffuse knapweed, Mediterranean sage, Russian knapweed, spotted knapweed, yellow starthistle, and Malta starthistle.

Dicamba is considered a general use herbicide for forestry, rangeland and rights-of-way uses. It is a selective herbicide used to control broadleaf weeds, brush, and vines. It affects target plants by regulating growth. About half of this product is broken down by microbial activity in 10 to 35 days once applied. Breakdown is slower with low soil moisture and low temperatures. The main metabolite of dicamba breakdown in soil is 3,6-dichlorosalicylic acid (Infoventures, 1995c). Dicamba is highly mobile in the soil and does have the potential to contaminate ground or surface water. This herbicide is very versatile in weed control and has been proven successful in treatment of biennial thistles, Canada thistle, dyer's woad, leafy spurge, rush skeletonweed, spotted knapweed, sulfur cinquefoil, and yellow and Malta starthistles. There are no records of dicamba having been used on the Tonto NF in the past. It is approved for use along state and federal highways on National Forests in Arizona (U.S.F.S., May 2004).

Glyphosate is a broad-spectrum, nonselective herbicide used for control of annual and perennial plants including grasses, sedges, broadleaf weeds, and woody plants. This herbicide is used on a variety of crops and its method of action is to inhibit amino acid and protein synthesis (Durkin, 2011a). It is moderately persistent in the soil and has an estimated half-life of 30 to 50 days. Glyphosate is strongly absorbed in most soils and normally does not leach out of the profile. Microbes are primarily responsible for the breakdown of this herbicide in the environment. Glyphosate has been successful in controlling Canada thistle, cheatgrass, leafy spurge, spotted knapweed, Dalmatian toadflax, yellow and Malta starthistles, buffelgrass and fountain grass. It appears that this product was used to some degree for reforestation site preparation in the 1970s and early 1980s on the Coconino NF and North Kaibab RD. Records on the Kaibab NF indicate that Roundup (glyphosate) and Dowpon M were used to treat about 2,000 acres to control unwanted vegetation prior to planting. Glyphosate is approved for use along state and federal highways on National Forests in Arizona (U.S.F.S., May 2004).

EPA initially registered (licensed) the first glyphosate product in 1973. In 1993 and in subsequent years, EPA's program to systematically re-evaluate the safety of all registered pesticides determined that glyphosate continues to meet EPA's safety standards provided it is used according to label directions. Products formulated with glyphosate are approved for use in the U.S. with aerial, ground, and hand-held applicators on certain food crops such as corn, industrial and forest land, and aquatic sites for control of terrestrial and aquatic weeds. Glyphosate products are also approved for use on home lawns and gardens. Glyphosate herbicides are used extensively in the U.S. and many other countries.

After a rigorous analysis of extensive sets of studies for each herbicide, EPA determined that glyphosate herbicide products can be used according to label directions without causing unreasonable adverse effects to humans or the environment. Risks to humans and wildlife animals are below EPA's levels of concern; however, there are risks to nearby non-target plants, which can be effectively managed with proper application measures (EPA, 2009).

Imazapic is a selective herbicide for both pre- and post-emergent control of some annual and perennial grasses and broadleaf weeds. It affects plants by inhibiting the production of amino acids that ultimately reduces cell growth (Durkin & Follansbee, 2004b). Its half-life in the soil is 120 days, and it is considered moderately persistent. The primary mechanism of degradation is through microbial action. It does not volatilize when applied. Imazapic is known to be effective in control of Canada thistle, leafy spurge, and cheatgrass. Imazapic is approved for use along state and federal highways on National Forests in Arizona (U.S.F.S., May 2004).

Imazapyr is also a broad-spectrum herbicide that can be applied pre- or post-emergence. It is appropriate to use this herbicide on rangelands, forestlands and rights-of-way, although cropland use is excluded. Imazapyr is absorbed by the leaves and roots and moves rapidly through the plant. It acts by accumulating in the meristem region and disrupting protein synthesis by interfering with cell growth and DNA synthesis (Durkin, 2011c). Unlike most other herbicides proposed for use by the forests, it can remain active in soil for six months to two years (Infoventures, 1995d). It has a strong affinity to bind to soils and rarely moves beyond the top few inches of the soil. As such, it has a low potential for leaching to ground water, but may reach surface water during storm events over recently treated land. Sunlight and microorganisms break down Imazapyr. Little is lost to evaporation. Imazapyr is approved for use along state and federal highways on National Forests in Arizona (U.S.F.S., May 2004). Habitat, an imazapyr-based herbicide is being used by the Coconino and Prescott NFs in cut-stump treatment of saltcedar along the Upper Verde River, with very good results.

EPA initially registered (licensed) the first imazapyr product in 1985. In 2006 and in subsequent years, EPA's program to systematically re-evaluate the safety of all registered pesticides determined that imazapyr continues to meet EPA's safety standards provided it is used according to label directions. Products formulated with imazapyr are approved for use in the U.S. with aerial, ground, and hand-held applicators on certain food crops such as corn, industrial and forest land, and aquatic sites for control of terrestrial and aquatic weeds. This herbicide is used extensively in the U.S. and many other countries (EPA, 2009).

Metsulfuron methyl is used to control brush and certain unwanted woody plants, annual and perennial broadleaf weeds, and annual grassy plants. This herbicide has a half life of 120 to 180 days and affects plants by inhibiting cell division in the roots and shoots, thereby stopping growth (Klotzbach & Durkin, 2004b). Generally, soil microorganisms break down this herbicide into nontoxic products, although chemical hydrolysis can also break it down (Infoventures, 1995e). Metsulfuron methyl dissolves easily in water and can leach through the soil to contaminate ground water, but this situation is confined to soils that are either sandy or porous. This herbicide has been proven successful in control of biennial thistles, Canada thistle, dyer's woad, Russian knapweed, and whitetop. Metsulfuron methyl is approved for use along state and federal highways on National Forests in Arizona (U.S.F.S., May 2004).

Picloram is considered a "Restricted Use" herbicide and, as such, can only be sold and used by a licensed pesticide applicator. This classification is due to this herbicide's mobility in water combined with the sensitivity of many crops that can be damaged with the use of picloram. It is used to control broadleaf plants, brush, conifers, and broadleaf trees. It interferes with the weed's ability to make proteins and nucleic acids and is broken down to carbon dioxide by sunlight and microorganisms (Durkin, 2011). The half-life of picloram is 90 days and it dissolves easily in water. This herbicide works well in control of biennial thistles, Canada thistle, Dalmatian toadflax, diffuse knapweed, dyer's woad, leafy spurge, Mediterranean sage, oxeye daisy, rush skeletonweed, Russian knapweed, Scotch thistle, spotted knapweed, sulfur cinquefoil, whitetop, and yellow and Malta starthistles. A combination of his herbicide and tebuthiuron was used on the Kaibab NF in the mid 1980s to control piñyon and juniper trees on 15,000 acres of rangeland (U.S.F.S., Feb 2004). This decision was short lived, and the program was suspended in 1984, when the Forest was enjoined from further applications of herbicides. Picloram is now approved for use along state and federal highways on National Forests in Arizona (U.S.F.S., May 2004).

Sethoxydim is a general use herbicide for control of annual and perennial grasses. Sethoxydim is easily absorbed by plant roots and foliage and transported through the xylem and phloem to the meristematic tissues of the plant (WSSA, 1994). It kills grasses by preventing the synthesis of lipids, which leads to failure of cell membrane integrity. This results in a cessation of shoot and rhizome growth, leading to necrosis and death of shoot meristems and rhizome buds and ultimately plant death. It has an average half life in soils of four to five days, but this can range from a few hours to 25 days. Sethoxydim is water soluble and does not bind strongly with soils, so it can be highly mobile. It is degraded readily by light and microbial metabolism. Rapid degradation generally limits extensive movement in the environment. Sethoxydim is not highly volatile (Tu, et al., 2001). This herbicide works well to control bromes, quackgrass, and wild oats. Sethoxydim is now approved for use along state and federal highways on National Forests in Arizona (U.S.F.S., May 2004).

Sulfometuron methyl is considered a general use registered herbicide. It is applied to control annual and perennial grasses, as well as broadleaf weeds. Sulfometuron methyl stops plant growth by inhibiting cell division in the growing tips, roots, and shoots of target plants (Klotzbach & Durkin, 2004c). This herbicide has a half life of about 30 days and is broken down to carbon dioxide by microorganisms, sunlight, and chemical hydrolysis. Sulfometuron methyl is insoluble in water. In acidic soils it has a low potential for movement; whereas in alkaline soils, where it is close to ground water, it has some potential for movement (Infoventures, 1995f).

Sulfometuron methyl is approved for use along state and federal highways on National Forests in Arizona (U.S.F.S., May 2004).

Triclopyr is a pyridine and works by disrupting plant growth. It is absorbed by green bark, leaves, and roots and moves to the meristem of the plant. It is active in soil, and is rapidly broken down by microbes, particularly in warm climates. It has a half life in the soil of 30 to 90 days; the ester and amine salt formations convert to an acid, which degrades into carbon dioxide, a relatively nontoxic salt and organic matter through microbial action (Durkin, 2011b). Triclopyr has a moderate-to-low solubility in water and normally binds to clay and organic matter, so its potential to contaminate ground water is slight. Triclopyr is effective in the treatment of saltcedar, tree of heaven, Russian olive, and Siberian elm. Triclopyr is approved for use along state and federal highways on National Forests in Arizona (U.S.F.S., May 2004).

Surfactants are commonly used in herbicide formulations to ensure even distribution and improve absorption or permeation of the herbicide into the plant, or to prevent herbicide drift. Surfactants play a key role in the effectiveness of an herbicide formulation. Information on the types of surfactants used and the toxicity of surfactants can be limited since pesticide manufacturers consider these formulations to be proprietary information which does not require coverage under FIFRA as do pesticide active ingredients.

Table 3. Typical and maximum application rates for herbicides and carriers (in pounds active ingredient per acre)

Herbicide/ Carrier	Rangeland	Forestland	Facilities	Right-of-Way	Recreation /Administration	Riparian
Aminopyralid	0.078 to 0.11	0.078 to 0.11	0.078 to 0.11	0.078 to 0.11	0.078 to 0.11	0
Chlorsulfuron*	0.75 to 3	0.75 to 3	0.75 to 3	0.75 to 3	0.75 to 3	0.75 to 3
Clopyralid	0.25 to 0.5	0.25 to 0.5	0.25 to 0.5	0.25 to 0.5	0.25 to 0.5	0.25 to 0.5
Dicamba	2 to 4	2 to 4	2 to 8	2 to 4	2 to 4	2 to 4
Glyphosate	1 to 4	2 to 4	2 to 4	2 to 4	2 to 4	2 to 4
Imazapyr	1 to 1.5	1 to 1.5	1 to 1.5	1 to 1.5	1 to 1.5	1 to 1.5
Metsulfuron methyl	0.5 to .75	0.5 to 1.8	0.5 to 1.8	0.5 to 1.8	0.5 to 1.8	0.5 to 1.8
Picloram	1 to 2	1 to 2	2 to 3	2 to 3	1 to 2	1 to 2
Sethoxydim	4.3 to 7.2	4.3 to 7.2	4.3 to 7.2	4.3 to 7.2	4.3 to 7.2	4.3 to 7.2
Sulfometuron methyl	2 to 9	2 to 6	2 to 9	2 to 9	2 to 9	2 to 9
Triclopyr	1.5 to 2	3 to 6	4 to 9	4 to 9	1.5 to 2	4 to 8
Imazapic	.03 to .06	.03 to .06	.03 to .06	.03 to .06	.03 to .06	0
Carriers						
Mineral Oil	2 to 4	4 to 8	2 to 8	2 to 14	2 to 4	2 to 4
Vegetable Oil	2 quarts	2 quarts	2 quarts	2 quarts	2 quarts	2 quarts
Methylated Seed Oil	1 to 2 pints	1 to 2 pints	1 to 2 pints	1 to 2 pints	1 to 2 pints	1 to 2 pints

**** This application rate is provided in ounces of active ingredient per acre.***

Alternatives

Alternative 1 – No Action

This alternative allows all previous decisions regarding treatment of noxious weeds on the Tonto NF to continue. These actions include:

- Continuation of a prescribed burning program to prevent spread of Malta starthistle along Highway 188 from the junction with the Beeline Highway to Cholla Recreation Site (U.S.F.S., Tonto NF, 10/2004).
- Treatment of yellow starthistle and diffuse knapweed with prescribed fire, grubbing, and herbicides at the Pleasant Valley Ranger Station Administrative Site (U.S.F.S., Tonto NF, 3/2004).
- Use of hand tools and hand-pulling to remove weeds forestwide (U.S.F.S., Tonto NF, 2005b).
- Use of prescribed fires less than 10 acres in size, within 50 feet of Forest System Roads (U.S.F.S., Tonto NF, 2005b).
- Use of herbicides along all federal and state highways through the Tonto NF. Herbicides may be sprayed with ground-based equipment on rights-of-way, and 200 feet beyond the right-of-way onto National Forest system land (U.S.F.S., May 2004).
- Use of herbicides in sites covered by Categorical Exclusions, that is to say administrative and recreation sites.

Under this alternative, the Forest's weed management program will be limited to manual weed removal, use of prescribed fire only in blocks of 10 acres or smaller, and along a portion of Highway 188, and use of herbicides and prescribed fire at the Pleasant Valley Ranger Station horse pasture. Prescribed burns greater than 10 acres in size and herbicides will not be used (although some "housekeeping" uses may be categorically excluded from documentation at administrative and recreation sites), and no mechanical, cultural, or biological weed control measures will be used.

Up to 200 acres per year would be treated by manual control, up to 1,000 acres would be treated with herbicides under projects already approved, up to 2,000 acres could be treated with prescribed burning under existing project documentation, and up to 300 acres could be treated with herbicides at administrative or recreation sites.

The No Action alternative is required by law. It addresses both Issues 1 and 2 as described above in the Issues section, but does not fulfill the purpose and need to effectively address the introduction and spread of invasive plants according to Forest Service policy and law.

Alternative 2

This alternative provides for use of all integrated vegetation management tools, as described under the proposed action, except the use of herbicides would be excluded. Mechanical, manual, prescribed burning and cultural control methods would be used to manage existing invasive plant populations and to control new infestations as they occur. Mechanical methods would include mowing, or using equipment to cut tops off invasive plants. Up to 2,000 acres of mechanical treatments would be conducted. Manual methods would include cutting off seedheads and severing taproots, digging, or pulling plants. Up to 400 acres per year could be treated by manual control. Cultural control methods would be used to improve ground cover and heal disturbed ground locations, to reduce vulnerability of sites to new weed infestations. Acres treated by cultural control methods would be approximately the same as for the proposed action, or up to 2,000 acres. Acreage of mechanical and prescribed burn treatments would be increased from the proposed action, in an attempt to meet objectives of the program. Up to 2,000 acres would be treated by mechanical methods, and up to 2,000 acres would be treated with prescribed fire. Monitoring would be conducted to assess effectiveness of treatments. Surveys would be conducted to locate new weed infestations. Education, prevention, and cooperation would occur as described under the proposed action.

This action was developed to address concerns for effects of chemical herbicides on non-target species and human health (both issues 1 and 2 in the Issues section above).

Mitigation Measures Common to the Proposed Action and Alternative 2

In response to public comments on the proposal, mitigation measures were developed to ease some of the potential impacts the various alternatives may cause.

- Invasive species populations would be treated only after the area has been evaluated and surveyed for federally-listed and sensitive plant and animal species. Field surveys will be conducted within occupied and potential habitat for sensitive species. The scope of the survey will be dependent on the type of treatment proposed, but will be sufficient to provide for the identification and protection of sensitive species within the project area. Individuals and populations of sensitive plants will be flagged or otherwise identified so they can be avoided during treatment. If necessary, a buffer zone of sufficient size will be established to protect sensitive species from mechanical disturbance or spray drift.
- Heritage resources will be identified and protected from any ground disturbing activities.
- Spray trucks, all-terrain-vehicles (ATVs), tractor-mounted mowers and other equipment used for invasive plant management will not be used in such a way that would increase erosion. Steep or highly erodible slopes will be avoided, and soil disturbance will be minimized.
- Heavy equipment will not be used within 30 feet of any stream bank. Handheld or ATV-mounted equipment will be used within this zone.
- Prevention measures prescribed in appendix C will be followed during agency activities to the degree possible to minimize invasive plant introduction and spread on the Forest. This is the single most effective and least expensive weed management option available.
- The only biological control agents that would be considered for use would be those selective for the target species, and approved by the APHIS for use on that species. No biological control agents will be used to control saltcedar.
- If restoration of treated areas includes establishing new plants, this would be accomplished by broadcast seeding of native species or non-persistent, nonnative cover crops.
- All seed used for revegetation will be checked for presence of the Tonto NF's list of invasive species, in addition to routine weed seed testing performed by seed companies.
- All sites treated for invasive species will be monitored and retreated as necessary. Monitoring is a follow-up part of each treatment activity. Baseline monitoring to determine existing conditions will occur prior to treatment.

Mitigation Measures Involving the Use of Herbicides

The application of herbicides is tightly controlled by state and federal agencies. The Forest Service is required to follow all state and federal laws and regulations concerning the use of herbicides. The following measures will be followed for the proposed action:

- Herbicides will be used when it is determined that they offer the most practical, timely and economical method for control, and/or that they are an integral part of an integrated treatment strategy.
- All applicable state and federal laws, including herbicide label requirements will be followed.
- Projects will be supervised by a Forest Service certified applicator, who will be responsible for ensuring safe storage, handling, application, and disposal of herbicides.
- Herbicides will be applied only by ground-based equipment, including hand painting or daubing, backpack sprayers, and spray units on ATVs or trucks.
- Picloram will not be used where the water table is within 40 inches of the surface, or where soil permeability would be conducive to water contamination.
- Persons involved in mixing, loading, and applying herbicides will be required to wear appropriate personal protective equipment as required on the label.
- Areas used for mixing herbicides and cleaning equipment shall be located where spillage will not run into surface waters or result in ground water contamination.
- Best Management Practices (BMPs) will be followed.
- All requirements of a Safety and Spill Plan (appendix E) will be followed
- Forest Supervisor approval of the Pesticide Use Proposal (Form FS 2100-2) will be necessary for the application of any herbicide, unless this authority has been delegated to the District Ranger. Use of herbicides in wilderness areas or wilderness study areas requires approval by the Regional Forester as per *Forest Service Manual 2151.04a*.
- Treatment areas will be signed to alert the public of the herbicide application.
- Landowners within one-half mile of the area to be treated with herbicide will be notified before the project is undertaken.
- Mitigation measures prescribed for federally-listed and sensitive species (see appendix G) will be followed.

Permits and Agency Approvals Required

The following permits or authorizations will be required for individual actions:

- Prior to burning, a burn permit will be obtained from Arizona Department of Environmental Quality.
- A concurrence or a biological opinion will be requested from the U.S. Fish and Wildlife Service on the biological assessment, addressing listed threatened, endangered, and proposed species, if the biological assessment and evaluation makes a “May Affect” determination. Subsequent actions will conform to Terms and Conditions of a Biological Opinion.
- Some situations may require concurrence from the Arizona State Historic Preservation Officer regarding identification, evaluation, and determination of effect of the project on heritage resources.

- A discharge permit either through the Arizona Department of Environmental Quality or the Corps of Engineers is required prior to application of any herbicide within navigable waters.
- Obtain any necessary permit from APHIS prior to release of biological control agents. Any agent to be used will have undergone extensive testing and have been approved by APHIS for use in the state of Arizona. A permit must be obtained from APHIS before biological control agents can be transported across state boundaries.
- Although biological control agents may be collected and released within the state without a permit from APHIS, the Arizona Department of Agriculture should be consulted for any regulations relating to movement of these agents inside the state.

If herbicides are to be used, at least one certified applicator will be on the project site to supervise others. This person will have training and certifications in use of herbicides, as required by Forest Service manual and state law.

The proposed action and alternatives 1 and 2 are compared in table 4.

Table 4. Comparison of alternatives

	Proposed Action	Alternative 1	Alternative 2
Meets the purpose and need for the action	Yes. Authorizes the most effective treatments for all invasive species across the Forest	No. Invasive species would not be effectively managed.	In part. Since the use of herbicides would not be authorized, effective treatment of certain invasive plant species would be limited and spread of some invasive species would not be adequately checked or prevented.
Consistent with Forest Plan	Yes. Hazardous conditions caused by noxious weeds (wildfire, toxic forage for animals, etc.) are reduced by using an effective suite of control methods; maintains or enhances the visual resource; provides for habitat for species diveristy; helps to bring rangeland to its highest condition; reduces erosion and provides for water quality; maintains wilderness character of a variety of native species in natural habitats.	No. Allows uncontrolled spread of invasive species.	Yes. However, reliance on cultural, mechanical, and manual methods would result in gradual increase in degradation of the visual resource, rangeland condition, wildlife habitat, and water quality, since treatment methods will not be sufficient to control some species.
Consistent with law, regulation, and policy	Yes. Responsive to the *Farm Bill of 1990, Forest Service Manual 2080 & 2150*, Forest Service national strategy, and *Executive Order 13112*.	Not responsive to laws and regulations.	Somewhat. Ineffective management results in dissatisfaction of cooperators and does not effectively prevent an increase in size of many invasive plant infestations.
Effect on human health – both public & employees	Little effect on human health. Risks associated with exposure to herbicides will be insignificant to the public. Minor risk of exposure to workers, which will be mitigated by use of personal protective equipment and training. Risks of burning toxic smoke during prescribed burns in areas that have been treated by herbicides are minimal, compared with risks of breathing smoke that occurs during wildfires and routine prescribed burns.	Little effect on human health. Increase in wildfire potential in the Sonoran Desert, which may lead to indirect effects from smoke.	Effects similar to alternative 1. Additional slight risk for injury to personnel performing prescribed burns and mechanical treatments.

	Proposed Action	Alternative 1	Alternative 2
Effect on the environment – soil & water quality, native vegetation, and wildlife	Removal of invasive plants, combined with restoration where needed, will favor the establishment of native vegetation and more natural soil and water quality conditions. Use of herbicides may result in short-term presence of herbicides in soil. Mitigation measures will reduce the risk of water contamination. Minor effects to non-target vegetation will be minimized by project design and mitigated by overall increases in plant diversity as invasives are reduced. No effects to federally-listed or sensitive plants or animals will be allowed. Herbicide exposure risks to wildlife are minimal. Long-term restoration of native plant communities will increase habitat capability in infested areas.	Very small possibility of herbicide contamination of vegetation, wildlife, soil or water. Increases in tap-rooted species may increase surface runoff in some areas. Increased distribution and density of annual and perennial exotic invasive grasses could increase wildfire occurrence, size, and impacts. Native plant communities could become less diverse as species such as starthistles and knapweeds spread and create monocultures in large areas. Some federally-listed and sensitive plants and animal populations may probably suffer from habitat degradation. This alternative results in highest level of degradation of forage and wildlife habitat.	Invasive species continue to spread, but not as rapidly as in alternative 1. Prevention measures proposed will slow introduction of invasives, but manual, mechanical and prescribed burning alone will not be sufficient to control the spread of existing populations and new infestations that will inevitably occur. As in alternative 1, some federally-listed and sensitive plants and animal populations will probably suffer from habitat degradation. Manual control may result in some short-term displacement of wildlife, and possibly increased erosion.
Acres treated by various methods:	Manual: 400 Mechanical: 500 Burning/torching: 2,000 Cultural: 2,000 Biological: will be used Herbicide: 9,000 Total: 13,900	Manual: 200 Mechanical: 0 Burning/torching: 2,000 Cultural: 0 Biological: will not be used Herbicide: 1,300 Total: 3,500	Manual: 400 Mechanical: 2,000 Burning/torching: 2,000 Cultural: 2,000 Biological: will be used Herbicide: 1,300* Total: 7,700

***** *This acreage is based upon previous decisions, as for the "No action" alternative.*

Chapter 3 – Affected Environment and Environmental Consequences

This section summarizes the physical, biological, social and economic environments of the affected project area and the potential changes to those environments due to implementation of the alternatives. It also presents the scientific and analytical basis for the comparison of alternatives presented in the chart above.

The analysis area for this environmental assessment is the entire Tonto NF (see map). The Forest is comprised of nearly three million acres in parts of four Arizona counties: Gila, Maricopa, Pinal, and Yavapai. From northwest to southeast, major mountain ranges include the New River Mountains, Pine Mountain, the Mazatzal Mountains, Sierra Anchas, Superstitions, and the Pinals. Elevations range from 1,260 to 7,914 feet. The Tonto NF includes a wide range of vegetation types over this elevation range, and encompasses a major portion of the watersheds of the Salt and Verde rivers. Smaller portions of the Forest also include upper reaches of the Agua Fria, New River, and Cave Creek watersheds. Major highways bisecting the Forest include the Beeline Highway (State Route 87), the Bush Highway that runs along the lower Salt River, north to Saguaro Lake and the Beeline, State Route 188 from SR 87 to Globe, State Route 60 from Phoenix to Globe and north to the San Carlos Reservation, State Route 70 from Globe west to the San Carlos Reservation, State Route 177 south of Superior, State Route 77 from east of Globe running south toward Winkelman, State Route 288 from Tonto Basin to Young, and State Route 88 (the historic Apache Trail) from Highway 60 to Roosevelt Dam.

The two major rivers, the Salt and Verde include two "chains of lakes:" Horseshoe and Bartlett on the Verde River; and Roosevelt, Apache, Canyon, and Saguaro on the Salt River. Dams on these rivers were constructed for water conservation and flood control; Salt River dams also generate electricity. The lakes and rivers are heavily utilized recreation sites for residents of the metropolitan area of Phoenix.

The description of the affected environment and disclosure of effects concentrates on not only the significant issues generated through scoping but also on the purpose and need of the proposed project. This includes such considerations as the capacity of an action to control the spread of invasive and noxious weeds, potential health impacts, potential impacts to clean water, and the ability of Native Americans to collect plants for traditional purposes if the use of herbicides is authorized. In addition, several other key resources are fully analyzed within the scope of this environmental analysis, including threatened, endangered and sensitive plant and animal species, as well as management indicator plants and animals.

For items within this analysis, the effects assessment consolidates the discussion of the impacts where appropriate, and highlights the relationship between local short-term uses of the environment and the maintenance as well as enhancement of long-term ecosystem productivity.

Cumulative effects are those that result from the incremental impact of this proposed action and alternatives when added to other past, present, and reasonably foreseeable future actions regardless of who undertakes those activities (*40 CFR 1508.7*). The cumulative effects analysis is found after the discussion of direct and indirect effects for the major groupings. If none are predicted, this is documented. Cumulative effects analysis is keyed to the major issues, purpose and need, and the other resource areas disclosed in this chapter, and must: 1) be additive with other activities found within the project impact zone, and 2) the effect of the proposed action and alternatives must overlap in time and space with these other activities. The project impact zone for this analysis is the land area of the Tonto NF and lands of other ownership adjacent to the Tonto NF. It also includes private inholdings and municipal areas such as Payson, Globe, and Young, and for some resources, such as human health, the Phoenix metropolitan area.

Soil Resources

Affected Environment

Geology on the Forest is a highly diverse mixture of igneous rocks (granite, rhyolite, basalt, diabase), metamorphic rocks (schist, quartzite), and sedimentary rocks (limestone, sandstone, shale, conglomerates). As a consequence, soils are highly diverse. The dominant soils are moderately deep to deep, strongly developed, and display a wide range of both internal and surface rock fragments. There are, however, significant areas containing shallow soils, many of which are poorly developed. Surface textures are mostly loams and sandy loams with a few areas having clay loam surfaces. Surface rock fragments typically range from 15 to 65 percent. About 60 percent of all soils have medium textured subsoils (loamy-skeletal, fine-loamy, coarse-loamy), about one-third have fine textured subsoils (clayey-skeletal, fine, very fine), and about 5 percent are coarse textured (sandy-skeletal, sandy). The finer textured soils tend to occur on slopes less than 40 percent, medium textured soils occur on all slopes, while coarse textured soils occur either on steep scarp slopes such as the Mogollon Escarpment or along drainages. Soils along drainages are highly variable in both texture and rock fragments. About 70 percent of the soils have greater than 35 percent rock fragments in the subsoil. The reaction (pH) of the soils varies with soil parent material and soil climate. The dominant soils have a neutral reaction (pH 6.6 to 7.3) but slightly acid soils (pH 6.1 to 6.5) and slightly alkaline soils (pH 7.4 to 7.8) are common. A few soils are moderately alkaline (pH 7.9 to 8.4) while strongly acid soils (pH 5.6 to 6.0) are rare (U.S.F.S., Tonto NF, 1979; U.S.F.S., Tonto NF, 1985a; & U.S.F.S., Tonto NF, 2005a). Soil texture, rock fragments, and pH (among other factors) can influence the movement of herbicides through the soil profile.

Unit of measure for effects to soils is the degree to which each alternative increases or decreases soil quality. Soil quality is based on an interpretation of factors that affect the following three primary soil functions:

- *Soil Hydrologic Function*. This function is assessed by evaluating or observing changes in surface structure, surface pore space, consistence, bulk density, infiltration or penetration resistance using appropriate methods. Increases in bulk density or decreases in porosity result in reduced water infiltration, permeability and plant available moisture.

- *Soil Stability*. Soil erosion is the detachment, transport, and deposition of soil particles by water, wind or gravity. Vascular plants, soil biotic crusts, and litter cover are the greatest deterrent to surface soil erosion. Visual evidence of surface erosion includes sheets, rills, and gullies, pedestalling, soil deposition, erosion pavement, and loss of the surface "A" horizon. Erosion models are also used to predict on-site soil loss.
- The current approximate soil condition on the Tonto National Forest shows 1.7 million acres *Nutrient Cycling*. This function is assessed by evaluating the vegetative community composition, litter, coarse woody material, root distribution and soil biotic crusts. These indicators are considered an important source of soil organic matter, which is essential in sustaining long-term soil productivity. It provides a carbon and energy source for soil microbes, stores and provides nutrients which are needed for the growth of plants and soil

organisms, and provides for cation and anion exchange capacities. Satisfactory - The soil indicators (hydrologic function, soil stability, and nutrient cycling) signify that soil function is being sustained and the soil is functioning properly and normally. The ability of the soil to maintain resource values and sustain outputs is high.

Interpretation of these three factors results in soils being placed in one of three condition classes:

- *Satisfactory* - The ability of the soil to maintain resource values and sustain outputs is high.
- *Impaired* - The ability of the soil to function properly has been reduced and/or there exists an increased vulnerability to degradation
- *Unsatisfactory* - The soil indicators (hydrologic function, soil stability, and nutrient cycling) signify that loss of soil function has occurred

Approximately 1,640,000 acres (60 percent) are in Satisfactory Condition, six hundred thousand acres (22 percent) in Impaired Condition, and five hundred thousand acres (18 percent) in Unsatisfactory Condition. Soil conditions that are less than satisfactory are because of past management activities including domestic livestock grazing, recreation use including OHV activities, and wildfire. At the present time soil quality on the Forest is not considered to be significantly affected by the presence of invasive species because of limited extent and the relatively short period of time of infestation. However, the spread of invasive species could, over time, lead to a decrease in soil quality especially due to increased erosion and poor nutrient cycling. Many invasive species are tap-rooted and can affect soils quality in areas where bunchgrasses are replaced by these weeds. In other areas, exotic grasses such as red brome, buffelgrass, wild oats, and lovegrass can temporarily increase the amount of soil cover but also add fine fuels that increase the risk of wildfire and increased soils erosion following wildfire.

Table 5: Soil Properties

	N. Tonto/Globe TES*	TES Crew*
By Soil Family		
Sandy-Skeletal/Sandy	3%	8%
Coarse-Loamy	2%	4%
Fine-Loamy	7%	10%
Loamy-Skeletal	55%	45%
Fine	23%	15%
Clayey-Skeletal	10%	19%
By Textural Groups		
Coarse (Sandy)	3%	8%
Medium (Loamy)	64%	59%
Fine (Clayey)	33%	34%
By Rock Fragments		
Skeletal	68%	72%
Non Skeletal	32%	28%

	N. Tonto/Globe TES*	TES Crew*
By Soil Depth		
Deep	39%	39%
Moderately Deep & Deep	53%	32%
Shallow	8%	29%

North Tonto and Globe TES (Terrestrial Ecosystem Survey) data are developed from acreage associated with each map unit from the North Tonto and North East Globe TES surveys covering 982,000 acres. TES Crew data are derived from counts of the number map units developed by the Tonto TES crew from their progressive mapping of the remainder of the Tonto NF.

Environmental Consequences

Table 6: Effects of various weed control methods on soils:

Treatment Type and Acreage	Treatment Description
Manual Proposed Action – 400 acres Alternative 1 – 200 acres Alternative 2 – 400 acres	Most manual treatments involve extremely slight soil disturbance. However, some manual treatments, especially hand pulling or grubbing can result in soil disturbance around each plant and also provides an effective seed bed for germination of weed seed. This disturbance is relatively minor, short-term (likely less than one year), and of limited extent. The net long-term effects are generally positive for weed control, but some localized, short-term negative effects on soil disturbance may occur.
Mechanical Proposed Action – 500 acres Alternative 1 – 0 acres Alternative 2 – 2,000 acres	Most mechanical treatments involve some degree of soil disturbance. Most disturbance is short-lived (one to two years) and restricted to a realtively few acres (less than 0.1percent) on the Forest in the vicinity of weed infestation. Mechanical control of rhizomatous species may not be effective in controlling those species and could actually result in their spread. Many species are difficult to control because of the persistence of large seed banks once weeds have become established. The net long-term effects are generally positive for weed control but some localized short-term negative effets on soil disturbance may occur.
Burning/torching Proposed Action – 2,000 acres Alternative 1 – 2,000 acres Alternative 2 – 2,000 acres	Burning can be effective in controlling weeds, especially annual weeds. It is especially effective in removing large quantities of seeds of annual weeds. Some invasive species are difficult to control using fire and fire can also impact non-target species and result in increased soil erosion. There may be some short-term (one to two years) negative effects on soil disturbance in a few areas but the long-term net effect of burning is likely to be positive for weed control and soil condition.
Cultural Proposed Action – 2,000 acres Alternative 1 – 0 acres Alternative 2 – 2,000 acres	Cultural practices are designed to establish desirable plants in order to prevent infestation by invasive plants. There may be some short-term disturbance in areas prepared for seeding establishment, but the long-term effect is an expected decrease in erosion.

Treatment Type and Acreage	Treatment Description
Biological Proposed Action – Will be used Alternative 1 – Will not be used Alternative 2 – Will be used	Biological controls involve grazing animals, approved insects and pathogens to control weeds. The use of biological controls, except for grazing animals, would have little to no direct or indirect effects on soils. The use of grazing animals, however, could have both short and long-term effects on soils. Grazing that is heavy enough to control weeds may also severely reduce the cover of native plants and lead to increased erosion. The net effect of using biological controls, except for grazing animals, is likely to be positive. The net effects of grazing animals could be positive with strict controls or negative if native vegetation is affected.
Herbicide Proposed Action – 9,000 acres Alternative 1 – 1,300 acres Alternative 2 – 1,300 acres	Herbicides that selectively target only invasive species and/or are used in spot treatments would allow native species to recover which should reduce soil erosion and enhance nutrient cycling. Possible negative effects of herbicide application include the potential for decreasing or altering microbial populations in the soil profile. Studies on soil organisms show that herbicides could cause a temporary shift in soil microbial populations by reducing biodiversity and relative biomass of individual species (U.S.F.S., Bitterroot NF, 2003). Declining numbers of some macro-organism species have been observed at herbicide application test sites. These effects, however, are temporary and populations generally recover after a few days or weeks (Brady & Weil, 1999). The net effects of herbicides would likely be short-term negative effects to soil microbes but a long-term positive effect to overall soil quality.
Total Acres Treated Proposed Action – 13,900 acres Alternative 1 – 3,500 acres Alternative 2 – 7,700 acres	

Comparison of Alternatives

Direct and Indirect Effects

The proposed action is more likely than the other alternatives to limit or reduce the spread of invasive plants because more acres per year could be treated and more control methods are available (see treatment comparisons in above table). Assuming that native plant communities will replace tap-rooted invasives after treatment, soil protection and nutrient cycling should be enhanced. Alternative 1 would be the least effective in preventing the spread of invasive plants since this alternative would treat the fewest acres and have the fewest methods available for treatment. Alternative 2 would be somewhat intermediate in effectiveness. While the proposed action has the greatest total area of disturbance, the greatest direct impact to soils is by alternative 2, with more acres of mechanical treatment. Alternative 1 would have the least direct disturbance to soils.

The control of exotic annual grasses such as red brome will be difficult under all alternatives given the relatively small areas treated annually, ranging from 3,500 acres in alternative 1 to 13,900 acres in the proposed action, versus the hundreds of thousands of acres that can be infested during wet winters. Infestations of red brome can lead to unnaturally severe wildfires, especially within the Sonoran Desert. These wildfires can cause unnaturally high erosion due to loss of ground cover.

The direct effects of treatments depend on the type and extent of treatment. Physical removal (manual and mechanical) will result in localized, short-term disturbance. The most disturbance occurs in the proposed action with the least occurring in alternative 1. Burning may result in some localized, short-term (one to two years) negative effects; but prescribed burning to manage noxious weeds should result in controllable conditions for fire frequency, duration, and intensity based on environmental conditions used during implementation, thus resulting in fairly predictable ecological effects on soils. The effects of burning are same for all alternatives. The direct effect of cultural practices may be some slight, short-term disturbance in areas prepared for seeding. The effects are the same in the proposed action and alternative 2 but there would be no cultural practices in alternative 1. The use of biological controls (occurring only in the proposed action and alternative 2) would have little to no direct effects on soils quality unless grazing animals are used. If grazing animals are used heavy grazing could affect non-targeted native vegetation. The direct and indirect effect of using herbicides varies. Broadcast treatment by non-selective herbicides could destroy native species at a higher rate than weeds which would create more bare soil. On the other hand, herbicides that selectively target only invasive species and/or are used in spot treatments would allow native species to recover. Possible negative effects of herbicide application and persistence include the potential for decreasing microbial populations or altering species composition of microorganisms in the soil profile. Studies of potential impacts on soil organisms show that herbicides could cause a temporary shift in soil microbial populations by reducing biodiversity and relative biomass of individual species (U.S.F.S., Bitterroot NF, 2003). There is potential for inhibiting growth of some micro-organism species. Declining numbers of some macro-organism species have been observed at herbicide application test sites. These effects, however, are not expected to persist because the negative effects are temporary and populations generally recover after a few days or weeks (Brady & Weil, 1999). More acres would be treated under the Proposed Action than the other alternatives and the overall negative direct effects on soils of this alternative, while small, are slightly greater than the other alternatives.

Cumulative Effects

Other past, present and future activities may potentially contribute to cumulative effects on soil quality. Appendix I lists projects that may possibly impact the area. Activities that may affect soil quality include road use and construction, vegetation management (primarily fuels reduction), range management, fire suppression (primarily fire lines and safety zones), recreation management (primarily OHV use), and land and mineral resources. These activities can directly affect soil by compaction, displacement, removing protecting vegetation cover, and concentrating runoff. These activities can also indirectly affect soils by creating favorable environments for establishment and spread of noxious weeds.

Evidence suggests that the probability of cumulative toxic effects on soil biota caused by herbicide application is low due to low herbicide application rates, low inherent toxicities of the chemicals applied, the low levels at which they are present in soils, and the short duration of persistence of residues in soils relative to rotation lengths. Studies of potential impacts on soil organisms show that herbicides could cause a temporary shift in soil microbial populations by reducing biodiversity and relative biomass of individual species (U.S.F.S., Bitterroot NF, 2003). There is potential for inhibiting growth of some micro-organism species. Declining numbers of some macro-organism species have been observed at herbicide application test sites. These effects, however, are not expected to persist because the negative effects are temporary and populations generally recover after a few days or weeks (Brady & Weil, 1999).

All alternatives have the potential to physically affect soil quality during implementation of treatments. Activities can cause short-term localized soil compaction, and remove vegetation and litter cover. These effects are short-term (less than two years) and localized (covering less than 0.5 percent of the forest).

Water Quality

Affected Environment

Arizona Department of Environmental Quality (ADEQ) had identified ten major watersheds in the State of Arizona. The watersheds associated with the Forest are located on the Salt and Verde rivers with small portions on the Upper and Middle Gila River. All stream courses are evaluated on their ability to meet or "support" state water quality standards using data collected by state and federal agencies. These water quality standards vary and are based on the designated use of a particular stream. These designated uses include aquatic and wildlife, full or partial body contact related to recreation, fish consumption, domestic water source, agricultural irrigation and agricultural livestock watering. Many streams will have more than one designation, with the most restrictive criteria applied for water that is for domestic water supplies. Some of the tests commonly run for water quality are for bacteria (*Escherichia coli*), turbidity, temperature, dissolved oxygen, pH, hardness, and metals. While herbicide constituents are sampled for on a project or site specific basis in lakes and streams, they are routinely assessed in wells (ADEQ, 2009a). The overall assessment for each stream monitored is rated to be "attaining (all or some uses)," "not attaining," "impaired," or "inconclusive" (ADEQ, 2009b).

The Salt Watershed occupies 6,242 square miles or five percent of the state's land area. The watershed is defined by the Salt River drainage area from its headwaters to Granite Reef Dam, excluding the Verde River drainage area. The Salt River drainage area below Granite Reef Dam is included in the Middle Gila Watershed. Tonto NF encompasses about 43 percent of this watershed, or approximately 2,686 square miles. There are no unique waters (a surface water classified as an outstanding state resource) identified within this basin. Principal land uses are recreation, grazing and silviculture, with mining centralized in the Miami-Globe area (ADEQ, 2009b).

Of the 283 miles of streams assessed on the Tonto NF, 176 miles were classed as attaining water quality standards for all or some uses (12 reaches) and the 82 miles (ten reaches) were assessed as impaired or not attaining water quality standards for one or more uses. The assessment of the remaining stream miles were inconclusive (ADEQ, 2009b).

Water quality standards for Christopher Creek was assessed as impaired by ADEQ for phosphorus and *E. coli* bacteria. Two reaches of Tonto Creek were assessed as impaired due to low dissolved oxygen and exceedences of phosphorus. Five Point Mountain, a tributary to Pinto Creek was determined impaired due to copper. Three reaches of Pinto Creek were determined to be "not attaining" water quality standards for some uses due to copper, and one reach was found impaired due to selenium. Salt River between Pinal Creek and Roosevelt Dam was found impaired due to suspended sediments and another reach of the Salt, between Stewart Mountain Dam and Verde River was found to be impaired due to low dissolved oxygen levels (ADEQ, 2009b).

Of the 22,015 lake acres assessed, Saguaro Lake (1025 acres) was assessed as attaining water quality standards for some uses. Apache and Canyon lakes (2640 acres) were assessed as impaired due to low dissolved oxygen. Roosevelt Lake (18350 acres) was assessed as attaining some uses by ADEQ, but was found impaired by EPA for mercury in fish tissue (ADEQ, 2009b).

Perennial waters associated with the **Tonto Creek Drainage** include Tonto, Horton, Christopher, Haigler, Spring, Rye, Slate, Gun, and Greenback creeks and the Tonto Arm of Roosevelt Lake. Noxious and invasive weeds found within this fourth code watershed include yellow starthistle, Malta starthistle, bull thistle, Russian thistle, sweet resinbush, dalmatian toadflax, Russian knapweed, black mustard, Saharan mustard, and wild mustard.

Other perennial waters associated with **Salt River** include, Pinal, Pinto, and Cherry Creeks, Salt River through the Salt River Wilderness, and the Salt Arm of Roosevelt Lake. Saharan mustard, bull thistle, Canada thistle, quackgrass, sweet resinbush, yellow starthistle, diffuse knapweed, saltcedar, and tree of Heaven are common weeds in this watershed. Apache, Canyon, and Saguaro lakes and Lower Salt River are all located downstream from Roosevelt Lake. Listed weed species identified in this watershed include fountain grass, buffelgrass, Malta starthistle, and saltcedar.

The **Verde Watershed** is roughly 6,624 square miles and represents approximately 6 percent of the state's land area. The Verde River drainage area defines this watershed and about 20 percent of it is on the Tonto NF (1,297 square miles). Flows from the Verde River are regulated at two reservoirs – Horseshoe and Bartlett lakes. A small portion of the Phoenix Active Management Area (AMA) is on the Verde Watershed portion of the Tonto NF (ADEQ, 2009b).

Of the 156 miles of streams in the Verde Watershed located on the Tonto NF that were assessed, 76 miles were attaining water quality standards for all or some uses (seven reaches) and 70 miles (three reaches) were assessed as impaired or not attaining designated uses. Of the 4,355 lake acres assessed, Bartlett Lake (2375 acres) was assessed as attaining all uses while Horseshoe Reservoir's assessment was inconclusive (ADEQ, 2009b). Saltcedar is the major invasive plant on the Upper Verde.

On the Tonto NF, the East Verde River between Ellison Creek and American Gulch was assessed as impaired due to selenium exceedances while the East Verde reach between American Gulch and the Verde River was found impaired due to arsenic and boron. Verde River between West Clear Creek and Fossil Creek, about half being on the Tonto NF, was assessed as "not attaining" due to turbidity (ADEQ, 2009b).

Perennial streams and lakes located on the Tonto NF within the Verde Watershed include Lower Verde and East Verde rivers, Camp, Sycamore, Tangle, Red, Wet Bottom, and Fossil creeks, Horseshoe and Bartlett lakes. Noxious and invasive weeds found in the Lower Verde Watershed include Malta starthistle, brome grasses, fountain grass, and saltcedar.

The **Upper Gila Watershed** occupies 7,354 square miles a little more than 6 percent of the state total. The watershed is defined by the Gila River drainage area from New Mexico to Coolidge Dam (San Carlos Reservoir). The Tonto NF occupies only 0.01 percent of the total basin area or roughly 98 square miles. There are no perennial or intermittent streams inventoried that are within the Tonto NF. None of the stream reaches on the Tonto NF in this watershed were assessed (ADEQ, 2009b).

The **Middle Gila Watershed** is defined by the Gila River area below Coolidge Dam in the east to Painted Rock Dam in the west. This does not include the Santa Cruz River and San Pedro River drainages and the Salt River above Granite Reef Dam. The Salt River below Granite Reef Dam is included in this watershed, instead of the Salt River Watershed, because the water in the Salt River normally is diverted at Granite Reef Dam into a system of canals and becomes hydrologically disconnected from its natural fluvial system. This watershed occupies 12,249 square miles or 11 percent of the total land area within the state. Outside the urban Phoenix area, livestock grazing is the primary land use. The Tonto NF occupies approximately 552 square miles of this basin, about 0.05 percent of the total watershed. Groundwater basins within the Middle Gila Watershed include the Phoenix AMA, Agua Fria, and Dripping Springs. There are no unique waters identified in these watersheds (ADEQ, 2009b). Over four million people live in this watershed, or 60 percent of the state's population.

Of the 60 miles of streams on the Tonto NF that were assessed in this watershed, 28 miles (two reaches) were in full attainment and 17 miles (two reaches) were inconclusive. The remaining 15 miles, two reaches on Queen Creek, were assessed as impaired due to exceedances of the copper standard (ADEQ, 2009b).

Perennial streams within this watershed located on the Tonto NF include Queen Creek, Arnett Creek, and Devils Canyon, all located on the Globe and Mesa ranger districts, while New River, Bishop Creek, Squaw Creek, Cave Creek, and Seven Springs Wash are on the Cave Creek Ranger District. Noxious and invasive weeds identified in this watershed include buffelgrass, wild mustard, Malta starthistle, and saltcedar fountain grass, oleander, and sweet resinbush.

Ground Water Quality

Ground water basins recognized by the Arizona Department of Water Resources are being examined by ADEQ for regional ground water quality. Systematic, grid-based random sampling of ground water monitoring wells is conducted to investigate potential nonpoint source pollution impacts on ground water quality. Currently, none of the Tonto NF basin studies have been completed; however, monitoring is continuing in the Tonto, Upper Salt and Lower Salt River basins. Samples from some of these wells have shown exceedances in arsenic, fluoride, hardness, nitrate, gross alpha (radioactive particles), uranium and total dissolved solids (ADEQ, 2004).

Arizona's Pesticide Contamination Prevention Program is intended to prevent contamination of ground water, soil, and the vadose zone from pesticides used in agriculture. The Ground Water Protection List includes a list of 152 active ingredients that have the potential to pollute groundwater in Arizona. Another 37 pesticides are on the list of banned pesticides. Twenty-two of the 189 pesticides listed or banned have an Aquifer Water Quality Standard, including Glyphosate and picloram (listed) and 2,4-D and Silvex (banned). Glyphosate and picloram, are listed for use in this proposed action. They are currently approved for use by ADOT along federal and state highways including those on the Tonto NF. Glyphosate is currently approved for use in "housekeeping" (recreation and administrative sites) on the Tonto NF. Five wells within the Tonto NF were monitored for pesticides between 1993 and 2002 with results in all wells below the lab detection limit (ADEQ, 2004).

Environmental Consequences

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Under this alternative, hand-grubbing, pulling or mechanical treatment of weeds would occur. Mechanical treatments would occur to a lesser extent than under alternative 2 but higher than alternative 1. Soil disturbance associated with this activity may contribute in the short term to sedimentation in water courses adjacent to the site. Manual treatments would cause less disturbance on soils than mechanical treatments, though for both, the long term improvements would outweigh the short term effects of the treatments.

Burning/torching would be used on the same acres in all three alternatives. Again, the long term improvements from the treatment would outweigh the short term effects of the treatment.

Cultural treatments (planting native vegetation) is proposed in this alternative as well as alternative 2, but not alternative 1. The effects of planting native species would help to control the spread of invasive species and provide ground cover which would be a favorable improvement.

Biological treatments are proposed for this alternative and alternative 2 but not alternative 1. The biological treatment most likely to affect water quality would be livestock grazing by cattle, goats, etc. While the proper timing and intensity of grazing could increase sediment in the streams in the short term, the long term effects could be favorable.

Herbicide use is proposed to treat the greatest number of acres in this alternative. Again, while removing invasive species over large areas could have a short term effect on soil loss causing an increase in sedimentation the overall net result would be better protection of the soils through improved groundcover.

Overall, by removing target invasive plants, currently a minor component of forest vegetation, and by preventing their spread, native vegetation will be favored that will serve to intercept contaminants and sediments creating a more stable watershed.

Both direct and indirect water quality impacts can result from the use of herbicides to control vegetation. Direct adverse effects could result from improper applications for the following situations: (1) Waters receive herbicide from spray, drift, or spills; or (2) Large-scale applications to impervious surfaces and compacted soils, combined with runoff, could transport herbicides to water resources. However, the herbicides proposed for use, based on the mitigation measures and BPA's required for their application, are expected to have little to no negative impact on water quality. Utilization of mitigation measures and safety practices (appendices D and G) will further reduce the potential adverse effects. To ensure proper application and to avoid problems related to runoff, all herbicide applications would be conducted by or under the supervision of a Certified Pesticide Applicator.

The ability of herbicides to leach to ground water depends on several factors including depth to ground water, soil depth to bedrock, soil texture, and soil pH. Except for some perennial streams and springs, the depth to ground water on the Tonto NF is greater than 40 inches. About ten to twenty percent of soils on the Tonto NF are less than 20 inches deep to bedrock. These soils often occur along with exposed bedrock. Fractures in bedrock could allow herbicides to reach ground water. Herbicide applications to areas with extensive bedrock should be avoided. About ten percent of the soils are coarse textured, occurring mostly on steep slopes or near drainages. These soils are more likely to allow leaching of herbicides than finer textured soils. Soil pH can affect leaching. The leaching potential for most of the herbicides considered for use is moderate at pH 7, but less at pH 6. The dominant soils on the Tonto NF have a neutral reaction (pH 6.6 to 7.3). A substantial number, however, have pHs below 6.6 or above 7.3. Leaching potential could be higher in soils above a pH of 7.3 so pH should be considered when determining where to apply herbicides (U.S.F.S. Tonto NF, 1979; & U.S.D.A. Soil Survey Division Staff, 1993).

In areas of shallow bedrock, the potential for herbicides leaching through the soil profile and reaching water is greatest. However, several mechanisms prevent or retard the migration of herbicides through the soil profiles. These mechanisms include chemical precipitation, chemical degradation, volatilization, physical and biological degradation, biological uptake, and adsorption. Clays and organic matter in the soil adsorb (adhere to) certain organic compounds such as herbicides (e.g., glyphosate). As a result, the ability of herbicides to leach through the soil column for entry to ground water is reduced significantly.

A soil monitoring study of soil leaching conducted in Montana supports this expectation. For two years, soil was monitored for presence of clopyralid and picloram. Clopyralid was applied at 37 sites. Clopyralid was not detected below two inches at any site 30 days after application. Picloram was also monitored at 42 sites and one year after application detected at 16 ppb (parts per billion) at 2.1 inches with a trace detected below ten inches (Rice, et al., 1992). Based on the results of this study, pesticide use proposed in this document is likely to have little or no effect on water quality through soil leaching.

Table 7. Potential for surface runoff and leaching for proposed herbicides (Senseman, 2007)

Common Name of Herbicide	Solubility in Water (mg/L)	Half Life in Soil	Potential for Surface Runoff	Potential for Leaching
Aminopyralid **	2,480 (unbuffered)	20 to 32 Days, activity may carry over for one year	Moderate only on sites with high soil clay content; otherwise low.	Low
Chlorsulfuron	587 (pH 5) – 31,800 (pH 7)	40 Days	Low	Moderate at pH 7, but less at pH 6
Clopyralid	1,000 (acid) – 300,000 (salt)	40 Days	Low	Moderate
Dicamba	4,500 (acid) – 720,000 (salt)	Less than 14 Days*	Low	Low to Moderate
Glyphosate	15,700 (pH 7) – 900,000 (salt, pH 7)	47 Days	Low	Low
Imazapic	2,200	120 Days	Low	Low
Imazapyr	11,272 (pH 7)	25 to 142 Days*	Low	Low

Common Name of Herbicide	Solubility in Water (mg/L)	Half Life in Soil	Potential for Surface Runoff	Potential for Leaching
Metsulfuron methyl	548 (pH 5) – 2,790 (pH°7)	30 Days	Low	Moderate at pH 7, but less at pH 6
Picloram	430	90 Days*	Moderate	High
Sethoxydim ***	4,000	5 to 25 Days	High, but is degraded by sunlight in 1 to several hours	Low, due to rapid breakdown by soil microbes
Sulfometuron methyl	10 (pH 5) – 300 (pH 7)	20 to 28 Days	Low	Moderate at pH 7, but less at pH 6
Triclopyr	23 (ester) – 2,100,000 (salt)	30 Days	Not Available	Not Available

***   May persist significantly longer under conditions of low soil moisture and rainfall and soil types.***
***** Data for Aminopyralid from Aminopyralid Risk Assessment (Durkin, 2007)***
****** Data for Sethoxydim from Tu, et al., 2001.***

The design of this alternative includes streamside buffer zones, described in appendices D and G, in which only certain herbicides may be used. Herbicide applications will be limited to spot and small scale treatments and will exclude aerial applications. Aquatically labeled formulations of glyphosate, imazapyr and triclopyr can be safely applied up to the edge of water. These herbicides are short-lived, not translocated through soil, and do not have other properties that would prevent safe use within the riparian zone. Chlorsulfuron, clopyralid, dicamba, metsulfuron, picloram, sethoxydim, and sulfometuron cannot be safely applied adjacent to water and will not be used within the streamside buffer zone. A general permit from Arizona’s Department of Environmental Quality will be necessary before any use of herbicide that could reach “waters of the U.S.”

The known area infested with invasive plant species (other than brome species and wild oats) currently is less than 1 percent of the forest. Consequently, the amount of herbicides needed to treat this relatively small area each year is expected to be low. This further reduces the risk of surface or ground water contamination. In addition, average annual precipitation on the Tonto NF is about 20 inches per year with only a few areas receiving more than 25 inches annually. Consequently, there is less likelihood of herbicide translocation to ground water with this relatively low level of precipitation.

Cumulative Effects

Other past, present, and future activities that would potentially contribute to cumulative effects to water quality in the project area include livestock grazing, off-road vehicle use, dispersed recreation and road maintenance. The effect of this proposal, in combination with other activities on the forest, would result in little or no significant issues. Since the herbicides considered for use in this EA are short-lived, degrade in the environment, and have mitigations and BMPs that will reduce the chances of herbicides moving into water, it is concluded that the typical application rates proposed under the proposed action will not contribute to any significant cumulative impacts to water quality.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

The No Action alternative would result in an increase in size and density of existing invasive plant populations. New populations and new species of invasive exotic plants would become established. These increases would cause declines in native grasses and herbs and eventually decrease the watershed conditions in the project area. Sheley and Petroff (1999) noted that the spread of noxious and invasive weeds influences watershed conditions in several ways including a loss of effective ground cover in the form of plants and litter, a corresponding increase in soil erosion and sedimentation, and a gradual loss in the productive capacity of the soil. Reduced ground cover leads to reduced infiltration which causes less water storage and subsurface flow, adversely affecting the quality and quantity of the surface water (Olsen, 2001). If allowed to expand, populations of species associated with riparian areas such as saltcedar and giant reed would potentially dry up springs and other riparian areas by lowering surface water tables through transpiration (U.S.F.S. IITF, 2004).

Treatments currently used, such as hand pulling and grubbing activities, would increase soil disturbance, surface runoff, and sediment yield in small localized areas to nearby streams in the short term, while long term effects would show no improvement compared to the other two alternatives.

Burning/torching would be used on the same acres in all three alternatives. Again, the long-term improvements from the treatment would outweigh the short-term effects of the treatment.

There would be no cultural treatments (planting native vegetation) in this alternative. As compared to the other two alternatives, the net loss of the favorable native vegetation would lead to an increase in invasive species eventually leading to a decrease in the watershed condition.

Biological treatments are not proposed for this alternative or alternative 2. The biological treatment most likely to affect water quality would be livestock grazing by cattle, goats, etc. In the short term, there would be less soil disturbance by livestock than in the proposed action, However, the biological treatment proposed in the proposed alternative would provide better control over the noxious weed populations.

Herbicide use is proposed to treat only 1,300 acres in the two alternatives as compared to 9000 acres in the proposed action. This will lead to a continued spread of noxious plant communities and an overall decline in watershed condition as described above.

Cumulative Effects

Other past, present and future activities that would potentially contribute to cumulative effects to water quality in the project area include livestock grazing, off-road vehicle use, dispersed recreation and road maintenance. The effect of this action, in combination with other activities on the Forest, would result in little or no significant effects.

Selection of this alternative would result in an increase in erosion and reduction in water quality.

Alternative 2: Integrated Vegetation Management Excluding the Use of Herbicides.

Direct and Indirect Effects

Alternative 2 involves only non-chemical methods of plant control. Effects to water from the non-herbicide weed control alternative would likely be higher than those shown in the other two alternatives. Weed populations would possibly spread at a slower rate than in alternative 1. Increases in soil disturbance, surface runoff, and sediment yield in small localized areas to nearby streams in the short term would result from current treatments such as hand pulling and grubbing. Because this alternative does not include the use of herbicides, there will be no effects to water quality from herbicide use.

Under this alternative, hand-grubbing, pulling or mechanical treatment of weeds would occur. Mechanical treatments would occur to a greater extent than in the other alternatives causing more disturbance to soils. Soil disturbance associated with this activity may contribute in the short term to sedimentation in water courses adjacent to the site. Manual treatments would cause less disturbance on soils than mechanical treatments, though for both, the long term improvements would outweigh the short term effects of the treatments.

Burning/torching would be used on the same acres in all three alternatives. Again, the long-term improvements from the treatment would outweigh the short term effects of the treatment.

Cultural treatments (planting native vegetation) is proposed in this alternative as well as the proposed action. The effects of planting native species would help to control the spread of invasive species and provide ground cover which would be a favorable improvement.

Biological treatments are not proposed for this alternative or alternative 1. The biological treatment most likely to affect water quality would be livestock grazing by cattle, goats, etc. In the short term, there would be less soil disturbance by livestock than in the proposed action, However, the biological treatment proposed in the proposed alternative would provide better control over the noxious weed populations.

Herbicide use on the forest will be limited to 1,300 acres, under projects previously approved, if either alternative 1 or 2 is selected for implementation. The proposed action proposes to use herbicides on up to 9,000 acres of weed infestations across the forest annually. This will lead to a continued spread of noxious plant communities and an overall decline in watershed condition as described above.

Cumulative Effects

Other past, present and future activities that would potentially contribute to cumulative effects to water quality in the project area include livestock grazing, off-road vehicle use, dispersed recreation and road maintenance. If this effect, in combination with other activities on the forest, would result in significant effects is not known.

Selection of alternative 2 would result in an increase in erosion and reduction in water quality.

Vegetation Communities and Fire Regimes

Affected Environment

Elevations range from 1,260 feet near Granite Reef Dam on the Salt River to 7,914 feet on the Mogollon Rim near Promontory Butte. This large difference in elevation has resulted in diverse assemblages of plant communities. Ten broad vegetation communities have been identified based on data from existing Terrestrial Ecosystems Surveys (TES) (869,238 acres), mapping for various forest projects (807,423 acres), and the Arizona Gap Vegetation Program (1,287,771 acres). In some cases the existing Terrestrial Ecosystems Survey data were modified for use in project mapping and is included in the acreage for project mapping. The vegetation map is not intended to be site-specific and represents grouping of similar vegetation types. Each vegetation polygon may contain major inclusions of dissimilar vegetation types (U.S.F.S., Tonto NF, 1979; U.S.F.S., Tonto NF, 1985a; U.S.F.S., Tonto NF, 2005a; and U.S.G.S. Biological Resources Division, 1998. See map 7 and table 8, below.

Table 8. Vegetation types present within the Tonto National Forest, and known weeds

Terrestrial Ecosystems	Acres within the Tonto NF	Percent of Tonto NF	Total Weed Species	Known Acres Mapped
Streamside Vegetation	49,021	2%	26	653
Sonoran Desert	771,286	26%	18	865
Velvet Mesquite Grasslands	359,061	12%	14	97
Piñyon/Juniper/Oak Woodlands	654,122	22%	25	122
Alligator Juniper Savannas	85,275	3%	4	1
Alligator Juniper Woodlands	43,034	1%	5	12
Chaparral and Chaparral Woodlands	634,685	21%	27	86
Arizona Cypress Woodlands	23,002	1%	2	1
Ponderosa Pine Forests	241,602	8%	21	8,228
Mixed Conifer Forests	61,642	2%	6	12,884
Private Land/Disturbed Land	22,663	1%	32	49
Water	19,913	1%	2	25
Total Area*	2,965,322	10%		23,024

**** Acreage includes some private lands within the boundary of the Tonto National Forest. A map of general potential natural vegetation types on the Tonto NF is included in the appendix. Characteristics of the vegetation types in the project area are described below, with discussions of their natural fire regimes. Weed infestation information is based on data as of December, 2011. Weed totals do not include acres of annual grasses which can vary widely from year to year depending on climatic conditions.***

Descriptions of fire regimes are general because of fire's tremendous variability over time and space (Whelan, 1995). Nevertheless, fire regime is a useful concept because it brings a degree of order to a complicated body of knowledge (Lyon, et. al., 2000).

On the Tonto NF there are five basic fire regimes that exist in varying combinations. They are: Coniferous (*Ponderosa Pine and Mixed Conifer Forests*), Piñyon-Juniper (*Pinyon/Juniper/Oak Woodlands, Alligator Juniper Woodlands, Arizona Cypress Woodlands*), Chaparral and Oak Woodlands (*Chaparral and Chaparral Woodlands*), Grasslands (*Velvet Mesquite Grasslands, Alligator Juniper Savannas*), and Deserts (*Sonoran Desert*). Fire affects each of these regimes differently based on variations in frequency, duration, intensity, and type of fire. The ecological effects of fire vary enormously according to the time of year; the quantity, condition, and distribution of the fuel; the prevailing climatic conditions; the duration and intensity of the fire, the slope, aspect, and elevation; and the type of vegetation and soil.

Streamside Vegetation (no specific fire regime) – This is associated with the stream channels that were broad enough to be mapped at the scale of TES mapping (1:24,000). It includes riparian vegetation as well as some upland vegetation found on higher stream terraces. Small, isolated areas of riparian vegetation have not been delineated for this project. At present 350 acres of noxious weeds have been mapped in this vegetation type and include bull thistle, jointed goatgrass, Malta starthistle, quackgrass, Saharan mustard, and yellow starthistle. The extent of saltcedar has not been mapped at present but is known to be a dominant vegetation type along much of the upper and lower Salt River and grows as scattered trees along the Verde River. Native trees and forbs still dominate the riparian vegetation growing along the Verde River. Saltcedar probably occupies less than five percent of the total canopy of vegetation.

Fire regime – No specific fire regime exists for this vegetation type. The fire regime is often influenced by the surrounding upland vegetation type.

Sonoran Desert *(deserts fire regime)* **–** These ecosystems are found at the lowest elevation on the forest. The key indicator species are giant saguaro *(Carnegia gigantea)*, little-leaf paloverde *(Parkinsonia microphyllum)*, creosote bush (*Larrea tridentata tridentata*), triangle-leaf bursage *(Ambrosia deltoidea)*, jojoba *(Simmondsia chinensis)*, pricklypear cactus *(Opuntia phaeacantha*), white brittlebush (*Encelia farinosa)*, flat top buckwheat *(Eriogonum fasciculatum)*, and trace amounts of threeawn, *(Aristida spp.)* and false mesquite *(Calliandra eriophylla)*. The understory is normally very sparse with few or no perennial grasses. At present 336 acres of noxious weeds have been mapped in this vegetation type including black and wild mustard, buffelgrass, fountain grass, brome grasses, Malta starthistle, oleander, Saharan mustard, and sweet resinbush. While the extent has not been mapped, annual bromes are known to inhabit large expanses of the Sonoran Desert.

Deserts fire regime - Seasonal weather and grazing influence fire potential in deserts (Wright & Bailey, 1982). A wet year produces large quantities of grasses and forbs, which provide fuel to carry fire. The Sonoran Desert only has enough ground cover to carry fire after occasional unusually wet growing seasons (Humphrey, 1974). Thomas (1991) estimates that intervals between fires prior to European American Settlement were as short as 3 years in some desert grasslands and more than 250 years in dry areas such as the Sonoran Desert.

Regrowth following fire depends on the availability of moisture. If burning is followed by a wet season, production of perennial grasses and some forbs may increase (Wright & Bailey, 1982). Studies have shown substantial differences between species and also complex interaction among available moisture, grazing, and plant species (Cable, 1967; Wright & Bailey, 1982). Several studies report increase in exotic annual plants, including red brome and filaree, after fire in desert ecosystems; both frequency and intensity of fires may have increased since the introduction of these annual plants (Rogers & Steele, 1980; Young & Evans, 1973).

Velvet Mesquite Grasslands *(grasslands fire regime)* **–** These semi-desert grasslands occur above the Sonoran Desert and below the woodland zone. The key indicator species are velvet mesquite (*Prosopis velutina)*, catclaw acacia (*Acacia greggii*), pricklypear cactus *(Opuntia spp.)*, desert ceanothus *(Ceanothus greggii)*, catclaw mimosa *(Mimosa aculeaticarpa)*, shrubby buckwheat (*Eriogonum wrightii*), and jojoba. Blue paloverde can be found on the hotter/drier parts of this type. Redberry juniper (*Juniperus coahuilensis*) and turbinella oak (*Quercus turbinella*) may occur on cooler/moister sites. Common graminoids include blue grama (*Bouteloua gracilis*), hairy grama (*B. hirsuta*), black grama (*B. eriopoda*), sideoats grama (*B. curtipendula*), curly mesquite (*Hilaria belangeri*), bush muhly (*Muhlenbergia porteri*), cane beardgrass (*Bothriochloa barbinodis*), threeawn, tridens (*Tridens spp.*), desert stipa (*Achnatherum speciosum*), green sprangletop (*Leptochloa dubia*), tobosa (*Pleuraphis mutica*) and a variety of forbs. At present three acres of noxious weeds have been mapped in this vegetation type and include Malta starthistle, fountain grass, and Russian thistle.

Alligator Juniper Savannas *(grasslands fire regime)* – These are normally found at the same elevation as the piñyon/juniper/oak woodlands and are often intermixed with them. They consist of grasslands with scattered alligator junipers. The canopy coverage of juniper is normally less than 10 percent. Key herbaceous species include sideoats grama, blue grama, hairy grama, threeawn, bottlebrush squirrel tail, mutton bluegrass, and annual bromes. In areas with high amounts of clay at the surface, plant composition includes western wheatgrass *(Agropyron smithii),* and vine mesquite *(Panicum obtusum*). Arizona piñyon pine, Arizona white oak, Emory Oak, turbinella, sugar sumac, skunkbush sumac, and desert ceanothus occur only in isolated patches or beneath junipers acting as nurse trees. Utah juniper may occur at lower elevations or on southern exposures. At present 32 acres of noxious weeds have been mapped in this vegetation type and include Canada thistle, jointed goatgrass, and yellow starthistle.

> **Grasslands fire regime -** The fire regime of the grasslands prior to settlement and development for agriculture was one of stand-replacing fires on a short return interval, every year in some areas (DeBano, et al., 1998; Wright & Bailey, 1982). Prairie fires were often vast, burning into the forest margins and preventing tree invasion of grasslands.
>
> Burning maintains dominance by fire-adapted grasses and forbs, maintains the productivity of grasslands, and grass quality and availability are improved because the fire removes dead plant material and improves access to new growth. Generally, grass yields increase because removing cover and darkening the soil surface allows it to warm more quickly and stimulate earlier growth.

Piñyon/Juniper/Oak Woodlands *(piñyon-juniper fire regime)* **–** This vegetation type occurs above the velvet mesquite grassland zone but below the ponderosa pine zone and is very diverse. At lower elevations the overstory is dominated by redberry juniper (*Juniperus coahuilensis*) and turbinella oak. At mid-elevations Arizona piñyon (*Pinus fallax*) becomes a major overstory species and Utah juniper (*Juniperus osteosperma*) may occur along with redberry juniper and turbinella oak. At higher elevations alligator juniper (*Juniperus deppeana*) replaces the other juniper species and is co-dominant with Arizona piñyon, turbinella oak, Emory oak (*Quercus emoryi*) and Arizona white oak (*Q. arizonica*) Common shrubs include birchleaf mountain mahogany (*Cercocarpus montanus glaber*), skunkbush sumac (*Rhus trilobata*), sugar sumac (*R. ovata),* desert ceanothus (*Ceanothus greggii*), shrubby buckwheat, hollyleaf buckthorn *(Rhamnus crocea)*, beargrass (*Nolina microcarpa)*, and red barberry (*Mahonia haematocarpa*). Crucifixion thorn (*Canotia holacantha*) occurs on highly calcareous soils. The cover of trees and shrubs can be highly variable ranging from open woodlands with an herbaceous understory to dense stands with nearly a closed canopy. Understory grasses can include blue grama, hairy grama, sideoats grama, curly mesquite, plains lovegrass (*Eragrostis intermedia*), cane beardgrass, green sprangletop, bottlebrush squirreltail (*Elymus elymoides*) piñyon ricegrass (*Piptochaetium fimbriatum*), Junegrass (*Koeleria macrantha*), mutton bluegrass (*Poa fendleriana*), and three-awns. At present 241 acres of noxious weeds have been mapped in this vegetation type and include Malta starthistle, Dalmatian toadflax, diffuse knapweed, jointed goatgrass, Russian knapweed, sweet resinbush, and yellow starthistle.

Prominent overstory species include but are not limited to: piñyon pines, Utah juniper, one seed juniper, and alligator juniper. Because of the open nature of piñyon-juniper woodlands, grasses and shrubs are prominent in the understory. In pre-settlement times, stand-replacing fires probably occurred at average intervals of less than 50 years. Where livestock grazing reduced herbaceous fuels, fire occurrence decreased, and piñyon–juniper woodlands expanded.

Alligator Juniper Woodlands *(piñyon-juniper fire regime)* – These are normally found at the same elevation as the alligator juniper savannas and are often intermixed with them. The canopy coverage of overstory trees is greater than 10 percent. Arizona piñyon occurs but is most often associated with nurse junipers. Emory oak, Arizona white oak, sugar sumac, skunkbush sumac, and desert ceanothus may also occur. Key herbaceous species include sideoats grama, blue grama, hairy grama, threeawn, bottlebrush squirrel tail, mutton bluegrass, and annual bromes. Most of this vegetation type was formerly an alligator juniper savanna. Grazing pressure and lack of fire have allowed junipers and other woodland species to encroach into this type. Most of the junipers are less than 50 years old. Herbaceous forage is normally much less than in the alligator juniper savanna type. In the past, many areas of alligator juniper woodland have been treated (pushed) with management objective to maintain grasslands and to increase available forage. In recent years, these treated areas have not been maintained and, as a result, the areas now have dense stands of younger junipers. At present, two acres of noxious weeds have been mapped in this vegetation type. Yellow starthistle is the only species identified.

Arizona Cypress Woodlands *(piñyon-juniper fire regime)* – This community type is found in the same elevation as chaparral vegetation. The key indicator species is Arizona cypress (*Cupressus arizonica arizonica*). There is normally a dense understory of shrubs including manzanita, sugar sumac, desert ceanothus, mountain mahogany, banana yucca, hollyleaf buckthorn, Wright buckwheat, turbinella oak, Wright silktassel, Arizona piñyon, and Palmer oak (*Quercus dunnii*). The herbaceous layer is normally sparse, producing little forage. Much of this vegetation type contains shrubs palatable to livestock and wildlife, including mountain mahogany and desert ceanothus. About 40 percent (9,000 acres) of this type burned during the 2004 Willow Fire, leaving this area vulnerable to invasion by noxious weeds. At present, no noxious weeds have been mapped in this vegetation type.

> **Piñyon-juniper fire regime** -The impact of fire depends on tree density and the amount of grass and litter in the stand. Post-fire, piñyon-juniper woodlands present a landscape of dead trees and nearly bare soil. Annual plants become established in a few years. These are followed by perennial grasses and forbs. Invading plants often include weedy species, especially on bare soil. Reestablishment of junipers and shrubs typically takes 4 to 6 years and shrubs are replaced by new stands after 40 to 60 years (Barney & Frischnecht, 1974; Koniak, 1985).

Chaparral and Chaparral Woodlands *(chaparral and oak woodlands fire regime)* **–** Typically these types are found at the same elevations as the piñyon/juniper/oak woodlands. The **chaparral** type is dominated by low growing shrubs. Overstory trees are sparse or absent. Dominant shrub species include, turbinella oak, point leaf and pringle manzanita (*Arctostaphylos pungens* and *A. pringlei*), silktassel, mountain mahogany, desert ceanothus, skunkbush sumac, Wright silktassel (*Garrya wrightii*), hollyleaf buckthorn and evergreen oaks. Herbaceous vegetation is normally sparse. **Chaparral woodlands** are similar to chaparral, but contain an overstory cover of trees of up to about 15 percent. Overstory trees can include Arizona piñyon, redberry juniper, Utah juniper, alligator juniper, Emory oak, Arizona white oak, and occasionally ponderosa pine.

Chaparral woodlands often occur intermixed with dense piñyon/juniper/oak woodlands. At present 63 acres of noxious weeds have been mapped in this vegetation type and include, diffuse knapweed, jointed goatgrass, fountain grass, sweet resinbush, tree of heaven, and yellow starthistle.

Chaparral and Oak Woodlands fire regime - These regimes often include broad-leafed shrub and tree species that are well adapted to fire. These vegetation types are notorious for frequent, fast moving, stand replacing fires. Both chaparral and oak resprout vigorously after fire and also establish from seed. In chaparral, stand-replacing fires occur every 30 to 60 years. Frequency is reduced in areas where grazing has reduced surface fuels.

Annual and perennial herbs flourish after fire in chaparral, along with seedling and resprouting shrubs. Herbs are gradually eliminated as the dense overstory of large shrubs matures (DeBano, et al., 1998). Burning at 20 to 30 year intervals maintains a diverse mixture of species. If the fire return interval is longer, sprouting species will dominate, reducing plant species diversity (Paysen, et al., 2000).

Ponderosa Pine Forest *(coniferous fire regime)* **–** This vegetation type occurs above the piñyon/juniper/oak woodlands, but below the mixed conifer type. The dominant overstory species is ponderosa pine *(Pinus ponderosa scopulorum)*. Other common species include alligator juniper, Arizona white oak, and Emory oak. Gambel oak (*Quercus gambelii*) normally occurs on some cooler sites. Arizona piñyon may occur on warmer/drier sites. Other species may include pointleaf manzanita, pringle manzanita, mountain mahogany, New Mexico locust (*Robinia neomexicana*), and desert ceanothus. The understory is normally sparse but may include blue grama, sideoats grama, mutton bluegrass, and dryspike sedge *(Carex foenea)*, goldenrod *(Solidago spp.),* and a variety of other perennial forbs. At present 165 acres of noxious weeds have been mapped in this vegetation type and include bull thistle, jointed goatgrass, Scotch thistle, and yellow starthistle.

Mixed Conifer *(coniferous fire regime)* – This vegetation type occurs on the highest elevation of the Tonto NF. Indicator species present include white fir *(Abies concolor)*, Douglas fir *(Pseudotsuga menziesii glauca)*, ponderosa pine, Gambel oak, and New Mexico locust. Arizona white oak, Emory oak, alligator juniper, and pointleaf and pringle manzanita may occur on warmer/drier areas. The overstory is normally dense and the understory of herbaceous vegetation is sparse but may include mutton grass and longtongue muhly *(Muhlenbergia longiligula*). At present, no noxious weeds have been mapped in this vegetation type.

Coniferous fire regime - Important dominant trees include but are not limited to ponderosa pine, Southwestern white pine, Douglas fir, and white fir. In past centuries these forests had a variety of fire regimes; understory, mixed-severity, and stand replacement. At low elevations, understory fires maintained large areas of ponderosa pine and Douglas-fir in an open, park-like structure for thousands of years prior to the 1900s. Fire on these sites increased grass and forb production. Pre-settlement mean fire return intervals (the average number of years between fires at a given location) range from less than ten years (Arno, 1976) to more than 300 years (Romme, 1980). Forests with a multistoried structure, including dense thickets of young conifers, were more likely to experience stand-replacing fire than open, park-like stands. Stand-replacing fires were unusual in ponderosa pine during pre-settlement times but are now more common because of increased surface fuels and “ladder” fuels (shrubs and young trees that provide continuous fine material from the forest floor into the crowns of dominant trees).

In pre-settlement times, repeated understory fire maintained an open forest with grasses and forbs on the forest floor and scattered patches of conifer regeneration. Fires occasionally killed large, old trees, creating openings where the exposed mineral soil provided a seedbed suitable for pine reproduction (Weaver, 1974). Regenerating stands often produce large volumes of browse until the tree canopy closes, 25 or more years after fire.

Environmental Consequences

Table 9: Effects of various weed control methods on vegetation communities

Treatment Type and Acreage	Description of Treatment
Manual Proposed Action – 400 acres Alternative 1 – 200 acres Alternative 2 – 400 acres	Manual treatments may involve extremely slight disturbance to native vegetation. Any disturbance is short-term (likely less than one year), and of limited extent. The net long-term effects are generaly positive for weed control and benefical to plant communities.
Mechanical Proposed Action – 500 acres Alternative 1 – 0 acres Alternative 2 – 2000 acres	Many mechanical treatments involve some degree of disturbance to surrounding native vegetation. Most disturbance is short-lived (one to two years) and restricted to a relatively few acres (less than 0.1 percent) on the forest in the vicinity of weed infestation. Mechanical control of some rhizomatous species may not be effective in controlling those species and could actually result in their spread. Other species are difficult to control because of the persistence of large seed banks once weeds have become established. The net long-term effects are generally positive for weed control but some localized increases in weed populations.
Burning/torching Proposed Action – 2,000 acres Alternative 1 – 2,000 acres Alternative 2 – 2,000 acres	Burning can be effective in controlling weeds, especially annual weeds. It is especially effective in removing large quantities of seeds of annual weeds. Some invasive species are difficult to control using fire and fire can also impact non-target species and result in increased soil erosion. There may be some short-term (one to two years) negative effects on native plants in a few areas but the long-term net effect of burning is likely to be positive for weed control plant communities.
Cultural Proposed Action – 2,000 acres Alternative 1 – 0 acres Alternative 2 – 2,000 acres	Cultural practices are designed to establish desirable plants in order to prevent infestation by invasive plants. There may be some short-term disturbance to native vegetation in areas prepared for seeding establishment but the long-term effect is an expected decrease in weed populations.

Treatment Type and Acreage	Description of Treatment
Biological Proposed Action – Will be used Alternative 1 – Will not be used Alternative 2 – Will be used	Biological controls involve grazing animals, approved insects and pathogens to control weeds. The use of biological controls, except for grazing animals, would have little to no direct on native vegetation. The use of grazing animals, however, could have both short and long-term effects on vegetation. Grazing that is heavy enough to control weeds may also severely reduce the cover of native species. The net effect of using biological controls, except for grazing animals, is likely to be positive. The net effects of grazing animals could be positive with strict controls or negative if native vegetation is affected.
Herbicide Proposed Action – 9,000 acres Alternative 1 – 1,300 acres Alternative 2 – 1,300 acres	Herbicides that selectively target only invasive species and/or are used in spot treatments would allow native species to recover which should reduce soil erosion and enhance nutrient cycling. Possible negative effects of herbicide application include the potential that some non-target species would be affected. If negative effects occur they are likely to be localized (less than 0.3 percent of the forest) and short-term (one to two years) The net effects of herbicides would be some possible short-term negative effects to native plants but long-term positive effects to plant communities.
Total Acres Treated Proposed Action – 13,900 acres Alternative 1 – 3,500 acres Alternative 2 – 7,700 acres	

Comparison of Alternatives

Direct and Indirect Effects

General Effects on Vegetation-The proposed action is more likely than the other alternatives to limit or reduce the spread of invasive plants because more acres per year could be treated and more control methods are available (see treatment comparisons in above table). Assuming that native plant communities will replace tap-rooted invasives after treatment, vegetation communities should remain stable or be enhanced. Alternative 1 would be the least effective in preventing the spread of invasive plants since this alternative would treat the fewest acres and have the fewest methods available for treatment. Alternative 2 would be somewhat intermediate in effectiveness. The control of exotic annual grasses such as red brome will be difficult under all alternatives given the relatively small areas treated annually, ranging from 3,500 acres in alternative 1 to 13,900 acres in the proposed action, versus the hundreds of thousands of acres that can be infested during wet winters. Even with the use of herbicides, it may not be possible to adequately control non-native annual grasses to significantly reduce fine fuels. Also, it may not be possible to stock up cattle numbers quickly enough to adequately control non-native annual grasses. Infestation of invasive annual grasses is so extensive on the Tonto NF that herbicide use is not practical except in key areas such as highway rights of way. The risk of wildfire caused by a buildup of annual grasses will remain high. Infestations of red brome can lead to unnaturally severe wildfires, especially within the Sonoran Desert. These wildfires can cause unnaturally high erosion due to loss of ground cover.

The direct effects of treatments depend on the type and extent of treatment. Physical removal (manual and mechanical) will result in localized, short-term disturbance. The most disturbance occurs in the proposed action with the least occurring in alternative 1. Burning may result in some localized, short-term (one to two years) negative effects but prescribed burning to manage noxious weeds should result in controllable conditions for fire frequency, duration, and intensity based on environmental conditions used during implementation, thus resulting in fairly predictable ecological effects on native vegetation. The effects of burning are same for all alternatives. The direct effect of cultural practices may be some slight, short-term disturbance in areas prepared for seeding. The effects are the same in the proposed action and alternative 2 but there would be no cultural practices in alternative 1. The use of biological controls (occurring in the proposed action and alternative 2) would have little to no direct effects on native vegetation quality unless grazing animals are used. If grazing animals are used heavy grazing could affect non-targeted native vegetation. The direct and indirect effect of using herbicides varies. Broadcast treatment by non-selective herbicides could destroy native species at a higher rate than weeds. On the other hand, herbicides that selectively target only invasive species and/or are used in spot treatments would allow native species to recover. More acres would be treated under the proposed action than the other alternatives and the overall negative direct effects of this alternative while small are slightly greater than the other alternatives. The proposed action would have the greatest direct negative impact on native vegetation because of a greater area of disturbance associated with treatments, however, the effects to vegetation are likely to be temporary (less than two years) and localized (less than 0.5 percent of the forest). Alternative 1 would have the least direct disturbance to native vegetation while alternative 2 would be intermediate.

Effects on Vegetation Communities by Fire Regime - The ecological effects of fire on each fire regime vary enormously according to the time of year; the quantity, condition, and distribution of the fuel; the prevailing climatic conditions; the duration and intensity of the fire, the slope, aspect, and elevation; and the type of vegetation and soil. Given all the variables associated with fire regimes, the effects from invasive plants can be widely variable ranging from very minimal to very large depending on the magnitude of infestation and overall ecological conditions. Although the proposed action is more likely to control invasive weeds than the other alternatives, the effects on some fire regimes may not be measurable.

The **Coniferous fire regime** *(ponderosa pine and mixed conifer forests),* with the exception of areas burned during the 1990 Dude Fire, may not be measurably affected by the presence of invasive weeds at the present time or during the ten-year planning period. Fires are now more common because of increased surface fuels and “ladder” fuels (shrubs and young trees that provide continuous fine material from the forest floor into the crowns of dominant trees) These factors may completely overwhelm the relatively small presence of invasive weeds (less than 0.1 percent of the type). The area burned in during the Dude Fire has an altered fire regime. The area is in an early seral state with the mixed conifer and ponderosa pine vegetation replaced by alligator juniper, oaks, and manzanita with an understory of seeded, non-native weeping lovegrass. The Dude Fire area represents more than 99 percent of the mapped population of weeping lovegrass. In some places, the density weeping lovegrass could lead to an increased risk of wildfire, however, in most places within the Dude Fire, the cover of weeping lovegrass in decreasing (U.S.F.S., Tonto NF files, Dude Fire photo points 1990 to 2009), being reduced by competition with overstory trees and shrubs.

The Piñyon-juniper fire regime *(pinyon/puniper/oak woodlands, alligator juniper woodlands, Arizona cypress woodlands)*, is highly diverse (more than 50 Habitat Types occur in the Southwest {U.S.F.S., Southwestern Region, 1997}) and the impact of fire depends on tree density and the amount of grass and litter in the stand. The effects of invasive weeds can also be highly variable ranging from minimal to large. Most areas in most years have only a small presence of invasive weeds (less than 0.1 percent of the type); however, in years following wet winters, some areas can have a heavy covering of annual grasses, especially red brome which is most likely to occur in lower elevation woodlands and areas with bare soil. The presence of annual grass is the major factor in altering fire frequency and intensity and it is only minimally affected by treatments under different alternatives given the hundreds of thousands of acres potentially affected versus a maximum of 13,900 acres treated under the proposed action.

The **Chaparral and Oak Woodlands fire regimes** (*chaparral and chaparral woodlands*) are notorious for frequent, fast moving, stand replacing fires which occur every 30 to 60 years. The occurrence of invasive plants is low in these types (less than 0.1 of the area). The main effect of invasive plants occurs when surrounding vegetations types become infested with annual grasses following wet winters and fire spreads from these types into chaparral as happen in the 2005 Cave Creek Complex Fire (Norm Ambos, personal observation). None of the alternatives are likely to have more than a minimum effect on the distribution of red brome.

The **Grasslands fire regime** (*velvet mesquite grasslands, alligator juniper savannas*), prior to settlement, was one of stand-replacing fires on a short return interval, every year in some areas (DeBano, et al., 1998; Wright & Bailey, 1982). Prairie fires were often vast, burning into the forest margins and preventing tree invasion of grasslands. Burning maintains dominance by fire-adapted grasses and forbs, maintains the productivity of grasslands, and grass quality and availability are improved because the fire removes dead plant material and improves access to new growth. The largest effect on this fire regime is the presences of non-native annual and perennial grasses which occur mostly in wet years and can affect hundreds of thousands of acres. This can lead to an increase in the current fire frequency which is thought to be much lower than the natural frequency. Fires in grasslands generally increase productivity but in some cases, such as a hot fire occurring when grasses are drought stressed, can lower productivity. None of the alternatives are likely to have more than a minimum effect on the distribution non-native grasses.

The Desert fire regime (*Sonoran Desert*) historically was one of long fire return intervals, more than 250 years. Seasonal weather and grazing influence fire potential in deserts (Wright & Bailey, 1982). A wet year produces large quantities of grasses and forbs, which provide fuel to carry fire. The Sonoran desert only has enough ground cover to carry fire after occasional unusually wet growing seasons (Humphrey, 1974). Several studies report increase in exotic annual plants, including red brome and filaree, after fire in desert ecosystems; both frequency and intensity of fires may have increased since the introduction of these annual plants (Rogers & Steele, 1980; Young & Evans, 1973). Most of the dominant plants in the desert communities (palo verde, saguaro, and other cacti, for example) are readily killed by fire. The presence of annual grass is the major factor in altering fire frequency and intensity and it is only minimally affected by treatments under different alternatives given the hundreds of thousands of acres potentially affected versus a maximum of 13,900 acres treated under the proposed action. None of the alternatives are likely to have more than a minimum effect on the distribution of red brome. Other invasive plants only occupy about 0.1 percent of the Sonoran Desert and are unlikely to alter the fire regime on a large scale.

Cumulative Effects

Other past, present and future activities may potentially contribute to cumulative effects on plant communities. Appendix I lists projects that may possibly impact the area. Almost all activities that have occurred, are occurring, or will occur could potentially impact populations of invasive weeds either by introducing seeds or portions of weeds into non-infested areas, creating conditions favorable for germination or spread, or by reducing native plants that serve to compete with weeds. The primary activities which may affect vegetation include road use and construction, vegetation management (primarily fuels reduction), range management, fire suppression (primarily fire lines and safety zones), recreation management (primarily OHV use), and land and mineral resources. Recreation can disturb soils and create conditions conducive to the introduction of invasive species. Recreationists, their vehicles and pets can act as vectors for the dispersal of weed seeds from other areas. Likewise, livestock grazing can contribute to the introduction and spread of non-indigenous plants by transporting seeds into uninfested sites, disturbing the soil and preferentially grazing native plants over weed species (Belsky & Gelbard, 2000). On areas of the forest where grazing occurs, livestock may continue to contribute to the spread of invasive species. Fire suppression may also contribute to the introduction and spread of nonnative plants by creating favorable growing conditions and through the transportation of seed sources. All the activities listed above have at least some potential to increase the spread of invasive plants. All the alternatives can potentially limit or reduce the spread of non-native plants. The proposed action would be the most effective in controlling the spread followed by alternative 2 and then alternative 1.

Invasive Plants

Affected Environment

Plant descriptions, origins, locations in Arizona, and effects on ecosystems can be found in appendix A.

Vectors of Spread

Livestock

1. Sheep brought onto driveways from farms in other parts of the state may carry weed seeds in their wool, especially since they are not sheared until they reach their summer range in the White Mountains (McKinney, 2005). Species such as fountain grass have been identified growing in the Heber-Reno Sheep Driveway in a tributary to Sycamore Creek in Round Valley, a site not easily accessed by vehicular traffic. Other species common in the valley that could be transported are buffelgrass, mustards, various grain seeds and weeds common in grain crops. Cattle permits where the herd spends time on lands other than the Tonto NF could bring new infestations onto the forest.
2. Some base properties associated with term grazing permits have acreage devoted to raising some type of crop for livestock feed. These fields could have invasive plant infestations. If the crop is harvested and fed only on the private land, the weeds could be dispersed thru the manure of the livestock that have been fed and turned back onto the National Forest. If livestock are allowed access to the crop fields, they could transport weed

seeds and plant parts to other areas in their feet and on their coats. If the crop is harvested and baled for subsequent feeding in other areas, such as the National Forest, weed seeds can be scattered and trampled into the ground at the feeding site.

3. Forest Service livestock can also spread new infestations in the same way, if they are fed weed-infested hay.
4. Equipment brought in to do range improvement work can be contaminated with weed seeds and plant parts, and spread weeds to project sites.
5. Recreational stock, or any animals brought in to do contract packing jobs for any type of project can bring weed seeds and plant parts in their feet, on their coats, or as manure, if they have eaten non-weed-free feed before coming onto the National Forest. Any feed brought in for them that is not weed-free can spread new weed infestations.
6. Picketed pack stock can remove vegetation from a campsite, leaving it open to noxious weed infestation. Also, any livestock concentration area, if in the vicinity of known infestations of weeds is vulnerable to invasion by those weeds.
7. If a pasture is known to have an infestation of noxious weeds, livestock can spread the infestation to new sites if they are in the pasture during the season when the plant is producing seeds.

Recreation

1. Recreational vehicles, such as two or four-wheel drive vehicles, ATVs, bicycles, or motorcycles can bring weed seeds and plant parts onto the forest from other sources. They can also spread existing infestations into new sites. ATVs commonly drive in the right-of-way along Hwy 188. Much of this right-of-way has had a Malta starthistle infestation for several years. When ATVs move from the right-of-way onto the forest road network, they are quite likely to spread Malta starthistle throughout the entire Tonto Basin.
2. Hikers can bring weed seeds in on their clothing, bootlaces, pack/camping/hunting equipment, or pets. These infestations are most easily found at trailheads, along trails, and at major trail destinations. But hikers are not confined to trails, so an infestation spread by this means can attain a large size before it is ever detected.

Road Construction and Maintenance

1. Road grading equipment can spread weed infestations along forest roads and highways, if it works from areas with infestations and grades into “clean” areas.
2. Fill dirt brought in can be a source of weeds. Also excess dirt removed from work sites can spread existing infestations elsewhere.
3. Revegetation seed mixes can contain noxious weed seeds. Containerized plants brought in from outside the project area can also contain weeds.
4. Mulch used to stabilize new road cuts can contain weed seeds.
5. Newly cleared areas created during road construction are especially vulnerable to new infestations from weeds growing near the project area. There are no existing plant populations to compete with any weed seeds that are blown in or brought in by other means.
6. Dirty equipment may bring in noxious weed plant parts and seeds.

Fire Management Activities

1. Equipment brought in to fight fires may bring weed seeds and plant parts to burned areas that are especially susceptible to infestation. This includes the entire gamut of vehicle types

that are brought into areas of fire management activities: all types of trucks, ATVs, water tenders, office and other special use trailers for Incident Command Posts and fire camps, dozers, forklifts and other heavy equipment, and helicopters.

2. Fire staging areas may be established in or near existing infestations.
3. Hot Shot Bases and crew quarters may be infested with weeds that are transported to fires on fire fighters' clothing and boots.
4. Post-fire seed mixes or mulch may be contaminated with noxious weeds.
5. Prescribed fire, if conducted in areas in poor vegetation condition, may cause an even further decline in condition. This can leave areas such as perennial grasslands open to invasion and ultimate conversion to annual grasslands. Once this happens, it can be very difficult, if not impossible to reverse the situation and change back to a perennial grass-dominated vegetation type.

Forest Management

1. Trucks and other equipment brought in to harvest timber or fuelwood may be contaminated with noxious weeds. This applies to both commercial and personal sales.
2. Prescribed burning of slash piles may leave them open to infestation of weeds from existing infestations in the vicinity.
3. Post-sale revegetation may bring in noxious weeds.

Wildlife

1. Wildlife may spread infestations to new sites if the infestations are growing in heavily used sites such as bedding or fawning grounds.
2. Wildlife such as elk can heavily graze meadows or riparian areas, leaving them open to infestation from nearby noxious weeds.

Lands

1. The Forest Service could acquire lands that have noxious weed infestations.
2. The Forest Service could trade lands where there are noxious weed infestations. By doing so, we would lose the ability to control the weeds.

Mining

1. Equipment brought in from off-site can bring in new infestations of weeds.
2. Large areas that have been laid bare are susceptible to infestation by noxious weeds.

Natural Vectors

1. Some weeds are adapted to disperse seeds using the wind. These plants either have light fluffy seeds that are easily airborne, or the entire plant breaks off when mature and "tumbles," scattering seed along its path. Russian thistle and Saharan mustard are two examples of "tumbleweeds." While tumbleweeds are usually blown across fairly level ground or downhill, dust devils are able to move weed propagules to higher elevations.

2. Weeds that grow in riparian areas often have seeds that are transported by water. When deposited in fresh silt on a drainage, the seed germinates.

3. Some weeds are palatable to wildlife. Seeds may be eaten in addition to vegetative plant parts. These seeds may even require a “scarification” process, or treatment of the tough seed coat with an acid, in order to germinate.

Environmental Consequences

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

The proposed action most completely fulfills the need for control of invasive species on the forest. All of the integrated vegetation management tools are available for creation of long-term treatment strategies of all types of weeds. Multiple-year treatments will be required, as for the other alternatives.

Hand-pulling, small-scale mechanized treatments and small-scale prescribed burns will continue to be treatments of choice for small infestations. Volunteer groups are ideal for participation in this type of treatment, both to remove early-detected/small infestations, and to educate their members.

Larger prescribed burns and flaming (use of fire to sear plants, such that water within their cells boils thereby destroying the cells and killing the plant) can be used for larger infestations that are spreading rapidly, such as Malta and yellow starthistle. These techniques are most effective when used in combination with herbicide applications. We should be able to confine Malta starthistle to boundaries given in the weed description section, and gradually beat back the infestation to smaller and smaller areas through time. Some revegetation may be necessary in areas where the infestation has become especially dense.

Perennial weeds with extensive root systems that contain large amounts of carbohydrate reserves will be treated more effectively with systemic herbicides.

Cultural treatments such as seeding with native species in large areas that have been treated with one of the control methods will serve to provide vegetative competition for invasive plants. This will help to prevent their germination, as some of them require abundant sunlight to germinate. Established root systems of neighboring plants will take up soil moisture, making it less available for invasive plants.

Biological control methods will work only for larger infestations, and will be used in conjunction with other control methods. As populations of target invasive plants decline, biocontrol agent populations also decline and there is a lag time for the biocontrol to “catch up” to have a serious impact on invasive plants as populations rebound. This method is best used to weaken and reduce very large infestations.

All of the above methods will need to take place over a period of many years to achieve results of containment or eradication.

Cumulative Effects

Most other ongoing actions have the potential to bring new invasive weeds onto the forest from remote sources, or to spread existing infestations. Implementation of the proposed action should allow the Tonto NF to keep on top of new infestations with ongoing education programs, and to treat them quickly with the best available method.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

Under current management, weed infestations will be expected to continue to grow out of control.

Cumulative Effects

Since most other ongoing actions have potential to bring or spread weeds, the Tonto NF would suffer from increasing acres and species of invasive plant infestations every year. Existing treatments are not keeping up with the spread of existing infestations. Some rural communities, such as Young and Tonto Basin would be particularly impacted by the uncontrolled spread of invasive species on the National Forest, since it would negate any efforts they took to treat their private lands for infestations.

Alternative 2: Integrated Vegetation Management Excluding the Use of Herbicides

Direct and Indirect Effects

Under this alternative, larger prescribed burns and biological control would be allowed. This alternative would slow the rate of spread of some weed species. However, because many infestations would not be completely controlled or eliminated with the types of control allowed under this alternative, long-term expansion of noxious weeds into suitable habitat would be expected. Some species with large potential for expansion (such as starthistles) or with extensive root systems (such as camelthorn and Russian knapweed) would not be controlled with tools this alternative provides.

Burning and mechanical treatments, the main methods available for large-scale treatment of infestations, may affect non-target species after several years of repeated treatment. These methods are usually fairly non-species specific, so may require extensive restoration after treatment.

Effects due to biocontrol would be the same as for the proposed action.

Cumulative Effects

Without the use of herbicides, the Tonto NF would be missing a very effective tool for managing spreading infestations in a cost-effective manner. As for alternative 1, weed infestations would grow, but not as rapidly.

Endangered, Threatened, Candidate and Sensitive Plant Species

Affected Environment

Plant lists used for this report are the January 2007 U.S. Forest Service Southwestern Region Sensitive Plant List (U.S.F.S., 2007), and the U.S. Fish and Wildlife website (USFWS, 2011a).

The project area contains populations of 27 and federally-listed and sensitive plant species. While no threatened or candidate species are found within the project area, two endangered species are present: Arizona cliffrose and Arizona hedgehog. Of the total number of sensitive species, two species listed in the table below have never been found on the forest, but are on the Forest Service Region 3 Sensitive Plants List. They should be on the survey list for any project proposal due to their proximity to and potential occurrence on the forest.

Table 10. Known and potential endangered and sensitive plant species that are known or suspected to occur on the Tonto National Forest

Scientific Name	Common Name	Status[1]	Watershed/Location	Weeds in Habitat (Yes, No, Unknown)	Invasive Species in or near Habitat
Ehinocereus triglochidiatus var. *arizonicus*	Arizona hedgehog	E	Queen Creek, Upper Salt/ Top of the World, Superstitions, Apache Peak	Yes	Malta starthistle
Purshia subintegra	Arizona cliffrose	E	Verde/Horseshoe Dam, Chalk Mountain	Yes	Malta starthistle
Abutilon parishii	Pima Indian mallow	S	Superstitions, possibly near Mercury Mine in Mazatzals	Unknown	Fountain grass, oleander
Actaea arizonica	Arizona bugbane	S	Salt River/ Sierra Anchas	Unknown	
Agave delamateri	Tonto Basin agave	S	Tonto, Salt/Tonto Basin, Deer Cr.	Yes	Brome spp.
Agave murpheyi	Hohokam agave	S	Salt/ Tonto Basin	Yes	Brome spp.
Arenaria aberrans	Mt. Dellenbaugh Sandwort	S	Yavapai & Gila Counties. Rare.	Unknown	
Carex chihuahuensis	Chihuahuan sedge	S	Upper Salt/ Reynolds Creek	Unknown	
Carex ultra	Giant sedge	S	Verde/ Tangle Cr, Verde River	Unknown	Yellow sweetclover, Arundo, saltcedar
Cirsium parryi ssp. *mogollonicum*	Mogollon thistle	S	Unknown	Unknown	
Erigeron anchana	Mogollon fleabane	S	Upper Salt, Verde/ possible face of Mogollon Rim	Unknown	Yellow starthistle

1 T = Threatened , E = Endangered, S = Sensitive species according to Forest Service Region 3 listing.

Erigeron piscaticus	Fish Creek fleabane	S	Salt River/ Fish Creek	Unknown	
Eriogonum ripleyii	Ripley's wild buckwheat	S	Verde/Horseshoe, Chalk Mtn	Yes	Malta starthistle, red brome
Heuchera eastwoodiae	Eastwood alum root	S	Salt, Verde, Tonto/ Tonto Creek, Houston Creek, Pine Creek, and Parker Creek, First Water Canyon, Devil's Chasm, Workman Creek	Unknown	
Heuchera glomerulata	Arizona alum root	S	Upper Salt, Gila/ Pinal Mtns	Unknown	
Lotus alamosanus	Alamos deer vetch	S	Salt, Queen Cr/ Superstition Mtns.	Unknown	
Lotus mearnsii var. equisolensis	Horseshoe Deer Vetch	S	Horseshoe/Lime Creek area	Yes	Malta starthistle, red brome
Mabrya acerifolia	mapleleaf false snapdragon	S	Lower Salt, Queen Cr/ Horse Mesa Dam road, Fish Creek Hill, Goldfield Mountains, Canyon Lake, Hewitt Ridge Canyon, Fish Creek Canyon, La Barge Canyon, Bluff Spring Canyon, Peralta Canyon, and Tortilla Creek.	Unknown	
Packera neomexicana var. toumeyi	Toumey groundsel	S	Pinal Mountains	Unknown	
Penstemon nudiflorus	Flagstaff beardtongue	S	Tonto Cr/ Buckhead Mesa	Unknown	
Perityle gilensis var. *gilensis*	Gila rock daisy	S	Not known to grow on the Tonto NF. It does grow on the Coconino NF near the Mogollon Rim, which abuts the Tonto NF	Unknown	
Perityle gilensis var. salensis	Salt River rock daisy	S	Salt River Canyon cliffs	Unknown	
Perityle saxicola	Fish Creek rock daisy	S	Salt/ Fish Creek	Unknown	

Phlox amabilis	Arizona phlox	S	Tonto Cr./ Christopher Creek	Unknown	
Polygala rusbyi	Hualapai milkwort	S	With endangered cliffrose, Horseshoe/Lime Creek area	Unknown	
Rumex orthoneurus	Blumers dock	S	Sierra Anchas	Unknown	
Salvia amissa	Aravaipa sage	S	Upper Salt/ Devil's Chasm, PB Creek	Unknown	
Thelypteris puberula var. sonorensis	Aravaipa woodfern	S	Near Roosevelt Lake, Four Peaks area	Unknown	

Sources for information: USFWS, 2011a; Lutch, 2000; USFS SW Region, 2007.

Of the 29 species that are considered special status taxa, 9, or roughly 31 percent, are documented to have weeds within or adjacent to known populations. Brome grasses and probably other exotic cool-season annual grasses are known to grow throughout the Sonoran Desert where regionally-listed agaves grow. Agave species do not normally weather wildfire well, which exotic grass species are adapted to and tend to bring to the Sonoran Desert.

Arizona Hedgehog Cactus *Echinocereus triglochidiatus var. Arizonicus*
Federal: Endangered

This robust perennial cactus occurs on the Tonto NF in the vicinity of Highway 60 from Top of the World to Pinto Creek, on Apache Peak north of Globe, and in the southeastern corner of the Superstition Wilderness. It has dark green cylindroid stems that occur as single stems, or more frequently, clusters of stems. Flowers are bright red or crimson. It occurs within Interior Chaparral and Madrean Evergreen Woodland communities at elevations ranging from 3,300 to 5,700 feet. Preferred habitat is found on parent materials of igneous origin, primarily Schultze Granite and Apache Leap Tuff (Dacite); plants occurring on the Pinal schist and Pioneer formations are found only in proximity to the preferred parent materials and where the formations are expressed as exposed bedrock (AZGFD, 2003). No critical habitat has been identified for this species.

Primary threats include collection, mining, off-highway vehicle creation of unauthorized roads and trails, and road construction.

Arizona Cliffrose *Purshia subintegra* Federal: Endangered

Arizona Cliffrose is a perennial shrub, growing from 3 to 6 feet tall and generally wider than tall. As a genus, cliffroses are morphologically variable and this can create identification problems when *P. subintegra* occur in proximity to *P. stansburiana* (e.g., Verde Valley and Horseshoe areas). This species is restricted to nutrient-deficient, calcareous limy-tuff soils derived from Tertiary lacustrine deposits. Crucifixion-thorn is the most common plant associate. Subpopulations at the Horseshoe Lake site occur at elevations between 2,100 and 2,700 feet. No critical habitat was identified or designated for this taxon at the time of listing. Listing occurred under the former genus *Cowania*. A Recovery Plan was developed for this species in 1994. It did not address the threat of invasive species.

Monitoring conducted in the early 1990s showed seedlings of this species to be rare and also extremely slow-growing. They typically germinate in April, and have the driest months of the year (May and June) to become established. Deer were observed to contribute as much to browsing of Arizona cliffrose plants as domestic livestock under the annual spring grazing season that was used at that time. The cliffrose population on Chalk Mountain was never affected by cattle, probably because of the difficult footing and sparse vegetation on that topographic feature.

Malta starthistle infestations in the Horseshoe area have been identified and mapped in close vicinity to the endangered Arizona cliffrose vegetation assemblage, which includes three other local endemic sensitive plant species: Ripley wild buckwheat, Horseshoe deer vetch, and Hualapai milkwort. The Cave Creek Complex Fire of 2005 only stopped short of burning through these species' habitat because the white substrate in which they grow does not support a dense vegetative groundcover. However, a fairly recent Malta starthistle infestation may expand to the white Tertiary lakebed sediment where these endangered and sensitive species grow (Fenner, personal observations).

Pima Indian Mallow *Abutilon parishii* Status: Sensitive

This herbaceous perennial is presently known from 84 populations in 17 mountain ranges. Its occurrence in Arizona is primarily within the south-central and southeastern part of the state. This species has a woody base and herbaceous branches that can grow up to three feet tall from a woody rootstock. One aid to identification is the presence of dead stems up to one meter high, with empty fruit capsules that persist throughout the winter. This species occurs in mesic situations in full sun within higher elevation Sonoran Desert scrub, desert grassland, and Sonoran deciduous riparian forest. Typical localities are on rocky hillsides, cliff bases, lower side slopes and ledges of canyons among rocks and boulders. Slopes can exceed 45 degrees. It can occur on flat secondary terraces in riparian zones, but typically not in canyon bottoms. The majority of the Arizona populations are in the Santa Catalina Mountains. There are two documented locations of this plant on the Tonto NF: near the Mercury Mine in the Mazatzal Mountains (AZGFD, 2000a), and on the south shore of Canyon Lake, near the Apache Trail. The first locality is questionable. It was based on a collection by Eastwood in 1929, but there is confusion in field notes as to collection site location. This identification needs verification. It is disjunct from the Tucson area populations and is in questionable habitat. Van Devender searched the area in September, 1991, and did not find appropriate habitat (AGFD, 2000a). A voucher specimen for the second location is in the Tonto NF herbarium.

Two populations in Mexico were eliminated after wildfire carried by the exotic invasive plant buffelgrass, as reported by C. D. Bertelsen to Arizona Game & Fish Department in 2000 (AZGFD, 2000a).

Arizona Bugbane *Actaea arizonica* Status: Sensitive

This herbaceous perennial occurs in central Arizona, and is the only species of this genus in Arizona. It was originally listed as a candidate species for federal listing under the name *Cimicifuga arizonica*. After the Conservation Strategy for Arizona bugbane was approved in 1999 (U.S.F.S. et al., 1998), U.S. Fish & Wildlife Service removed this species from its Candidate list (*Federal Register*, 2000).

Plants average three to six feet in height with large, long-petioled lower leaves and small sessile upper leaves. Small white petal-less flowers clustered on flower stalks make this plant very conspicuous when in bloom. This species occurs within moist, forested areas near perennial streams, intermittent streams or seeps between 6,000 and 8,300 feet in elevation. Rich fertile soils high in humus are typical. Surrounding vegetation is generally mixed conifer with an understory of deciduous shrubs and trees that is often dense and shady. This species is often the dominant understory species where found. It appears that a high level of humidity is typical at many of the Arizona populations. The distribution of Arizona bugbane includes Bill Williams Mountain, Oak Creek, West Fork of Oak Creek, and West Clear Creek (AZGFD, 1999).

The only known populations on the Tonto NF are associated with Workman Creek and Cold Springs Canyon in the Sierra Ancha Mountains. Potential habitat exists in unsurveyed areas in the Sierra Anchas. Arizona Game and Fish Department's plant abstract for Arizona bugbane summarizes information to date on locations of this plant (AZGFD, 2008).

Tonto Basin Agave *Agave delamateri* Status: Sensitive

This is a large suckering agave with very tall, open, unfruited flower stalk and a dense rosette. The flower stalk has a few lateral branches that are perpendicular to the main stalk. It is usually found on south and southwest facing slope edges and atop benches, occasionally on northeast facing gentle slopes. It occupies cobbly and gravelly, deep and well-drained soils at elevations from 2,300 to 5,100 feet, and is often associated with prehistoric sites. About 90 clones are known from Young, Arizona to San Carlos Reservoir, foothills of Mazatzal and Sierra Ancha Mountains, the Sunflower area, and near Oak Creek. The greatest concentration of sites occurs along the south end of Tonto Creek near the northwest end of Roosevelt Lake in Tonto Basin (AZGFD, 2003b).

Hohokam Agave *Agave murpheyi* Status: Sensitive

This agave has a dense rosette with a short terminal spine. It has a branched flower stalk, but flowers abort and bulbils develop at the nodes. *Agave murpheyi* does not resemble any other agaves in its area. It is found in south-central Arizona in Sonoran Desert. It is found on gentle bajada slopes, benches or terraces above major drainages with prehistoric habitations and/or agricultural sites (that suggest tending), typically from 1,300 to 2,400 feet. It requires well-drained soil. There are about 60 known sites in Arizona (AZGFD, 2003c).

Mt. Dellenbaugh Sandwort *Arenaria aberrans* Status: Sensitive

This plant is a small perennial forb (growing to six inches in height) that is endemic to Arizona. It grows in north to north-central Arizona, with populations in Coconino, Mohave, Yavapai, and possibly Gila counties (AZGFD, 2004a). It occurs in oak and pine forests, and also among junipers at elevations from 5,500 to 9,000 feet. It flowers May to July, with small white five-petalled flowers. It appears to grow in rocky habitats of ridges and canyon rims.

Chihuahuan Sedge *Carex chihuahuensis* Status: Sensitive

This grass-like perennial is one of 50 species of Carex in Arizona. It is known from southeastern Arizona, New Mexico, and Mexico. It blooms from April to August at elevations from 3,600 to 7,200 feet. It typically occupies north and northwest-facing slopes in wet soils in streambeds, wet meadows, cienegas, marshy areas, shallower draws in pine-oak forest and riparian woodland. It is often associated with pine oak forests and riparian woodlands. This sedge is known to occur in the Chiricahuas, Huachucas, Pinalenos, Santa Catalinas, San Luis Mountains, Rincons, Atascosas, Santa Ritas, and along the Santa Cruz River and San Bernardino Valley. It has been documented along Reynolds and Cherry creeks in the Sierra Ancha Mountains on the Tonto NF (AZGFD, 2004b, Tonto NF herbarium).

Arizona Giant Sedge *Carex ultra* Status: Sensitive

This herbaceous perennial is one of approximately 50 species of *Carex* known from Arizona. It has the appearance of a bulrush, but is actually a large sedge with round, stout, erect culms (up to three to seven feet tall). It flowers late March through September and grows from 2,000 to 6,000 feet in elevation. It often occurs on southeast-facing, shaded exposures in moist soil near perennially wet springs and streams. It is typically found in wet alluvial soil, sand and gravels, associated with aquatic/riparian woodlands or oak-piñyon woodlands. This species occurs in single patches in the Chiricahuas, Dragoons, Galiuros, Santa Ritas, Atascosa Mountains, Hieroglyphic Mountains, Aravaipa Canyon, and the Huachucas (several patches). There are two documented occurrences on the Tonto NF, both on the Cave Creek RD: along Tangle Creek (AZGFD, 2000b) and in Sycamore Creek just above its confluence with the Verde River.

Mogollon Thistle *Cirsium parryi spp. Mogollonicum* Status: Sensitive

This short-lived perennial is one of thirteen species of *Cirsium* in Arizona. It was first discovered in 1987. Aids to identification include white corollas, margins nearly entire in mature leaves, and spinulose ciliate margins in leaves below head-bearing branches. It can reach a height of 40 inches, has poorly developed spines and flowers that occur singly or several in a cluster. The stem branches only near the apex. It blooms from July through September and is pollinated by insects. Habitats include moist to very moist soils in the riparian understory of perennial streams at approximately 7,200 feet elevation. Coniferous forest surrounds the only known population in Arizona. The only locality known for this species is in Dane Spring Canyon near the Mogollon Rim on the Coconino NF. Barb Phillips, a botanist knowledgeable about this species, suspects it on the face of the Mogollon Rim on the Tonto NF (AZGFD, 2005a).

Mogollon Fleabane *Erigeron anchana* Status: Sensitive

This herbaceous perennial, also known as Sierra Ancha fleabane, occurs in central Arizona at elevations between 3,500 and 7,000 feet. This species forms a thick taproot with several crowded, thick caudex branches, with a total plant height of less than six inches. *Erigeron anchana* is the largest of the *Erigeron pringlei* complex. This plant blooms May through July (also noted through November) and inhabits rock crevices and ledges on boulders and vertical rock faces usually in canyons. It occurs at various exposures on igneous and metamorphic granites, in chaparral, piñyon-juniper and pine-oak forests. Its total range includes the Sierra Ancha, Mazatzal and Mescal mountains, and Pine Creek in northern Gila County. Occurrence records include Tonto Creek and Houston Creek on the Payson Ranger District (RD), Pine Creek on Tonto Natural Bridge State Park, and Parker Creek, First Water Canyon, Devil's Chasm, Workman Creek, and one population at the south end of Sierra Ancha Experimental Forest all in the Sierra Ancha Mountains (AZGFD, 2003f).

Fish Creek Fleabane *Erigeron piscaticus* Status: Sensitive

This annual fleabane occurs in central Arizona and is one of at least 29 species of *Erigeron* occurring in Arizona. Aids to identification include the lack of lobed leaves and the presence of only sparse hairs on the upper stem. It flowers from spring through fall and occurs between 2,250 and 3,500 feet in elevation. This plant typically occupies sandy alluvium substrates in canyon bottoms associated with riparian habitats near perennial streams. There are only four collections for this species in Arizona: two from Turkey Creek and Aravaipa Creek in Graham County and two from Fish Creek in the Superstition Mountains (Mesa RD of the Tonto NF). A survey at all of these sites in 1990 did not locate any plants (AZGFD, 2001a), but because it is an annual it may not emerge in some years. The last time this species was seen and collected was in 1979 by Peter Warren (AZGFD, 2001a).

Ripley's Wild Buckwheat *Eriogonum ripleyi* Status: Sensitive

This woody perennial is known from central to northwestern Arizona. It is a mat-forming sub-shrub that grows 2 to 8 inches tall with numerous branches. It can be distinguished from other species in this genus in that it is low and heavily branched with short linear leaves. It flowers April through June and occurs at elevations from 2,000 to 6,000 feet. This species inhabits heavily calcareous soils in Sonoran Desert scrub and piñyon-juniper woodland. Known localities include Maricopa, Yavapai, Coconino, and Mojave Counties. Locations on the Tonto NF include populations near Horseshoe Lake and Chalk Mountain. The Horseshoe Lake and Cottonwood (Coconino NF) populations each have thousands of plants (AZGFD, 1997).

Eastwood Alum Root *Heuchera eastwoodiae* Status: Sensitive

This is a distinctive perennial herb in the Saxifragaceae family, with a rosette of rounded leaves with heart-shaped bases growing from a woody root crown. It is found only in central Arizona from 3,480 up to about 7,874 feet elevation, occupying moist slopes in ponderosa pine forests and canyons. It blooms from May to August. Plants reach heights of 20 inches; small flowers are yellowish green, often without petals. Leaves are dark green, roundish, finely haired and scalloped. Basal leaves occur on long leaf stalks. It is one of seven species of *Heuchera* in Arizona. Collection records include Oak Creek, West Fork of Oak Creek, Chevelon Creek, and Hunter Creek in the Bradshaw Mountains and the Verde Valley. On the Tonto NF, this plant has been observed along Christopher Creek and Barnhardt Pass on the Payson RD, along Reynolds Creek on the Pleasant Valley RD, and on Lime Creek and at the north end of the New River Mountains on the Cave Creek RD (AZGFD, 2005b). There is a specimen in the Tonto NF herbarium taken from Big Pine Flat on the Tonto Basin RD.

Arizona Alum Root *Heuchera glomerulata* Status: Sensitive

This herbaceous perennial occurs in southeastern Arizona and New Mexico. It flowers from May to August at 4,000 to 9,000 feet in elevation. It is found on north-facing shaded rocky slopes, near seeps, springs, and riparian areas, often in humus soil. It is typically associated with oak and pine woodlands, ponderosa pine, and mixed conifer vegetative communities. Arizona Alum Root is known to occur in one locality on the Tonto NF, in the Pinal Mountains south of Globe, Arizona. Other records in the state include the Pinaleno and Galiuro Mountains, and southern Apache, Greenlee and Navajo counties (AZGFD, 2004c). The most knowledgeable individual on this species (Elvander, 1992) notes that this "is a very difficult genus, highly variable at many levels and needing much additional research. It occasionally interbreeds with *H. novomexicana* in Greenlee, southern Apache, and southern Navajo counties and may be of hybrid origin."

Alamos Deer Vetch *Lotus alamosanus* Status: Sensitive

This herbaceous perennial occurs primarily in southern Arizona and Mexico. It is a semi-aquatic plant that forms mats, clumps or carpets along streams. Stems are slender and numerous, somewhat sprawling and can be up to a foot high. This wetland obligate blooms in April and May at elevations between 3,500 to 5,500 feet and is restricted to stream banks in canyons. It is known to occur under both open canopies and partial shade and exists in mud, damp to wet soil or sand, in springs, seeps or streams. Occurrences in Arizona include the Nogales RD of the Coronado NF in Santa Cruz County and the Superstition Mountains on the Mesa RD of the Tonto NF (Lutch, 2000).

Horseshoe Deer Vetch *Lotus mearnsii var. equisolensis* Status: Sensitive

This plant grows on white powdery gypseous limestone of Tertiary lakebed sediment where it occurs with several other rare plants adapted to this specialized habitat. However, unlike the other plants with which it grows, Horseshoe deer vetch is known only from the Horseshoe Reservoir area. It is low-growing, with yellow flowers borne on long stems, with a palmate cluster of fuzzy grey-green leaves in the axil of each flowering stem. Pods are up to an inch in length (Lutch, 2000).

Maple leaf False Snapdragon *Mabrya acerifolia* Status: Sensitive

This herbaceous perennial vine/forb is in the snapdragon family (Scrophulariaceae) and has white to greenish-white five-lobed tubular flowers. Leaves are dark green, downy, sticky and heart- or kidney-shaped. This plant grows prostrate, up to ten inches in length. It inhabits shaded cliffs and rock ledges from 1,800 to 3,350 feet elevation. It is a mat-forming plant with brittle stems. Stems often hang down from moist rock ledges. This species was formerly considered *Maurandya acerifolia* and earlier references are to this genus. This plant is known only from south-central Arizona. The type locality is from Fish Creek Canyon and most occurrence records are from side canyons of the Salt River. Locations in the Arizona Game and Fish Department Heritage Data Management System (AZGFD, 2005c) include occurrences along the Horse Mesa Dam Road (Salt River), in the Goldfield Mountains, Canyon Lake, and numerous localities in the Superstition Mountains including Hewitt Ridge Canyon, Fish Creek Canyon, Fish Creek Hill, La Barge Canyon, Bluff Spring Canyon, Peralta Canyon, and Tortilla Creek.

Toumey groundsel *Packera neomexicana var. toumeyi* Status: Sensitive

This is a plant of infrequent occurrence in the Chiricahua, Huachuca, Santa Catalina, and Pinal mountains. It occurs mostly in pine forest at 5,200 to 9,200 feet in elevation. At the full species level, *Packera neomexicana* is perhaps the most abundant *Packera* in the southwest region. It is widespread in New Mexico, Colorado, Arizona, and Mexico (Rickett, 1970). The variety *toumeyi* is only found in Arizona. It grows to a height of from 2 to 28 inches; leaves are tomentose on the underside and hairless on the top; basal leaves are often purple on the underside (AZGFD, 2004d). It has been documented in several locations on the Tonto NF: mostly in ponderosa pine forest between Young and Punkin Center, with one Tonto NF herbarium specimen from the Pinal Mountain Road on the Globe RD.

Flagstaff Penstemon or Beardtongue *Penstemon nudiflorus* Status: Sensitive

This herbaceous perennial is known only from north-central Arizona. The type specimen is from Flagstaff (1884). It is found in dry ponderosa pine forests in mountainous regions south of the Grand Canyon at 4,500 to 7,000 feet in elevation. It blooms in the summer and is generally uncommon. It may be expected on dry soils of neutral pH. Many of the species in this genus are browsed. It is known to be associated with cinder hill type soils around Sunset Crater and Wild Bill Hill on the Coconino NF. The species occurs in Coconino, Gila, Mohave, and Yavapai counties. There is one occurrence for this species from the Tonto NF. It was collected in 1938 on Buckhead Mesa on the Payson RD. Other occurrences are known from the Coconino and Prescott NFs, with two locations southwest of Show Low (Lutch, 2000).

Gila Rock Daisy *Perityle gilensis var. gilensis* Status: Sensitive

This is a small perennial that grows on cliff faces, ledges, and rock outcrops. Based on information available to date, it is similar in appearance and growth form to *P. gilensis var. salensis* as described below. Information about this variety (as compared to var. *salensis*) is lacking. One study (Powell, 1973) hypothesized that geographical and morphological evidence indicates that var. *gilensis* originated from var. *salensis* via migration down the Salt River Canyon and through the establishment of autopolyploidy. It also noted distributional evidence and leaf morphology suggest that *P. saxicola* evolved from *P. gilensis* var. *salensis* as probably did *P. gilensis var. gilensis*. However, the only locality in Arizona in the Arizona Game and Fish HDMS database is a location on the Coconino NF near the face of the Mogollon Rim. More information is necessary to determine the status of this species on the Tonto NF.

Salt River Rock Daisy *Perityle gilensis var. salensis* Status: Sensitive

Like *P. gilensis* var. *gilensis*, this small perennial grows near seeps on cliff faces, ledges, and rock outcrops at 3,000 to 4,000 feet elevation. Plants typically reach heights of 12 to 28 inches and have a sprawling growth form. It has dark green leaves and yellow flowers are born on rather stout stems. It flowers in the spring and fall. This is a variety of the more common *Perityle gilensis var. gilensis*, and can be distinguished by its long, extremely narrow leaves. It is also geographically separated from the typical variety. The type locality is on sandstone with a north-facing aspect. This plant is known only from the type locality on the San Carlos Indian Reservation on the Salt River between Showlow and Globe, but it is expected to occur in the Salt River Canyon downstream on the Tonto NF (Lutch, 2000).

Fish Creek Rock Daisy *Perityle saxicola* Status: Sensitive

This herbaceous perennial occurs in central Arizona at elevations between 2,000 and 3,500 feet. It is woody at the base, has herbaceous branches and can reach a height of 16 inches. It produces yellow flowers and sets seed from May to June. This plant grows from cracks and crevices on cliff faces, large boulders and rocky outcrops in canyons and on buttes composed of Barnes conglomerate and Mescal limestone. Habitats are very xeric and plants are often associated with east and northeast exposures in Arizona Upland Division of Sonoran Desert scrub. Many of the species of Perityle are edaphically restricted and are local endemics. This plant is known from Gila and Maricopa counties in Arizona. It is considered “locally common” at the Tonto National Monument, occurs on the Tonto NF near Roosevelt Dam, and in the Sierra Ancha Mountains above Horse Camp Creek. It is suspected throughout the Superstition Mountains (AZGFD, 2004e).

Arizona Phlox *Phlox amabilis* Status: Sensitive

This is a perennial low-growing plant in the Polemoniaceae family, with a taproot and thick, oblong leaves. It has conspicuous pink, wedge-shaped petal lobes with rounded tips (or slightly notched tips.). It flowers annually from March to May. Growth habits noted for this species include woody subshrub, woody shrub, and herbaceous forb/herb. The locality on the Tonto NF is in an opening in a ponderosa pine forest. This plant is endemic to central Arizona, and is known to occur in or near Prescott and Payson, Arizona. It has been collected in the vicinity of Christopher Creek on the Payson RD of the Tonto NF, and at several locations on the Prescott NF (AZGFD, 2005e).

Hualapai milkwort *Polygala rusbyi* Status: Sensitive

This species is known only from central Arizona. It is a narrow endemic, occurring in association with Arizona cliffrose, Ripley's buckwheat, and Horseshoe deer vetch in the Tertiary lakebed sediment in the area of Lime Creek and Horseshoe Reservoir, on the Tonto NF. This plant is a low sub-shrub two to six inches tall. The plants bloom in April through July. Little is known about the biology of this rare plant (Lutch, 2000).

Blumer's dock *Rumex orthoneurus* Federal: Sensitive (Proposed, but withdrawn 8/9/99)

This herbaceous perennial is known to occur in Arizona, New Mexico, and Mexico. It is characterized by the presence of iris-like rhizomes, succulence of its leaves, lateral leaf veins perpendicular to the main vein, and fruiting capsules. Plants have a cluster of large basal leaves, which are somewhat succulent and range up to 20 inches long and 7 inches wide. The inflorescence is a large narrow panicle occupying the upper half of the stem. Blumer's dock is one of 15 species in this genus in Arizona. This species occurs in riparian habitats at elevations between 6,500 and 11,500 feet. Suitable habitats include moist loamy soil adjacent to springs and flowing streams in open meadows or meadows with overstories. It is also known to occur in the drier headwaters of some areas. Surrounding forested areas are characterized by mixed conifer. It typically occurs in open, sunny locations, but can occupy more shaded sites. It is known to occur at two locations in the Sierra Anchas on the forest (AZGFD, 2002a).

A Conservation Assessment for Blumer's dock has been prepared for populations on the Tonto NF (Harris & Gobar, 1993). In the 1980s, seed from the Workman and Reynolds creeks' populations was used to grow plants that were introduced to various canyons in the vicinity of the Mogollon Rim, including Bray Creek, Christopher Creek, Canyon Creek, Pine Creek, Tonto Creek, Dude Creek, Ellison Creek, See Canyon, Weber Creek, Horton Spring, and Cold Springs Canyon. Some of these were damaged by flooding and erosion after the Dude Fire of 1990; insects and cattle grazing have impacted other introductions.

Aravaipa Sage *Salvia amissa* Status: Sensitive

This herbaceous perennial occurs in south-central Arizona at elevations of 1,500 to 5,000 feet. Its leaf shape, leaf hairs and elevation distinguish *S. amissa* from the other 14 *Salvia* species in Arizona. It flowers from July to October and occupies shady canyon bottoms near streams. It typically occurs on the floodplain in alluvium, is associated with oak woodland, deciduous riparian woodlands, and is commonly found where sycamore, ashes, and willows grow.

The primary range for the species is in southern Arizona including Aravaipa Creek, Santa Catalinas, Galiuros, and Winchester mountains. It was documented in the early 1990s on the Tonto NF in Devil's Chasm and PB Creek in the Sierra Anchas (AZGFD, 2002b).

Aravaipa Woodfern *Thelypteris puberula* var. *sonorensis* Status: Sensitive

This rare fern occurs at several localities across central Arizona, including sites in the Four Peaks area. It grows in Arizona at elevations from 2,220 to 4,500 feet. There are also populations in Arizona's Aravaipa Canyon, Mexico, and California. Spring development and water diversion could damage its localized wetland habitat. The fern's fronds are large (20 to 51 inches long and 6 to 12 inches wide). They are light green in color, papery to leathery in texture. The upper surface is covered with fine hairs. Stipes or frond stems, are 8 to 12 inches long, pale straw colored near the frond, with a pale brown base. The fern is rhizomatous: rhizomes are thick (3 to 8 mm in diameter), long-creeping, scaly prostrate or underground roots, which produce shoots. This species has been identified in granite boulder-strewn riparian habitat, growing in the shade of boulders. It emerges with summer rains, and grows into the winter (AZGFD, 2004f).

Environmental Consequences

Habitat of most listed plant species on the Tonto NF has not been surveyed for presence of noxious weeds or invasive plants. Surveys for federally-listed and sensitive plants will be conducted before any treatments, and treatments will follow adaptive management principles.

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Effects of herbicides to federally-listed and sensitive plants are expected to be negligible, with implementation of mitigation measures listed in appendix G. Manual and mechanical treatments will be used in buffer areas where herbicides may not be used; there is a slight chance that young plants could be mistaken for weeds, trampled, or inadvertently pulled. Presence of a person on the project knowledgeable of identification of the listed plant's characteristics at all life stages will minimize this risk.

Prescribed fire will not be used in the vicinity of listed plants, unless a fail-safe barrier exists between the project burn and the listed plants.

Biological control agents will have been tested by APHIS for effects to non-target plants prior to being permitted in the U.S.

Cumulative Effects

Most activities carried out on the National Forest have some potential to introduce invasive plants and/or noxious weeds. Since weeds can degrade habitat, disrupt ecosystem function, or outcompete federally-listed or sensitive plant species, it is critical to detect and remove infestations quickly before they have the chance to adversely affect protected plant species. Implementation of the most aggressive and comprehensive program possible (within budgetary constraints) is our best course of action to protect federally-listed and sensitive plants and their habitat. This program will include all tools for treatment including herbicides, manual and mechanical removal, prescribed fire, cultural treatments, and biological control. A sound prevention program that includes every activity on the forest is an important part of this alternative.

Arizona Department of Transportation's program to manage roadside vegetation using herbicides was evaluated and approved by a Decision Notice in 2004. Under this program, rights-of-way along federal and state highways within National Forests in Arizona may be treated with 16 different herbicides**:** chlorsulfuron, clopyralid, 2,4-D, dicamba, fluroxypyr, glyphosate, imazapyr, imazapic, isoxaben, metsulfuron methyl, pendimethalin, picloram, sethoxydim, sulfometuron methyl, tebuthiuron, and triclopyr. ADOT expects to use herbicide on less than three percent of these rights-of-way annually (5,000 acres), most of this on the northern forests, who have the greatest problem with invasive plants. Highways on the Tonto NF that are approved for herbicide treatments by ADOT are State Highways 77, 87, 88, 177, 188, 160, 288, and U.S. Highways 60 and 70. Under the proposed action, weed infestations that extend beyond the right-of-way + 200 feet will be allowed to be treated by herbicide also, so that rights-of-way will be less likely to be reinfested from National Forest lands. Total herbicide use will not be greatly increased, as the Tonto NF is proposing annual herbicide use on only about 0.3 percent of its land.

Most federally-listed or sensitive plants do not grow in or near rights-of-way of these highways. One exception is Arizona hedgehog cactus, which grows within the right-of-way of U.S. Highway 60, from Top of the World to the east slope of Pinto Creek Canyon. Hedgehog cactus has been demonstrated to be susceptible to direct application of a number of herbicides. In testing by Frank Crosswhite of the Boyce Thompson Arboretum in 1995, direct application of one-half to full maximum label rates of clopyralid and dicamba to species of hedgehog cactus did not affect survival, but did have an adverse effect on plant vigor and growth. Direct application of picloram and tebuthiuron to another species of hedgehog cactus adversely affected plant survival (Crosswhite, et al., 1995).

Effects of herbicide to this plant are currently mitigated by conducting survey for these plants and maintenance of buffer areas around each one. The Tonto NF's herbicide proposal includes this same buffer area for hedgehog cactus. Invasive plant infestation along U.S. Highway (Hwy) 60 is currently at a very low level in the vicinity of the Arizona hedgehog cactus. With ADOT's current program of herbicide application, and also general character of the habitat (granite boulders), weed infestations are not expected to grow in Arizona hedgehog habitat.

Road construction and maintenance by ADOT will continue to be potential threats to Arizona hedgehog. Mitigation will be needed for any authorized activities in the part of U.S. Hwy. 60 between Top of the World and Pinto Creek, for the Arizona hedgehog cactus.

Other potential threats listed in the Conservation Assessment and Plan are mining activities and removal by collectors.

The unique assemblage of federally-listed and sensitive plants in the Horseshoe Lake/Lime Creek/Chalk Mountain area is not currently being impacted by domestic livestock grazing, as livestock were removed during the drought in 2000 and have not returned. An Environmental Assessment is being conducted, that documents effects of various grazing and non-grazing management actions for the Sears-Club/Chalk Mountain Allotment. OHV activity, one of the threats listed in the Recovery Plan for Arizona cliffrose, is being addressed by an ongoing forestwide travel management program. Both grazing and uncontrolled vehicular traffic can easily spread seeds of Malta starthistle into sensitive species habitat. A program to eradicate this weed in the Horseshoe area is essential to continued health of Arizona cliffrose, Ripley's wild buckwheat, Horseshoe deer vetch, and Hualapai milkwort populations.

Effects of the forest's grazing program on federally-listed plants are not an issue, as there is no permitted grazing in areas where they grow. Many sensitive plants grow in areas not used by cattle, such as the Horseshoe/Lime Creek area, bouldery or cliff sites, or inaccessible riparian areas. There is a potential for grazing to directly affect some sensitive plants in other areas, or indirectly affect them by scattering weed seeds.

Rehab activities after wildfire could affect endangered or sensitive plants if seed mixes applied contain weed seeds. The Tonto NF's program that requires seed lab reports of seed lots to ensure they do not contain forest-listed weeds is our mitigation measure to prevent introduction of new weeds.

Grazing management on six allotments on the Globe and Tonto Basin ranger districts is being evaluated. One proposal is to graze riparian areas, which could affect sensitive plants.

The Tonto NF's travel management program will open roads that are currently closed, which has the potential to affect sensitive species.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

Under current management, invasive plants and noxious weed populations are increasing in size and number. With a very limited prescribed burn program, use of housekeeping-type herbicides only on administrative sites or recreation areas, and most removal limited to hand-pulling, it is very difficult and prohibitively expensive to effectively limit the growth and expansion of weed populations.

Weeds will most likely spread into areas of federally-listed or sensitive plants, where they will likely out-compete these plants for soil moisture. Some weeds exhibit allelopathy, which will more directly adversely affect sensitive plants by creating an environment where their seedlings cannot germinate and establish.

As with the proposed action, physical removal of weeds in the vicinity of protected plants has a potential of removing seedlings of protected plants. This can be mitigated by having a person who is able to identify seedlings of the protected plants on the project at all times.

Arizona Department of Transportation's program to manage roadside vegetation will be constantly frustrated by reinfestation from adjacent National Forest lands, where weeds will go untreated. In some areas, weeds spreading onto the forest from rights-of-way could reach habitat of federally-listed or sensitive plants.

Fountain grass has been documented growing in the Superstition Mountains. Buffelgrass also grows near this wilderness area. Fire carried by buffelgrass has been documented to cause the elimination of two populations of Pima Indian mallow in Mexico (AZGFD, 2000a). It could easily happen on the Tonto NF also, if spread of these grasses continues without effective removal. Manual removal can be done; however, it is extremely slow and expensive and large acreages already infested are not being effectively treated at this time. Manual treatment alone would not be sufficient to control these exotic grasses in the future.

The unique assemblage of plants in the Horseshoe Lake/Lime Creek/Chalk Mountain area will probably be infested and adversely affected by Malta starthistle, since manual techniques are not currently keeping up with the spread of this invasive plant, and prescribed fire is not an option where these sensitive plants grow. The most adverse effect would be that dense infestations of weeds would carry a wildfire through the area, decimating populations of the four listed/sensitive plants that grow here.

A prescribed burn program that is very limited in scope (burns of ten acres or less, in proximity to system roads) will help address incipient weed infestations before they grow beyond roadsides. Since many of the sensitive plants do not grow next to system roads, actions such as this may prevent weeds from reaching sensitive plant habitat. Where sensitive plants do grow near roads, prescribed burning is not an option.

Cumulative Effects

As with the proposed action, most activities carried out on the National Forest have the potential to introduce invasive plants. An aggressive prevention program is essential to try to limit the number of weed species. It is critical to prevent establishment of perennial invasive species, since they are the ones for which herbicidal treatment is sometimes the only effective tool.

Alternative 2: Integrated Vegetation Management Excluding the Use of Herbicides

Direct and Indirect Effects

Effects of implementation of this alternative are much like alternative 1, except larger prescribed burns can be used, treatments such as grazing by goats, sheep, and cattle can be implemented, and biological control agents can be introduced in sites with sufficient growth of invasive plants to sustain them.

As with alternative 1, most treatments are too costly to be used to the extent they will effectively diminish weed populations. Treatments such as grazing and prescribed burning will need to be used judiciously so that the ground is not disturbed and these practices do not actually bring in more weeds or otherwise exacerbate the problem. These practices have the potential to cause accelerated erosion and loss of site potential, since they both work through reduction in overall groundcover. It would be difficult to target weeds growing in or near habitat of listed or sensitive species using either of these treatment methods, without a consequent adverse effect to these plants.

As with the Proposed Action and alternative 1, manual or physical removal of weeds is a viable option.

We will not be able to permanently remove perennial plants such as camelthorn, Russian knapweed, saltcedar, tree of Heaven, and other plants with extensive root systems. These weeds grow very well in riparian areas, where some of the listed and sensitive plants are found.

As for alternative 1, the unique assemblage of plants in the Horseshoe Lake/Lime Creek/Chalk Mountain area will probably be infested and adversely affected by Malta starthistle, since manual techniques are not currently keeping up with the spread of this invasive plant, and prescribed fire is not an option where these sensitive plants grow. The most adverse effect would be that dense infestations of weeds would carry a wildfire through the area, decimating populations of the four listed/sensitive plants that grow here.

If an effective biocontrol agent is used for Malta starthistle, this alternative may prevent spread of the Horseshoe Lake infestation from reaching and adversely affecting sensitive and endangered plants in that area.

Cumulative Effects

This action, considered with other ongoing forest actions such as grazing, off-highway vehicle use, special use permits for various recreation activities, camping, etc. will most likely result in an increase in populations of invasive species. Ineffective treatment of invasive species will allow infestations already in or near habitat of listed and sensitive plants to expand. Invasive plants have evolved with various characteristics that allow them to out-compete native vegetation. They germinate and become established earlier in the spring/winter, thus using up the sometimes scant supply of soil moisture and nutrients before native plants are able to germinate. They produce copious amounts of seed, which is readily spread by various means, so that weed populations grow very rapidly.

Range Management

Affected Environment

Livestock grazing management activities occur on established active grazing allotments and are permitted by the issuance and administration of grazing permits for a ten-year period. Livestock are grazed through various management schemes that are intended to provide some level of improvement or maintenance of satisfactory soil, water, and vegetation resources. There are 104 cattle grazing allotments on the Tonto NF. One sheep driveway extends northeast from Mesa to the northeast corner of the forest where it enters the Apache-Sitgreaves national forests. Typical livestock grazing management activities include the following:

- Ranch horses are used to move livestock from one pasture to another.
- Livestock are held for short periods of time in working corrals to facilitate normal processing that includes sorting, branding, dehorning, and other practices. The feeding of livestock while they are temporarily held in working corrals may include processed feed, alfalfa or grass hay.
- Working ranch horses are temporarily held in corrals to facilitate pasture rotations and other livestock management practices. The feeding of ranch horses may include processed feed, alfalfa or grass hay and grain, such as rolled barley.
- Vehicles and livestock trailers are used to transport feed from areas off the National Forest to working corrals on an allotment to facilitate the processing of cattle in corrals and other management activities.
- Vehicles and livestock trailers are used to transport livestock to and from other pastures, allotments and other lands that are located off the National Forest.
- Vehicles and trailers are used to transport stock water to temporary troughs that may be located within a pasture or allotment to manage livestock grazing patterns, especially during drought. Stock water sources may be from nearby areas on the National Forest or from sources off the National Forest.

- Vehicles and ranch horses are used to access an allotment's range improvements for maintenance. Maintenance materials such as replacement wire or steel posts are transported to the allotment from sources off the National Forest. Some replacement materials may come from areas on the National Forest, such as juniper posts and stays.
- Vehicles and ranch horses are used for range management data collection and monitoring by both the Forest Service and permit holder. Ranch horses used for this purpose may be temporarily held in corrals on an allotment and will require the transport of livestock feed.

Environmental Consequences

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Manual, mechanical, and cultural treatments will cause minimal effects to livestock or range management. These treatments are plant specific and have limited impacts on ground cover and forage. While people are in the area working, some livestock may be temporarily displaced, but the disturbance will be limited in extent and duration. These short-term disturbances to livestock would be offset by the forage improvement of removing noxious weeds and the achievement of treatment objectives on the management in the project area.

Most treatments using fire will also be small scale with limited non-target impacts. Burn treatments that impact a large portion of a pasture may require rest periods for range recovery for a season or two afterwards. Cultural treatments could also require that a treated pasture be rested for a period of time to provide for establishment of native plants.

We anticipate that biological controls would create no disturbance to livestock or desirable forage species. It might limit spread of extensive infestations, thus improving range conditions. Biocontrol agents could interact with other insects, but they have been extensively tested and shown not to have adverse impacts on native insect or plant species.

Spot treatment of herbicides will not impact livestock management. Resting selected pastures per label directions, if applications are of a large scale may occur.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

This alternative would promote the highest loss of range forage, as only up to 0.1 percent of the forest would receive weed control treatments annually. Nonnative weeds would spread at the fastest rate, because there is very limited additional effort at containment, which leads to the greatest loss of habitat. Weed populations would expand exponentially and cause large losses in ungulate capacity during the next ten-year period. It would also change the character of the riparian ecosystem from fairly fire-resistant to one that is more susceptible to wildfire, through spread of fountain grass and saltcedar. Leafy spurge, Russian and diffuse knapweed, cheatgrass, starthistles, and biennial thistles would expand and invade previously uninfested grasslands and replace palatable, nutritious feed for livestock.

Cumulative Effects

Under alternative 1, noxious and invasive weeds would expand from the current population over the next ten years. All noxious and invasive weeds would increase in the project area.

Expansion of current noxious and invasive weed populations will also result from the Forest Service implementation of numerous ground-disturbing projects including road construction and maintenance, timber sale activities, forest restoration projects, prescribed burning, revisions of allotment management plans, watershed restoration, road obliteration, and mining. Inclusion of weed prevention best management practices in all project planning should reduce the potential of new introductions to low levels.

Alternative 2: Integrated Vegetation Management Excluding the Use of Herbicides

Direct and Indirect Effects

This alternative would result in the continuing spread of some weeds, but would not effectively treat the majority of weeds. It would treat less than 0.3 percent of the total forest acres. Mechanical, manual, prescribed burning, biocontrol, and cultural methods would be used. Burning is a short-term impact and livestock management can be adapted to accommodate small fires, so the effects would be small and, we predict, within the range of normal disturbances. Hand pulling and mechanical controls would have a minimal impact to livestock and would be beneficial to the habitat by maintaining native plant species. Effects of biocontrol would be the same as for the proposed action.

Treatments would not keep up with the rate of weed spread, and the number of acres occupied by weeds would increase, so a greater proportion of native forage could be lost than under the proposed action.

Cumulative Effects for the Proposed Action and Alternative 2

We anticipate that selection of either of the action alternatives in light of past, present, and reasonably foreseeable activities will improve forage conditions for livestock over the next 10 years, though the degree of improvement depends to a large degree on each action's ability to control weed populations. The proposed action is the only alternative that can achieve control objectives on most of the plants found in the project area.

Cumulative Effects Common to All Alternatives

Overall negative impacts to livestock (range management) that are currently occurring are increased disturbance from the growing number of humans living and recreating in the area, and long-term drought.

Community growth and development in the Phoenix area and Verde Valley would continue to have impacts to the Verde River system as well as increase the number of individuals using the project area. Potential effects include reduction in streamflow from increased water usage, reduced water quality from increased runoff and sediment input from development in the watershed, and impacts to riparian areas from increased recreational activities. Increased visitation within the project area could promote the amount of displacement of livestock though how much is hard to predict.

Endangered, Threatened, Proposed, Candidate, and Sensitive Wildlife Species

Affected Environment

The diversity of elevational range and vegetation community types on the Tonto NF supports complex assemblages of wildlife and plants. This habitat supports over 90 species of mammals, 60 species of reptiles and amphibians and 300 species of birds. A number of these species have been designated as special status species, such as threatened, endangered, proposed, candidate, sensitive, and management indicator species. Effects to management indicator species and their habitat are discussed in Appendix K, Management Indicator Species Report.

There are four endangered, three threatened, and one candidate terrestrial and aquatic wildlife species that are either found or have designated critical habitat in or near the project area. An additional 31 species are classed as sensitive and are on the U.S. Forest Service Region 3 list for terrestrial and aquatic wildlife.

Table 11. Threatened, endangered, and sensitive animal species on the Tonto NF

Scientific Name	Common Name	Status	Watershed/Location	Vegetation Type	Known Invasive Species in Habitat
Birds					
Empidonax traillii extimus	Southwestern willow flycatcher	E	Lower Verde, Upper Salt, Tonto/Roosevelt Lake at Tonto and Salt inflows, Pinal at Inspiration Dam	Riparian	Saltcedar, starthistles, bromes, yellow sweetclover, tree of heaven
Empidonax traillii extimus	Critical habitat		Verde – Fossil Cr. to upper end of Horseshoe Reservoir, Tonto Cr. from high water level of Roosevelt Lake upstream to confluence with Rye Cr. Salt River from diversion dam upstream to Cherry Cr. confluence	Riparian	Saltcedar, starthistles, bromes, yellow sweetclover, tree of heaven
Haliaeetus leucocephalus	Bald eagle	T	Salt & Verde rivers & associated reservoirs, Tonto Creek. Mature cottonwoods and cliffs	Riparian, ponderosa pine	Malta starthistle, saltcedar, yellow sweetclover, tree of heaven
Rallus longirostris yumanensis	Yuma clapper rail	E	Lower Verde, Lower Salt, Tonto Creek inflow at Roosevelt Lake	Riparian	Saltcedar, Malta starthistle, yellow sweetclover
Strix occidentalis lucida	Mexican spotted owl	T	Lower Verde, Upper Salt, Tonto Cr. Pine/oak and mixed conifer areas	Ponderosa-oak, mixed conifer	Bull thistle, starthistles, Canada thistle
Strix occidentalis lucide	Mexican spotted owl Critical habitat		Same as above	Same as above	Same as above

Scientific Name	Common Name	Status	Watershed/Location	Vegetation Type	Known Invasive Species in Habitat
Coccyzus Americanus occidentalis1	Yellow-billed cuckoo	C	Lower Verde, Upper Salt and others/ found in areas with mature multi-canopied riparian stands	Low elevation Riparian	Saltcedar, starthistles, bromes, yellow sweetclover, tree of heaven
Accipiter gentilis	Northern goshawk	S	Lower Verde, Upper Salt, Tonto/ Mogollon Rim, Sierra Anchas, Pinal Mtns.	Ponderosa-oak, mixed conifer	Saltcedar, Malta starthistle, knapweeds, yellow sweetclover
Aechmophorus clarkii	Clark's grebe	S	Coves, backwaters	Riparian	Saltcedar, starthistles, knapweeds, bromes, yellow sweetclover
Asturina nitida maxima	Northern gray hawk	S	Upper Salt, Lower Verde/ Cherry, Pinal and Cave creeks	Low to mid-elevation riparian areas	Saltcedar, Malta starthistle, tree of heaven, yellow sweetclover, giant reed
Buteo albonotatus	Zone-tailed hawk	S	Upper Salt, Lower Verde/ Cherry, Pinal and Cave creeks	Low to mid-elevation riparian areas	Saltcedar, Malta starthistle, tree of heaven, yellow sweetclover, giant reed
Buteogallus anthracinus	Common blackhawk	S	All/most drainages with mature riparian forests.	Riparian	Saltcedar, starthistles, knapweeds, bromes, yellow sweetclover
Falco peregrinus anatum	American peregrine falcon	S	All rock escarpments along rivers and mountain ranges on the forest.	Cliffs	Saltcedar, possibly others
Pipilo aberti	Abert's towhee	S	Lower Verde, Upper Salt and others found in areas with mature multi-canopied riparian stands	Low elevation Riparian	Saltcedar, starthistles, bromes, yellow sweetclover, tree of heaven
Vireo vicinior	Gray vireo	S	Upper and Lower Salt/Upper Verde rivers	Desert scrub, piñyon/ juniper with broad leafed shrubs, steep rocky slopes	Saltcedar, Malta starthistle, Saharan mustard, buffelgrass, fountain grass, tree of heaven, camelthorn
Mammals					
Leptonycteris curasoae yerbabuenae	Lesser long-nosed bat	E	No known locations on the forest	Saguaro, agave	Saltcedar, Malta starthistle, fountain and buffelgrasses, bromes, Saharan mustard

Scientific Name	Common Name	Status	Watershed/Location	Vegetation Type	Known Invasive Species in Habitat
Corynorhinus townsendii pallescens	Pale Townsend's big-eared bat	S	Upper and Lower Salt/Upper Verde rivers	Desert scrub and grassland	Starthistles, bromes, Mediterranean grass, mustards, fountain and buffel grasses
Euderma maculatum	Spotted bat	S	Upper Verde	Rocky cliffs & riparian	Dalmatian toadflax, saltcedar, yellow sweetclover, giant reed, fountain grass
Eumops perotis californicus	Greater Western mastiff bat	S	Upper and Lower Salt/ upper Verde rivers	Rocky cliffs & riparian	Dalmatian toadflax, saltcedar, yellow sweetclover, giant reed, fountain grass
Idionycteris phyllotis	Allen's big-eared bat	S	Upper Verde	Mountainous wooded areas & riparian	Saltcedar, Malta starthistle, knapweeds, yellow sweetclover
Lasiurus blossevillii	Western red bat	S	Upper and Lower Salt/ Upper Verde rivers	Riparian	Dalmatian toadflax, saltcedar, yellow sweetclover, giant reed, fountain grass
Macrotus californicus	California leaf-nosed bat	S	Lower Verde/Lower Salt rivers	Lowland desert scrub	Saltcedar, starthistles, bromes, yellow sweetclover, tree of heaven
Nasua narica	White-nosed coati	S	Upper & Lower Salt	Riparian	Dalmatian toadflax, saltcedar, yellow sweetclover, giant reed, fountain grass
Nyctinomops femorosaccus	Pocketed free-tailed bat	S	Lower Verde/ Lower Salt rivers	Rocky cliffs & riparian	Dalmatian toadflax, saltcedar, yellow sweetclover, giant reed, fountain grass
Ovis canadensis canadensis	Rocky Mountain bighorn	S	Upper Verde & Salt/ Mazatzal, Sierra Ancha moutain ranges	Ponderosa oak-mixed and rocky ridges	Brome grasses, mustards, Malta starthistle, wild oats, giant reed
Ovis canadensis mexican	Desert bighorn	S	Upper Verde, Upper & Lower Salt/ Superstition, Mazatzal, Goldfield, Sierra Ancha moutain ranges	Desert grassland, open, rocky ridges	Brome grasses, mustards, Malta starthistle, wild oats, giant reed
Reptiles					
Gopherus agassizii	Sonoran Desert tortoise	S	Lower Verde, Lower Salt/desert scrub, desert grassland in southwestern portion of the forest.	Desert scrub	Malta starthistle, brome grasses, Mediterranean grass, mustards, fountain grass

Scientific Name	Common Name	Status	Watershed/Location	Vegetation Type	Known Invasive Species in Habitat
Heloderma suspectum	Gila monster	S	Lower Salt, Lower Verde	Desert scrub & grassland	Malta starthistle, brome grasses, Mediterranean grass, mustards
Phyllorhynchus browni lucidus	Maricopa leafnose snake	S	Lower Verde, Lower Salt/ rocky or sandy desert	Desert scrub	Malta starthistle, brome grasses, Mediterranean grass, mustards
Thamnophis eques megalops	Mexican garter snake	S	Lower Verde, Lower Salt, Tonto/	Low elevation Riparian	Yellow sweetclover, saltcedar, Malta starthistle
Thamnophis rufipunctatus	Narrow-headed garter snake	S	Lower Verde, Upper Salt, Tonto/ mid-to-high elevation streams	Riparian	Yellow sweetclover, saltcedar, Malta starthistle
Amphibians					
Rana chiricahuensis	Chiricahua leopard frog	T	Lower Verde, Tonto Creek, Upper Salt River, various sites below the Mogollon Rim	Riparian, stock ponds	Yellow sweetclover, saltcedar, starthistles, tree of heaven
Bufo microscaphus microscaphus	SW (Arizona) toad	S	Lower Verde, Lower Salt, Tonto, Agua Fria. Widely distributed in permanent pools, rocky streams, and canyons. Appearing to select for shallow water flowing over sandy or rocky bottoms	Late seral riparian areas within desert grasslands, piñyon-juniper, pine-oak and ponderosa pine communities	Yellow sweetclover, saltcedar, Malta starthistle, fountain grass
Eleutherodactylus augusti cactorum	Western barking frog	S	No documented locations on the Tonto NF	Juniper/ oak woodlands, open pine forests	N/A
Rana pipiens	Northern leopard frog	S	No documented locations on the Tonto NF	Permanent water in grassland, chaparral, pine forest	N/A

Scientific Name	Common Name	Status	Watershed/Location	Vegetation Type	Known Invasive Species in Habitat
Rana yavapaiensis	Lowland leopard frog	S	All/ up to 6,000' but generally restricted to elevations below 3,500'. Permanent water with aquatic vegetation	Low elevation riparian	Malta starthistle, saltcedar, yellow sweetclover, fountain grass, pyracantha, oleander
Invertebrates					
Agathon arizonicus	Netwing midge	S	Upper Salt/ Workman Cr.	Riparian	Unknown
Cylloepus parkeri	Parker's riffle beetle	S	Lower Verde/ Roundtree Canyon, possibly Tangle Cr.	Riparian	Saltcedar, yellow sweetclover, bromes
Pyrgulopsis simplex	Fossil springsnail	S	Fossil Creek	Riparian	Unknown

Each of the above species is discussed in the Biological Assessment/Evaluation, Appendix J.

Environmental Consequences

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Manual, mechanical, flaming of weeds, and cultural treatments will cause minimal effects to wildlife. These treatments are plant specific and have limited impacts on ground cover and habitat conditions. While people are in the area working, some wildlife species may be temporarily displaced, but the disturbance will be limited in extent and duration. These short-term disturbances to wildlife would be offset by the habitat improvement of removing noxious weeds and the achievement of treatment objectives on the species found in the project area.

We anticipate that biological controls would create no disturbance to vertebrate animal species or desirable forage species. They could interact with other insects, but they have been extensively tested and shown not to have adverse impacts on native insect or plant species. Chemical treatments are not very disruptive to wildlife either and since applicators are in the area for a limited time period, we do not predict any displacement of wildlife resulting from these treatments.

A series of risk assessments were written by Syracuse Environmental Research Association on herbicides proposed for use in this document (appendix F). The following discussion on herbicide effects to wildlife in the project area is based on a comparison to these risk assessments.

The nontarget species hazard analysis summarized laboratory and field study findings that evaluated toxicity of the herbicides and carriers to wildlife and aquatic species. In many cases, toxicity studies with laboratory animals were used in this risk assessment because of the lack of specific wildlife studies. The results of laboratory animal studies are considered to be representative of the effects that would occur in similar species in the wild.

Wildlife doses were calculated for a group of wildlife species representative of those typically found in areas supporting rangeland, forest land, or riparian vegetation found in the West. These species represent a range of phylogenetic classes, body sizes, and diets for which biological parameters are generally available. Typical and extreme acute dose estimates were determined for each representative species for each of the three major exposure routes—dermal, ingestion, and inhalation. Since the herbicides degrade relatively rapidly and sites are normally treated only once per year, no analysis of chronic wildlife dosing was performed. Because the herbicides show little tendency to bioaccumulate (although several tend to bioconcentrate in aquatic environments), long-term persistence in food chains and subsequent toxic effects were not considered a problem and were not examined in the risk assessment.

The results of the risk analysis indicate that potential risks to individual animals are low for most of the herbicides. Estimated doses for typical exposures result in a low risk from all herbicides and carriers.

Dicamba is moderately toxic to insects at high doses. However, in the field it would only be applied in low doses. Triclopyr can be moderately toxic to guinea pig and mice. It does not bioaccumulate and the Garlon formulations are considered only slightly toxic. All the other herbicides proposed for use have low toxicity.

In summary, for typical exposures, the results of the nontarget species risk analysis indicate that all of the herbicides and carriers present a low risk to individual terrestrial animals (U.S. Forest Service, 1992).

The above information can be applied to animals found on the Tonto NF covered by this proposal. For threatened, endangered and sensitive species (TE&S) and Management Indicator Species (MIS), under typical exposures, no species are at risk. Though dicamba and triclopyr may have adverse impacts on the animals listed above if directly sprayed on the animals, the likelihood of this occurring is very low. Dicamba could potentially be used on several weed species, including Malta starthistle and spotted knapweed. Triclopyr and imazapyr will be used almost exclusively for the treatment of tree of heaven, Russian olive, saltcedar, and Siberian elm. The method of application will be cut and daub or injections into the bark, with no broadcast spraying involved. The chances of impacting any native wildlife or non-target vegetation by this method of application are very remote.

We do not anticipate any adverse impacts on wildlife species from a toxicological standpoint. We project that the low incidence of use and prescribed rate below what is recommended from the risk assessment will limit the risk to wildlife relating to toxicological impacts.

Most weed populations are small and scattered, so treatments that occur under this alternative will be localized. Therefore, treatments would only impact a minor portion of any wildlife species population at one time. Less than 0.5 percent of the land area on the Tonto NF would be treated with herbicide**.** As described above, treatments may create a short-term disturbance, while people are in the area working. For weeds with large populations, like saltcedar or the starthistles, only a portion of the population will be treated at one time, so the impacts on native wildlife are similar to some of the small populations of weeds.

Proposed application rates are typically well below the recommended amounts as disclosed in the risk assessment. We anticipate that this situation, in combination with the low amounts of National Forest to be treated in any given year, would reduce the potential for any toxicological problems to very low levels. In fact, successful treatment of invasive species will improve habitat conditions for the TE&S and MIS species. This includes elk, deer, turkey, Mexican spotted owl, and pronghorn.

Species' habitat will be maintained or improved by promoting native vegetation for food and cover. Some animals whose habitat have noxious and invasive weeds include, but are not limited to, Southwestern willow flycatcher, bald eagle, Mexican spotted owl, Chiricahua leopard frog, Mexican garter snake, northern goshawk, common black hawk, and Southwestern river otter.

Habitat for management indicator species (MIS) will be improved also (see Appendix K, Management Indicator Species Report), and any potential for noxious weeds to cause habitat fragmentation slowed down or stopped under this alternative, especially for wild turkey, mule deer, pronghorn, and elk. All these species depend on diverse, high quality grass or forbs for forage. In addition, for those MIS living in riparian habitats such as the Bell's vireo, summer tanager, and hooded oriole, the alternative reduces noxious and invasive weeds to low levels and promotes regeneration of native woody plants.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

This alternative would promote the highest loss of wildlife habitat. Nonnative weeds would spread at the fastest rate because there is no additional effort at containment, which leads to the greatest loss of habitat. Weed populations would expand exponentially and cause large losses in ungulate capacity during the next ten-year period. Over time, as weeds spread, tree structure along riparian areas could change from cottonwoods, willows, and other associated species to a near monoculture of saltcedar. We suspect this would reduce nest areas and forage for species found in this ecosystem including yellow-billed cuckoo, leopard frog, and black hawk. It would also change the character of the riparian ecosystem from fairly fire-resistant to one that is more susceptible to wildfire. Leafy spurge, Russian and diffuse knapweed, cheatgrass, starthistles and biennial thistles would expand and invade previously uninfested grasslands and replace palatable, nutritious feed for elk, deer, and pronghorn. As starthistle and bull thistle populations expand and grow into one another, small mammal populations would diminish, resulting from losses of forage and cover. This would invariably reduce the prey base for all raptor species, though of particular concern are goshawks and Mexican spotted owl.

Cumulative Effects

This would allow weeds to expand, precipitate a decline of native plants and decrease the amount of wildlife habitat available for threatened, endangered, sensitive, and management indicator species. It would reduce food (seeds and forage), habitat diversity, and cover for most animals found in habitats associated with the Verde and Salt River drainages. Reduction in plant diversity would interrupt insect life cycles, which could decrease food for birds, which would in turn adversely affect their predators. Weed invasion is likely to be especially hard on riparian species such as Yuma clapper rail, yellow-billed cuckoo, garter snakes, and leopard frog if saltcedar and Russian olive invade. This is at least partially due to the fact that many invasive species increase fire frequency in riparian areas.

Weed invasion, on top of these impacts, could be a cumulative adverse effect on wildlife population size, reproduction, health, and resilience. Some species are more susceptible to alterations in habitat, such as springsnails and yellow-billed cuckoo.

Alternative 2: Integrated Vegetation Management Excluding the Use of Herbicides

Direct and Indirect Effects

This alternative would result in the continuing spread of some weeds, and would not effectively treat the majority of weeds. It would treat less than 0.3 percent of the total forest acres. Mechanical, manual, prescribed burning, and cultural methods would be used. Burning is a short-term impact and wildlife is adapted to fires so the effects would be small and, we predict, within the range of normal disturbances. Hand pulling and mechanical controls would have a very small impact to wildlife and would be beneficial to the habitat by maintaining native plant species. Treatments would not keep up with the rate of weed spread, and the number of acres occupied by weeds would increase, so a greater proportion of wildlife habitat could be lost than under the proposed action or alternative 1.

Cumulative Effects for the Proposed Action and Alternative 2

We anticipate that selection of either of the action alternatives in light of past, present, and reasonably foreseeable activities will improve habitat for threatened, endangered, and sensitive species, as well as management indicator species over the next ten years, though the degree of improvement depends to a large degree on each action's ability to control weed populations. The proposed action is the only alternative that can achieve control objectives on most of the plants found in the project area.

Cumulative Effects Common to All Alternatives

Overall negative impacts to wildlife that are currently occurring are habitat fragmentation from land development and more roads, increased disturbance from the growing number of humans living and recreating in the area, and long-term drought.

Community growth and development in the Phoenix area and Verde Valley would continue to have impacts to the Verde River system as well as increase the number of individuals using the project area. Potential effects include reduction in streamflow from increased water usage, reduced water quality from increased runoff and sediment input from development in the watershed, and impacts to riparian areas from increased recreational activities. Increased visitation within the project area could promote the amount of displacement of wildlife species though how much is hard to predict.

Activities that could cumulatively improve overall habitat conditions of our native wildlife include: (1) current control efforts undertaken by the Arizona Department of Transportation which is curtailing the expansion of noxious weeds in road corridors under their jurisdiction; (2) current efforts on the Tonto NF related to weed control as mentioned above; and (3) the proposed control efforts to curb off-road vehicle use within the project area. All three activities will improve wildlife habitat, especially in riparian areas, and improve overall survivability of species found in this ecosystem.

Other activities that should promote wildlife habitat are the incorporation of *Chapter 90 of FSH 2209.13*. This formally adopts adaptive management as a tool for managing grazing. This, as well as practicing conservative utilization of forage resources, should improve the herbaceous understory and overall habitat conditions on the forest.

The reduction of small diameter trees in the ponderosa pine ecosystem within various areas throughout the Tonto NF will not only decrease the potential for wildfire, but also improve the available forage for native wildlife. This should increase the amount of habitat available for management indicator species like elk and turkey as well as improve foraging zones for many small mammals. This should increase the prey base for not only raptors, but other species as well.

The Forest Service has acquired instream flow rights for the Verde Wild & Scenic River from Beasley Flat downstream 40 miles to the confluence of Red Creek. The Tonto NF is actively attempting to acquire instream flow rights on tributaries of both the Salt and Verde rivers. Acquisition of additional instream flow rights in the project area would promote such species as the Southwestern willow flycatcher, bald eagle, peregrine falcon, river otter, and migrating birds. The *Fort McDowell Indian Water Settlement Act of 1990* authorized the Fort McDowell Indian Community, which is immediately downstream of the Tonto NF on the Verde River, to receive 36,350 acre feet of water per year (Jacobs, 1999). This, in effect, ensures water in the lower Verde River.

Neotropical Migratory Birds

Affected Environment and Environmental Consequences

Many of these birds are riparian obligates; therefore, the proposed action, which protects riparian habitat, is the optimum choice for this resource. Table 12 lists migratory bird species whose populations are of concern and their anticipated response to the Proposed Action, alternative 1, and alternative 2. Similar to the discussion above, the Proposed Action should have no direct effects to these species and indirect effects should be beneficial. Cumulative effects are also likely to be beneficial under the Proposed Action. Alternative 1 will not enhance native habitat and thus not improve habitat for migratory birds. Established weeds will continue to spread and degrade habitat for these species. Effects on habitat and population trend for these species will depend on the severity of the invasion of weeds. For some of the species listed in table 11, invasions could negatively impact habitat and population trend. Alternative 2 will improve some habitats by limiting the spread of weeds, but the majority of impacted habitats would not be controlled under this alternative.

Table 12. Migratory bird species of concern in Sonoran and Sierra Madre Occidental ecological regions of the Tonto National Forest, and estimated trend response to the proposed action and the two alternatives

Species	Vegetation Type	Habitat	Examples of Invasive Plant Species in or near Habitat	Current condition/trend forestwide	Estimated Trend in Habitat and Population Under the Proposed Action	Estimated Trend in Habitat and Population Under Alternative 1	Estimated Trend in Habitat and Population Under Alternative 2
Yellow-billed cuckoo	Low elevation riparian	Cottonwood and willow with dense patches	Saltcedar, tree of heaven, mustards, fountain grass, oleander, giant reed, Russian knapweed, camelthorn, yellow sweetclover, African sumac	No Change/Stable	No change	Potential Decrease	Potential Decrease
Elf owl	Sonoran Desert scrub, riparian, piñyon/juniper	Cavity nester	Starthistles, Saltcedar, tree of heaven, mustards, yellow sweetclover, African sumac, Siberian elm	Static/Increase	No change	No change	No change
Burrowing owl	Semi-desert grassland, grasslands	Nests in animal burrows in open ground	Mustards, Schismus, buffelgrass, fountain grass, bromes, sandbur	Static/Stable	No change	No change	No change
Loggerhead shrike	Sonoran Desert scrub, semi-desert grassland	Open areas	Mustards, Schismus, buffelgrass, fountain grass, bromes, sandbur	Static/Decreasing	No change	No change	No change

Species	Vegetation Type	Habitat	Examples of Invasive Plant Species in or near Habitat	Current condition/trend forestwide	Estimated Trend in Habitat and Population Under the Proposed Action	Estimated Trend in Habitat and Population Under Alternative 1	Estimated Trend in Habitat and Population Under Alternative 2
Gray vireo	Piñyon/juniper with broad-leafed shrubs	Low and tall shrubs with a tree component; drier, rocky, steep slopes	Bromes, knapweeds, starthistles, mustards	Static/Stable	No change	No change	No change
Bendire's thrasher	Sonoran Desert scrub, semi-desert grassland	Open habitat with large cacti, shrubs	Mustards, Schismus, buffelgrass, fountain grass, bromes, sandbur	No Change/Stable	No change	No change	No change
Yellow warbler	Riparian	Willows	Saltcedar, tree of heaven, giant reed, knapweeds, Siberian elm, oleander, fountain grass	Static/Increase	No change	Potential Decrease	Potential Decrease
Black-chinned sparrow	Sonoran Desert scrub, P/J-turbinella oak	Dense shrub w/ passages	Malta starthistle, bromes, Lehmann's lovegrass, Jerusalem thorn, buffelgrass, Russian thistle	Static/Stable	No change	No change	No change
Lark bunting	Sonoran Desert scrub, semi-desert grassland	Grass cover less than 30 centimeters	Mustards, Schismus, buffelgrass, fountain grass, bromes, sandbur, Jerusalem thorn	No Change/Stable	No change	No change	No change

Species	Vegetation Type	Habitat	Examples of Invasive Plant Species in or near Habitat	Current condition/trend forestwide	Estimated Trend in Habitat and Population Under the Proposed Action	Estimated Trend in Habitat and Population Under Alternative 1	Estimated Trend in Habitat and Population Under Alternative 2
Lawrence's goldfinch	Riparian, piñyon/juniper	Woodland near water	Starthistles, Saltcedar, tree of heaven, mustards, yellow sweetclover, African sumac, Siberian elm	Static/Increase	No change	Potential Decrease	Potential Decrease
Northern goshawk	Ponderosa pine	Denser portions of conifer stands	Oxeye daisy, Dalmatian toadflax, biennial thistles, Canada thistle, yellow starthistle, field bindweed, Japanese knotweed	No Change/Stable	No change	No change	No change
Gray hawk	Riparian	Woodlands with open areas	Starthistles, Saltcedar, tree of heaven, mustards, yellow sweetclover, African sumac, Siberian elm	No Change/Increase	No change	Potential Decrease	Potential Decrease
Common blackhawk	Riparian	Mature riparian woodlands with permanent water	Starthistles, Saltcedar, tree of heaven, mustards, yellow sweetclover, African sumac, Siberian elm	Static/Decrease	No change	Potential Decrease	Potential Decrease

Species	Vegetation Type	Habitat	Examples of Invasive Plant Species in or near Habitat	Current condition/trend forestwide	Estimated Trend in Habitat and Population Under the Proposed Action	Estimated Trend in Habitat and Population Under Alternative 1	Estimated Trend in Habitat and Population Under Alternative 2
Ferruginous hawk	Riparian, Sonoran Desert scrub, semi-desert grassland	Varied	Starthistles, Saltcedar, tree of heaven, mustards, yellow sweetclover, African sumac, Siberian elm, Jerusalem thorn	Static/Increase	No change	No change	No change
Peregrine Falcon	Sonoran Desert scrub, piñyon-juniper, chaparral	Cliffs, rocky outcroppings in open areas	Mustards, bromes, Schismus, Jerusalem thorn, camelthorn, white bietou, resinbush	No Change/Stable	No change	No change	No change
Flammulated Owl	Ponderosa pine, mixed Conifer	Open woodlands with brushy understory	Oxeye daisy, Dalmatian toadflax, biennial thistles, Canada thistle, yellow starthistle, field bindweed, curveseed butterwort, diffuse knapweed, Japanese knotweed	Static/Increase	No change	No change	No change
Lucy’s warbler	Low elevation riparian	Mesquite, willow, cottonwood with dense midstory	Giant reed, Jerusalem thorn, oleander, tree of heaven, Saltcedar, fountain grass	Static/Increase	No change	Potential Decrease	Potential Decrease

Species	Vegetation Type	Habitat	Examples of Invasive Plant Species in or near Habitat	Current condition/trend forestwide	Estimated Trend in Habitat and Population Under the Proposed Action	Estimated Trend in Habitat and Population Under Alternative 1	Estimated Trend in Habitat and Population Under Alternative 2
Broad-billed hummingbird	Riparian, piñyon/juniper	Small tree, shrub, vines	Giant reed, Jerusalem thorn, oleander, tree of heaven, Saltcedar, fountain grass, knapweeds	Static/Increase	No change	Potential Decrease	Potential Decrease
Costa's hummingbird	Sonoran Desert scrub	Small dense trees or shrubs near riparian zone and flowering plants	Buffelgrass, bromes, mustards, Malta starthistle, camelthorn, Schismus, fountain grass, sandbur, Jerusalem thorn	No Change/Stable	No change	No change	No change
Northern beardless-tyrannulet	Riparian	Cottonwood groves adjacent to water	Giant reed, Jerusalem thorn, oleander, tree of heaven, Saltcedar, fountain grass	No Change/Increase	No change	Potential Decrease	Potential Decrease
Greater pewee	Riparian	Woodland	Giant reed, Jerusalem thorn, oleander, tree of heaven, Saltcedar, fountain grass, teasel	Static/Stable	No change	Potential Decrease	Potential Decrease
Purple martin	Sonoran Desert scrub	Large saguaros with numerous holes in denser stands	Mustards, Schismus, buffelgrass, fountain grass, bromes, sandbur, Jerusalem thorn	No Change/Stable	No change	No change	No change

Species	Vegetation Type	Habitat	Examples of Invasive Plant Species in or near Habitat	Current condition/trend forestwide	Estimated Trend in Habitat and Population Under the Proposed Action	Estimated Trend in Habitat and Population Under Alternative 1	Estimated Trend in Habitat and Population Under Alternative 2
Baird's sparrow	Semi-desert grassland	Grass with no woody canopy	Buffelgrass, bromes, mustards, Lehmann's lovegrass	Static/Decrease	No change	No change	No change
Common blackhawk	Low and high elevation riparian	Perennial streams with tree galleries	Giant reed, Jerusalem thorn, oleander, tree of heaven, Saltcedar, fountain grass	Static/Increase	No change	Potential Decrease	Potential Decrease

Endangered, Threatened, Proposed, Candidate and Sensitive Fish Species

Affected Environment

The project area contains five federally-listed fishes (Colorado pikeminnow, razorback sucker, Gila topminnow, Gila trout, Gila chub), and one Region 3 Sensitive fish (roundtail chub).

Table 13. Endangered, threatened, sensitive, and native fishes of the Tonto National Forest

Common Name	Species	Status
Federally Listed		
Desert pupfish	*Cyprinodon macularius macularius*	E, WC
Bonytail chub	*Gila elegans*	E, WC
Gila chub	*Gila intermedia*	E, WC, CH
Woundfin	*Plagopteris argentissimus*	E, WC, EXT
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	E, WC
Colorado pikeminnow (squawfish)	*Ptychocheilus lucius*	E, WC, some ENE
Razorback sucker	*Xyrauchen texanus*	E, WC, CH
Spikedace	*Meda fulgida*	T, WC, PCH
Gila trout	*Oncorhynchus gilae gilae*	T, WC
Loach minnow	*Tiaroga cobitis*	T, WC, PCH
Sensitive Fish		
Longfin dace	*Agosia chrysogaster*	S
Desert sucker	*Catostomus clarki*	S
Sonora sucker	*Catostomus insignis*	S
Headwater chub	*Gila nigra*	C
Roundtail chub	*Gila robusta*	S, WC

** E = Endangered; T = Threatened, C = Candidate, EXT = Extirpated, S = Sensitive; WC = Wildlife of Special Concern in Arizona, as determined by Arizona Game and Fish Dept.; ENE = Experimental/Non-essential; CH = Critical Habitat, PCH = Proposed Critical Habitat*

Species in table 13 are described below.

Desert Pupfish *Cyprinodon macularius macularius* Status: Endangered

Desert pupfish once was widespread and abundant in southern Arizona, southeastern California, northern Baja California, and Sonora (Minckley, 1973). Its habitat in the lower Gila and Colorado River drainages comprised a wide diversity of waters that consisted of the margins of the larger lakes and rivers, desert springs, marshes, and tributary streams including the Salt, San Pedro, and Santa Cruz rivers. Currently no natural populations of desert pupfish occur in Arizona (Quitobaquito pupfish (*C. eremus*, formerly *C. m. eremus*) occurs on Organ Pipe Cactus National Monument). In California, several populations persist in tributaries to the Salton Sea, and in Mexico pupfish exist along the Colorado River Delta and in other nearby wetlands. Several transplanted populations are on private and public lands in Arizona and California, including one at Boyce Thompson Arboretum near Superior. Two transplanted populations occur on Tonto NF, both on the Mesa Ranger District (Calamusso, 2012).

Nearly all of the original range of desert pupfish has been irretrievably lost due to channelizing, damming, and diversion of water. The ecosystem that once supported innumerable numbers of pupfish no longer exists, save for a few isolated streams, springs, and wetlands. The continued existence of desert pupfish in the wild will depend on the efforts of humans to sustain them in habitats that meet their ecological needs. Artificial transplantation into suitable habitats, and continued maintenance of those habitats will be required. Even then, the fragmentation of a species that once was interconnected across many hundreds of stream miles may result in genetic drift and loss of viability of the population.

Bonytail Chub *Gila elegans* Status: Endangered

Originally found in the main stem of the Colorado River and some of its tributaries as far north as Wyoming, bonytail now persists in unknown numbers in some mainstem reservoirs (Mohave and Havasu) of the Colorado River, and maintains an apparently declining population in the Colorado River upstream from the Grand Canyon (Minckley, 1973). Locally, the species was collected from the Gila River near San Carlos, in the Salt River at Tempe and at the confluence of the Verde River. This species is extinct in the Gila River system. It does not currently occur on Tonto NF.

Loss or severe degradation of riverine habitat are primary reasons bonytail have declined. As with other big river fishes, their highly specialized adaptation to the harsh and unusual habitats of southwestern rivers is best demonstrated by the fact that when that environment changed, they decreased from being a common species to one of the rarest.

Gila chub *Gila intermedia* Status: Endangered

The Gila chub was historically distributed in central and southern Arizona, mostly in small creeks and cienegas at less than 4,900 feet in elevation (Minckley, 1973). It now occurs in 24 isolated streams or cienegas in the Gila River Basin in central and southern Arizona and northern Sonora. The species is now considered extirpated from the waters of New Mexico. The Gila chub is still found as a naturally occurring species in Silver Creek, on the Cave Creek RD. Trend on the Tonto NF is decreasing. Two streams on the Tonto NF are designated as Critical Habitat by the USFWS. They are: Mineral Creek on the Globe RD and Silver Creek on the Cave Creek RD. The species has been extirpated in Mineral Creek, but remains extant in Silver Creek on BLM lands, just downstream of the Tonto NF.

Adult Gila chub are highly secretive in nature and occupy the deeper waters of pools or concealed by cover in form of undercut banks, root wads, and instream woody organic debris. This type of stream structure is a key habitat component for Gila chub. Smaller individuals inhabit shallower stream margins and areas of aquatic vegetation.

The biology of this species is poorly understood. The species displays sexual dimorphism. Female chubs reach ten inches in size, but males rarely exceed six inches. Food consists primarily of immature and adult aquatic and adult terrestrial insects, which may fall into pools commonly inhabited by the species.

Gila chub reproduces in late spring to early summer (May through June) in optimal waters temperatures of 68 to 75^{o} F. Young of year chub grow rapidly their first summer and reach 3.5 inches by winter. In a constant temperature spring in southern Arizona, the species has been noted to spawn throughout the year. Spawning occurs over aquatic vegetation where eggs are broadcast. Gila chub develop brightly orange to red-colored fins during reproductive activity.

Currently, 24 populations of Gila chub exist in the state. Of these nine are of unknown status, six are considered unstable and threatened, eight are considered stable but threatened, and one is considered stable and secure. Groundwater pumping for municipal and irrigation uses, water diversions for irrigation, and damming of streams all contribute to drying of springs and reduction of streamflow, which are major threat to the species' persistence. In addition, introduction of nonnative, competitive and predatory species, especially green sunfish has negatively impacted the Gila chub. One undescribed form of this species in southern Arizona is now extinct due to a combination of dam construction and introduction of largemouth bass.

Woundfin *Plagopterus argentissimus* Status: Endangered

Woundfin likely occurred in larger streams throughout the lower Colorado River basin. Specimens were taken from near the confluence of the Salt and Verde rivers, to the mouth of the Gila at Yuma, and thence upstream into the Virgin River (Minckley, 1973). It is entirely probable that the species occurred further upstream on the Verde, Salt, and Gila rivers.

Currently it is restricted to the Virgin River in Arizona, Nevada, and Utah. Attempts to increase its range included transplanting into the Hassayampa, Pariah, and Salt Rivers, and Sycamore Creek in the Agua Fria drainage. None were successful. It does not currently occur on Tonto NF.

This species is in jeopardy due to extreme stress caused by alterations in its ecosystem. Nonnative fishes have brought disease and parasites, and they compete for food and space and prey on young of woundfin. Extremes of water flow and degraded quality contributed to loss of range. Dams and diverting water from streambeds, and groundwater pumping have caused many areas formerly capable of supporting the species to desiccate. Other land uses that result in a decrease in the amount of surface water have also contributed to their decline.

Gila topminnow *Poeciliopsis occidentalis* Status: Endangered

Gila topminnow was formerly widespread and the most common species in the Gila River and its tributaries, extending from the confluence with the Colorado up to the Frisco Hot Springs, San Francisco drainage, southwestern New Mexico (Minckley, 1973). It was historically also present into northern Sonora in the headwaters of the San Pedro and Santa Cruz rivers. The fish currently exists in Arizona in less than a dozen scattered populations, generally below 4,900 feet elevation. Gila topminnow typically inhabits lower elevation (< 4,900 feet) springs, cienegas and small streams. It historically inhabited shallow, often vegetated margins of probably most aquatic habitats.

This species is a short lived (ca. one year) member of the live-bearing or Poeciliid family. Eggs are fertilized internally and young are born alive. It is a small surface feeding fish, preying on mosquito and other aquatic insect larvae, amphipod crustaceans, bottom debris, and aquatic vegetation. Key habitat components are springs, cienegas, small streams, slow current, and aquatic vegetation.

The species normally breeds from January to August, peaking in June to July; however, pregnant females are present throughout the year with young produced even in winter. Numbers of young vary from 1 up to 25 per brood. Two broods may be developed simultaneously with intervals of about a month between broods. At peak breeding season, most females greater than 24 mm standard length are pregnant. Sexual dimorphism is present and males become blackened in breeding season. Individuals may mature in a few weeks to a few months.

Loss of habitat and nonnative, predatory fishes are the major threats to sustainability of the species. The introduced (late 1920s to 1930s), more aggressive and predaceous mosquitofish is the major nonnative fish threat to the species. In some streams, such as Cave Creek and Seven Springs, predation by crayfish is probably the main reason topminnow populations do not persist, despite repeated reintroductions. Since the late 1930s and more recently and intensively since 1980 by the Arizona Game and Fish Department efforts to restore the species to historic range have been largely unsuccessful. Of 175 locations stocked, only 17 have established populations; these are tenuous at best. Eleven of these are on the Tonto NF (Calamusso, 2012).

Colorado Pikeminnow ***Ptychocheilus lucius*** **Status: Endangered**

The Colorado pikeminnow was once widespread and abundant in the Colorado Basin. Records of this species are scarce after the late l940s, with the last specimens collected in Arizona in 1950 in the Salt River near the mouth of Cibeque Creek (Minckley, 1973). Populations declined abruptly between 1930 to 35 during closure of Hoover Dam and the extreme drought in 1934. The pikeminnow exists in Arizona only as repatriated populations. It still occurs naturally in the San Juan River, in extreme northwestern New Mexico. On the Tonto NF, it was stocked extensively into the Salt and Verde Rivers during the early 1980s. Individuals still persist but the population is not considered to be self-sustaining. Pikeminnow populations in these drainages are designated “experimental non-essential” (Calamusso, 2012). Waters deeper than three feet with moderate to strong currents are preferred habitat. Young inhabit backwaters or various substrate types.

The Colorado pikeminnow was the "top carnivore" in the Colorado River Basin and one of the world's largest minnows, reaching lengths of 6 feet and 200 pounds. It was so abundant in the lower Colorado in the early 1900s that it was pitchforked from canals, along with razorback sucker in the Phoenix area. The species becomes piscivorous at just over one inch in length and becomes progressively more so with age. In historic Arizona, it was normally associated with other large river fishes (i.e., razorback, bonytail, bluehead, and flannelmouth sucker). Foods of young pikemminnow (one inch or less) consist of crustaceans and aquatic diptera. With increasing size (two to four inches) more aquatic and terrestrial insects are consumed. Pikeminnow longer than four inches prefer a diet of fish.

Breeding behavior is unreported, largely due to turbidity during spring runoff. Based on hatchery observations, its behavior is probably similar to northern pikeminnow. Larvae appear to drift downstream to nursery areas comprised of backwaters and embayments. Breeding parallels spring runoff in the upper Colorado River as the hydrograph recedes and water temperatures warm (50^{o} F or greater). Spawning aggregations run up to 62 miles to suitable spawning sites, typically riffles and shallow runs. Key habitat components are deep riffles and pools.

This species has been declared extirpated in all free-flowing rivers in Arizona. Damming of rivers and introduction of nonnative, predaceous species, especially catfish and bass, are and continue to be the major threat to the species.

Razorback sucker ***Xyrauchen texanus*** **Status: Endangered**

Razorback sucker is endemic to the Colorado River basin. It was once widespread and abundant in the Colorado Basin (Minckley, 1973). It currently exists on the Tonto NF only as repatriated populations in the Verde River. These are not considered to be self-sustaining populations (Calamusso, 2012). Habitat is medium to large rivers with swift turbulent waters as well as backwaters. Key habitat components are deep riffles and pools. Critical habitat on the Tonto NF includes all of the Verde River upstream of Horseshoe Dam and the Salt River upstream of the Salt River Diversion Dam (Calamusso, 2012).

This species uses a variety of habitat types from mainstem channels to slow backwaters of medium and large streams and rivers, sometimes around cover. In impoundments they prefer depths of a meter or more over sand, mud or gravel substrates. Adult razorbacks tolerate a wide range of temperatures from near freezing to nearly 90^{o} F, with optimum temperatures around 72 to 77^{o} F (HDMS, 2005).

Spawning occurs from late winter through spring along gravelly shorelines or bays. Major threats to the species include habitat alteration, declines in water quality, and direct competition, and predation by nonnative fishes. Trend is declining on the Tonto NF.

Spikedace ***Meda fulgida*** **Status: Threatened**

The spikedace was common and locally abundant throughout the upper Gila River basin of Arizona and New Mexico (Minckley, 1973). Its distribution was widespread in large and moderately sized rivers and streams in Arizona, including the Gila, Salt, and Verde rivers and their major tributaries upstream of present day Phoenix, and the Agua Fria, San Pedro, and San Francisco river systems. Spikedace now is restricted to less than six percent of the historic range. In Arizona it occurs in Aravaipa and Eagle creeks, and the Verde River upstream of Tapco (above the Tonto NF).

The species is found in only one stream, Fossil Creek, on Tonto NF; although the Salt and Verde Rivers and Tonto Creek are historical collection sites. Distribution and abundance of spikedace has been severely reduced by habitat destruction due to damming, channel alteration and downcutting, riparian degradation, water diversion and groundwater pumping. Introduction and spread of exotic predatory and competitive fishes also contributed to its decline. Resource activities that affect water quality, such as removal of riparian vegetation, sedimentation, or control of water levels, can affect spikedace habitat quality, and should be avoided or corrected.

Gila trout ***Oncorhynchus gilae*** **Status: Threatened**

The species was once common in most all upper elevation (above 6,500 feet) tributaries of the Gila River headwaters and downstream to the mouth of the box canyon, northeast of Cliff, New Mexico (Minckley,_1973). It also occurred in the headwaters of the San Francisco drainage and in Eagle Creek and headwaters of the Verde River, Oak and West Clear creeks, Arizona. Restoration activities have increased the number of streams inhabited by Gila trout to nearly a dozen. This species is found in one location on the Tonto – Dude Creek. Trend is decreasing and that population may be extirpated.

The species occurs in both pool and riffle habitats, with adults more common in the former habitat type and young-of-year and juveniles in the latter. Pools with woody debris for cover are optimum habitat for the species. Water temperatures in streams inhabited by Gila trout are generally below 68° F. Key habitat components are riffles, pools, cold (< 68° F) water, and clean substrates.

Gila trout are generally less than ten inches total length in maximum size in the small, headwater habitats. The species feeds as an opportunist on aquatic macroinvertebrates, primarily caddisflies and mayflies. The species spawns in spring (April, May, and June) on the descending hydrograph as daytime water temperatures reach 46 to 50° F. Gravel cobble substrates are preferred spawning sites; fry emerge in about four weeks, and similar to Apache trout, reach two to four inches by the end of their first summer. Fecundity is low (75 to 150) eggs per female and year class strength is largely dependent upon flow regimes.

Similar to the Apache trout, this native southwestern trout species has been reduced dramatically in range. It occurs naturally in only five streams on the Gila National Forest, southwestern New Mexico. Introduction of nonnative trout, principally rainbow and brown trout, have resulted in loss of purity of populations through hybridization and competitive interactions. Recovery efforts to address these threats include replication of all natural populations through barrier construction, stream renovations and more recently, hatchery propagation.

Loach minnow *Tiaroga cobitis* Status: Threatened

Loach minnow was once locally common throughout much of the Gila River system, including mainstem and tributaries of the Verde, Salt, San Pedro, San Francisco, and Gila rivers, and the East, Middle and West forks of the upper Gila River up to about 7,200 feet elevation (Minckley, 1973). Its present range of occurrence represents about 15 percent of the former range, and includes the upper Gila River and its three forks, the San Francisco River, and Aravaipa Creek.

Loach minnow now occur in Fossil Creek on Tonto and Coconino national forests, where it was stocked in 2007 (Calamusso, 2012). There are no historical records of occurrence.

Activities that affect water quality, such as removal of riparian cover, sedimentation, or control of water levels, can affect loach minnow habitat quality. Dams and reservoirs appear to eliminate loach minnow for many miles upstream and downstream. Spread of exotic predators, especially flathead catfish and channel catfish, can also directly reduce loach minnow populations.

Longfin dace *Agosia chrysogaster* Status: Sensitive

Longfin dace is widespread in the Gila River Basin, Arizona and New Mexico, in the Bill Williams River, Arizona, and in the Yaqui, Magdalena, and Sonoyta basins of northern Mexico (Minckley, 1973). Although widely distributed and present in all habitable waters in the Southwest, it is reduced in abundance in larger streams and above 4,920 feet elevation. Longfin dace are widely distributed on the forest. Trend is stable but may be declining long-term due to nonnative fish encroachment.

The longfin dace is a small minnow (< 2.3 to 2.75 inch adult size), normally occurring in schools in open waters. The species is highly adapted to the rigors of southwestern streams and rivers. It is reported to survive in algae mats during midday loss of surface flow in small streams. Aquatic macrophytes along stream margins also are commonly inhabited to reduce exposure to extreme thermal conditions (> 86° F). Longfin dace feed on detrital material, filamentous algae, and microscopic crustaceans. This species frequents shallow, sandy-bottom glide and run habitats with velocities of less than 2.5 feet/sec. This shallow, sandy, low-velocity water is a key habitat component for longfin dace.

Longfin spawn over a long period of time - December through July to September in low elevation desert streams and rivers, and from spring to early summer at upper (> 3280 feet) elevations. Spates from summer monsoon rains may stimulate multiple spawning during a year. Saucer shaped depressions are excavated in fine sand typically along stream margins. These nests, often concentrated in clusters, are 6 to 8 inches wide, 1.5 to 2 inches deep with margins above surrounding stream substrates. Spawning occurs over these nests, eggs are deposited, young hatch in 4 days, young remain in nests until yolk-sacs are absorbed. Growth is rapid, with young spawned in the spring reaching 1.75 to 2 inches and capable of spawning the same year.

Longfin is very likely the most common and highly adapted native southwestern cyprinid, occupying waters in low hot deserts through mid elevation, canyon-bound streams to upper elevation, clear cool creeks in the conifer zone. Recent declines in the upper Verde River population appear to result from a combination of habitat change, lack of flooding and introduced, predatory fishes such as smallmouth bass. The primary physical threats are drought and diversion and pumping of stream aquifers, resulting in loss of surface flow.

Desert sucker *Catostomus clarki* Status: Sensitive

Desert sucker presently occurs in the Salt and Verde Rivers on the Tonto NF. It occupies low to high gradient riffles (0.5 to 2.0 percent gradient) over pebble to cobble substrates containing water velocities of 1.1 to 1.5 feet per second (BISON, 2010). Key habitat components are high-gradient riffles of moderate to swift velocity current, moderate depth (< 1.6 feet), and over pebble to cobble-boulder substrate. The species also inhabits pools with moderate current (Minckley, 1973).

Breeding generally occurs in riffles; however, it has not been specifically studied. Breeding season is late winter (January to February) to early spring (March to April). Threats include introduced species and habitat alteration.

Sonora sucker *Catostomus insignis* Status: Sensitive

Sonora sucker is widespread and abundant in the Gila and Bill Williams’s river drainages in Arizona, and the Gila and San Francisco drainages in Southwestern New Mexico. The species is widespread and abundant in the Verde and Gila headwaters. Habitat is streams and rivers from 300 to 3,000 m. in elevation, primarily in pool habitats over sand/gravel substrates (Minckley, 1973).

This fish can attain a size of 2.6 feet and a weight of greater than 4.4 pounds. It was used as food by early primitive human populations. Its food habits vary with availability. In one stream, Aravaipa Creek, it is principally a carnivore, whereas elsewhere in pool habitats diet consists of plant debris, mud, and algae. It has been observed to "suck" cottonwood seeds at the water’s surface much like the common carp does. Young often feed in large schools at stream margins on micro-crustaceans, protozoans, and other animal and plant groups. Key habitat components are pools with sand/gravel substrates for adults and shallow, low velocity riffles and backwaters for young.

Similar to most slim-bodied suckers, the species spawns in smaller streams over gravel substrates. Males darken in color and often display extreme tuberculation. Males flank a single, larger female. Gametes are emitted with considerable to extreme substrate agitation and fall into gravel interstices. Cleaning of gravels occurs much as reported for salmonid species. Breeding season is protracted, from as early as January to February at low elevations, to as late as July.

Threats to the species are construction and operation of dams, diversions, groundwater pumping, and introduced species.

Headwater chub *Gila nigra* Status: Candidate

This species occupies upper reaches of tributaries throughout the Colorado River Basin. On the Tonto NF, it occurs in upper Tonto Creek and tributaries, the East Verde, upper reaches of Fossil Creek, and Deadman Creek (tributary to the Verde River) on the Tonto NF (HDMS, 2005; Calamusso, 2012). It is often found in association with roundtail chub. Headwater chub is most commonly a pool inhabitant, with associated cover in the form of undercut banks, root wads and boulders, and containing sand/gravel substrates. This type of cover is a key habitat component for headwater chub.

Headwater chub is an omnivorous fish, consuming a wide variety of aquatic and terrestrial insects. Larger individuals are piscivorous.

Similar to roundtail chub, this species spawns in May when water temperatures reach about 72^{o} F. Spawning occurs in pool-riffle habitats or in riffles immediately above pools. Fecundity is age-dependent, with 5 year-old females producing over 30,000 eggs. Young grow to 2.75 inches in their first year. Growth rate appears to be directly proportional to habitat (pool) size.

Introduced, predatory sport fishes are perhaps the greatest threat to the species. Other threats include alteration and loss of habitat due to poor land use practices.

Roundtail Chub *Gila robusta* Status: Sensitive

Roundtail chub are found in moderate to large rivers of the Colorado River Basin. In Arizona, it still occurs in the mainstem and tributaries to the Verde and Salt Rivers, although populations have declined considerably during the past few decades (Minckley, 1973). On Tonto NF, it occurs in the Verde and Salt Rivers and many of their larger tributaries including Ash Creek, Cherry Creek, lower reaches of the East Verde, lower reaches of Fossil Creek, Rock Creek, Wet Bottom Creek, Salome Creek, Sycamore Wash (tributary to the Verde near Sheep Bridge), and the South Fork of Deadman Creek (Calamusso, 2012).

Roundtail chub occupy cool to warm water, mid-elevation streams and rivers where typical adult microhabitat consists of pools to eight feet deep adjacent to swifter riffles and runs. Cover is usually present and consists of large boulders, tree rootwads, submerged large trees and branches, undercut cliff walls, or deep water. Smaller chubs generally occupy shallower, low velocity water adjacent to overhead bank cover. Roundtail chub appear to be very selective in their choice of pools, as they are commonly found to congregate in certain pools, and are not found in similar, nearby pools.

Spawning takes place over gravel substrate. Tolerated water temperatures range up to 80º F. Young chubs feed on small insects, crustaceans and algal films, while older chubs move into moderate velocity pools and runs to feed on both terrestrial and aquatic insects along with filamentous algae. Large roundtail chubs take small fish, and even terrestrial animals such as lizards that fall into the water. Roundtail chub breed in early summer, often near beds of submergent vegetation or other kinds of cover such as fallen trees and brush, as spring runoff is subsiding. Fertilized eggs are randomly scattered over gravel substrate with no parental care. Individuals up to 20 inches in length and weighing 2 pounds may occur, but typically maximum size is between 10 and 16 inches.

The type of habitat seemingly preferred by adult roundtail chub is rapidly disappearing from southwestern streams as the very large and old riparian trees are not being replaced. Maintenance of natural flow regimes and occasional flooding are apparently important to continued survival of local populations. Predation by flathead catfish and smallmouth bass has been implicated in elimination of populations.

Environmental Consequences

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Impacts of treatment methods are evaluated based upon their effect on threatened, endangered, proposed and sensitive (TEP&S) fish and/or critical habitat (CH). Our analysis indicated there would be no direct effects to TEP&S species because aquatic weed treatments are not proposed. Thus fishes and their habitats would not be impacted.

While weed species cover a relatively small proportion of the Tonto NF, they do occur throughout its 2,872,876 acres. Treatments for noxious weed abatement and eradication will take place in each Ranger District and across ecotypes ranging from Sonoran Desert to mixed conifer forest. Watersheds within the project area include: Salt River, Verde River, Agua Fria, New River, and Cave Creek. Repeated treatments using various methods would be necessary for most weed species because seeds in the soil can be viable for 5, 10 or more years. Therefore, recurring treatments would be authorized until the desired control objective is reached. The annual combination of methods to be used is expected to vary depending on specific conditions.

The treatments identified under the Proposed Action (manual, mechanical, cultural, chemical) will cause minimal effects to fish and their habitats. Some siltation may occur due to actual weed treatment and work crews moving on the ground, but this should be insignificant as buffer strips of riparian vegetation will impede soil movement toward streams. If no buffer is present the short term disturbance and added silt load will be of minor significance over the long term.

Biological controls are predicted to cause no effect on fishes and watershed within treated areas. The control of these noxious plants will improve habitat conditions for native fish species that will result in higher ground covers and a lowering of the potential for sedimentation into perennial streams. However, we anticipate the most important aspect of reaching control objectives is the ability to stop the spread of nonnative tree species such as: tree of heaven, Russian olive, and saltcedar. Saltcedar is widespread in the Verde River drainage and presents real problems in the form of changes to channel morphology, presence of native insects and microfauna, fire (and consequent water quality damage), and continuation of a native tree community. Treatment of nonnative trees and noxious weeds will accomplish two objectives: preventing the loss of any additional habitat and improving the regeneration of native willows and other species on the treated acres. Habitat conditions for fishes in this drainage may improve once native plant communities expand. Native plant communities will provide a more natural riparian component to the riparian community and thus return overall drainage characteristics to a state where components evolved in concert with other constituents. Use of weed-free seed mixes and mulches would also promote native vegetative growth or inhibit/prevent weed expansion as control objectives are met.

All herbicides proposed for use are characterized by relatively low aquatic toxicity under typical concentrations (U.S. Forest Service, 1998). All herbicide applications would follow EPA label requirements, U.S.D.A. policy, Forest Service direction, and mitigation measures. There would be no aerial application of herbicides by either fixed-wing or rotary aircraft and no aquatic applications of herbicides. Only herbicides labeled for use adjacent to water would be used within riparian zones and areas with shallow ground water. These include aquatically labeled formulations of glyphosate, imazapic, imazapyr, and triclopyr. There would be no broadcast spraying in riparian zones. All treatments of weed tree species would be either cut stump, or straight injection into the bark of the tree.

Burning/torching/flaming is conducted by burning individual plants and does not cause off-site impacts that would affect water quality or fish habitat.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

This alternative would not implement a comprehensive weed program within the project area. Riparian areas would be impacted by continued expansion of weeds that would result in the reduction or loss of native riparian vegetation. Riparian areas along Tonto NF riparian corridors would be impacted and may affect overall watershed function. The loss of native riparian vegetation could result in long-term alteration of the aquatic habitat by: (1) reducing streambank stability that may increase erosion potential and sediment input into the stream channel; (2) potentially changing stream channel morphology (e.g., widths and depths) that would reduce aquatic habitat diversity; and (3) increasing the probability of reducing/altering the stream production of terrestrial and aquatic insects associated with native vegetation and clean riffle areas. Also, the probability increases for catastrophic fire hazard in tamarisk and Russian olive infested areas. These nonnative plant communities place native, non-fire adapted plant communities at risk of destruction or reduction. An indirect impact of this effect would be an even quicker expansion of saltcedar since this species is promoted by fire events. Water consumption rates are also higher in these nonnative communities and could lead to lower base flow. This could lead to a reduction or loss of habitat diversity, spawning habitats, and food supply (e.g., aquatic insects) from alteration of aquatic habitat for native TEP&S fishes and increased sedimentation in CH (Critical Habitats), which could directly affect spawning success and recruitment of TEP&S fishes.

Upland areas also have the potential to be negatively impacted by continued expansion of weeds. Loss of native vegetation often results in the loss of vegetative ground cover in turn reducing infiltration rates, increasing runoff, and soil erosion in affected areas. The spread of weeds could also alter the natural fire regime in these uplands (similar to riparian areas) and cause an increased probability of catastrophic wildfire events. The potential for increased runoff and soil erosion with subsequent input of sediments, ash, and nutrients into streams could occur and may impact TE&S and native fishes and their habitats.

Manual removal of weeds and small scale burning/flaming may increase siltation for the short-term by movement of crews in and around streams, as for the proposed action.

Implementation of this action would result in the greatest expansion of weeds throughout the project area and riparian corridors. The indirect impact of this will be a general deterioration of aquatic habitat conditions for TEP&S fish species and/or CH because of degrading riparian and watershed conditions.

Weed populations would continue to advance and impact uninfested areas. Effect of these actions on fish populations is predicted to be insignificant.

Cumulative Effects

Under alternative 1, noxious and invasive weeds would expand from the current population over the next ten years. All noxious and invasive weeds would increase in the project area.

Invasive tree species and other noxious weeds in riparian areas, together with impacts from increased recreational activities effects could result in lowered water tables and decreased water quality for fisheries.

Expansion of current noxious and invasive weed populations will also result from the Forest Service implementation of numerous ground-disturbing projects including road construction and maintenance, timber sale activities, forest restoration projects, prescribed burning, revisions of allotment management plans, watershed restoration, road obliteration, and mining. Inclusion of weed prevention best management practices in all project planning should reduce the potential of new introductions to low levels.

Alternative 2: Integrated Vegetation Management Excluding the Use of Herbicides

Direct and Indirect Effects

The treatments prescribed in alternative 2 (mechanical, manual, biological, prescribed burning and cultural methods) would not be as effective as the Proposed Action in treating noxious weeds on forest lands. Weed populations would continue to advance and impact uninfested areas. Effect of these actions on fish populations is predicted to be insignificant.

Positive effects of this action on TE&S fish, CH, and native fishes would be minimal.

Cumulative Effects for the Proposed Action and Alternative 2

If any of the action alternatives are selected, the potential exists for the greatest benefit to TE&S fishes, CH, and native fishes through large-scale reduction in alien tree species and noxious weed infestations.

There would be no direct effects to TE&S fish and/or CH based on the use of mitigation measures and best management practices. Continuation of any invasive plant control program would have beneficial effects to TEP&S fish and/or CH due to containment and/or control of weeds within roadway corridors. This would prevent, or at least reduce, the potential of these roadways from infesting the riparian areas on the forests.

The Forest Service has acquired instream flow rights for the Verde Wild & Scenic River from Beasley Flat downstream 40 miles to the confluence of Red Creek. Application for instream flow rights has been made on the upper Verde River for the benefit of threatened and endangered fishes. Instream flow assessments are being conducted for several tributaries of the Verde River and for East Clear Creek with TEP&S fish and/or CH for future application for instream flow rights. Acquisition of instream flow rights in the project area would have long-term beneficial effects to TEP&S fish and/or CH by maintaining adequate water quantity to sustain populations.

Livestock grazing occurs on many forest allotments, state lands, and private lands. Livestock grazing has been excluded along the Verde and Salt Rivers and other drainages for the benefit of threatened and endangered fish and/or CH. Range utilization standards and guidelines are in place on forest lands and are expected to improve riparian and watershed conditions and would have beneficial effects to TEP&S fish species and CH by reducing the potential for sedimentation.

Over the next five years, control of aquatic noxious weeds like Eurasian water milfoil will be evaluated. Treatments would occur in occupied habitat of TEP&S fish and/or CH in the project area. This project would have an overall beneficial effect to TEP&S fish and/or CH by returning aquatic habitat to historic conditions.

Social Concerns

Human Health

Short History of Herbicide Use on the Tonto National Forest

The earliest documented attempts to use herbicides in vegetation management on the Tonto NF date to the 1930s. There are photographs taken in 1934 and 1936 in files at the Tonto NF Supervisor’s Office, of a project to control chain-fruit cholla with arsenic pentoxide. Exact location is not recorded, but there were probably two sites, at or near Schoolhouse Point and at Horrell Experimental Plot on the Globe RD.

In the 1960s, the Forest Service initiated a program to conduct vegetation type conversions from chaparral to grassland. The purpose of this was to increase runoff, and consequently increase the forest’s ability to provide water for the Phoenix metropolitan area. Arizona had experienced a drought during the 1950s, and water officials were concerned that the existing water supply and delivery system would not be adequate for the growing metropolis.

As early as 1962, herbicides were being aerially applied to chaparral in the Brushy Basin area near Four Peaks. 2,4-D was used in 1962, followed by pentachlorophenol, a defoliant, in 1963 (Tonto NF, 1964).

Several methods were used to remove chaparral vegetation from the Three Bar Experimental Watersheds in the 1960s: prescribed burning, grazing by goats, and application of herbicides. Herbicides were applied both by hand and aerially by helicopter from 1960 to 1969. Herbicides used were: 2,4,5-T (aerially applied at the rate of 1.6 lbs/acre), pelleted fenuron (hand applied at rates from 3.6 to 18.3 lbs/acre), granular tordon (hand applied at 9.3 lbs/acre), and granular Tandex, or karbutilate (hand applied at 4.4 lbs/acre in 1968, and aerially applied at 20 lbs/acre in 1969) (RMFRES, n.d.).

A report written in 1969 gives a total area of 17,700 acres of chaparral vegetation on the Tonto NF that had been treated by fire and/or herbicide to convert it to a grassland vegetation type. Sites that were sprayed with herbicides included Brushy Basin near Four Peaks (8,000 acres), Kellner and Icehouse canyons and Russell Gulch in the Pinals (2,300 acres), and Hutch Mesa, east of Cordes Junction (1,000 acres) (Tonto NF, 1969). In Brushy Basin, 2,4-D, 2,4,5-T (ester formulations of both) and fenuron were aerially applied by helicopter. Aerially applied herbicides were mixed in a carrier of diesel and water (Tonto NF, n.d.).

The Tonto NF, in cooperation with Salt River Project, conducted an experimental program using the herbicides 2,4-D, 2,4,5-T and Silvex (2,4,5-TP) to kill chaparral vegetation in the Pinal Mountains, south of the town of Globe, Arizona. These herbicides were applied by helicopter to watersheds ranging in size from 1,060 to 1,370 acres from 1965 through 1969 (Tonto NF, 1969). In June 1969, herbicides from the helicopter drifted over populated areas. Residents of these areas near Globe exhibited various physical symptoms ranging from skin rashes to cancer, over the ensuing years. In 1970, Billee Shoecraft and 20 other residents of Globe filed suit against Dow Chemical, three other chemical companies that manufactured the herbicides that were used, the helicopter company, a state agency that helped finance the project, and the U.S. Forest Service (Shoecraft, 1971; Trost; 1984, & Doyle, 2004). By 1974, most of the chemical companies and the helicopter company settled out of court. In 1981, Dow also settled out of court, with no admission of liability.

At the time of the lawsuit, Dow maintained that 2,4,5-T and Silvex were non-toxic to humans or animals. Dioxin was a known contaminant of both of these herbicides. Testing conducted at that time measured only for acute effects, not chronic effects of long-term low dose exposures to pesticides. In fact, before the EPA took over registration and approval of pesticides from the U.S. Department of Agriculture, chemical companies submitted only “scanty data – largely confined to acute poisoning effects – to a loosely monitored… system of review that did little original testing, that did not routinely rethink a chemical’s registration if new information about harmful effects came to light, and that removed a chemical from the market only under extreme pressure” (Trost, 1984). Dioxin is now known to be a carcinogen and teratogen (a substance that can cause birth defects) at levels lower than laboratory equipment could detect in the 1960s. A contractor hired by EPA to measure dioxin content in technical grade Silvex from two different manufacturers reported dioxin content ranged from 0.012 to 0.024 ppm (EPA 1979). Although Silvex manufacturers attempted to remove this contaminant, it could not be totally removed. It was not until 1979, and after many arguments about exactly what quantity of dioxin contaminant produced teratogenic and other adverse health effects, that an order by EPA (EPA, 1979) suspended distribution, sale and use of 2,4,5-T and Silvex for forestry, rights-of-way and pasture use due to the finding that they posed an imminent hazard to humans and the environment. The EPA reported that Silvex (which is always contaminated to some extent by dioxin) caused reproductive and oncogenic (cancer causing) effects in test animals. Dioxin was measured in the 2,4,5-T used at Globe to be 0.5 ppm (Trost, 1984). Dow discontinued manufacture of 2,4,5-T in the U.S. in 1983. Today both Silvex and 2,4,5-T are on EPA’s list of banned pesticides (Scorecard, 2005).

In 1984, EPA conducted tests of soils and water in the area of the 1969 Globe spray project. The EPA found dioxin (2,3,7,8-TCDD) in high concentrations at all three helispots used for mixing herbicides during that project. Levels ranged from 43 to 6623 ppt (parts per trillion) (6623 ppt = 6.623 parts per billion or 0.00623 parts per million). The authors of the paper documenting this monitoring reported that the upper value of TCDD found at one of the helispots was the highest level reported at any herbicide use area sampled under the National Dioxin Study (Simanonok & Beekley, 1986). In 1984, the Centers for Disease Control advised that soil levels (in residential areas) above one part per billion of TCDD could result in an unreasonable risk to human health. They qualified this statement by stating that this should not be viewed as a universal standard but as an operational starting point to analyze each situation. They also stated that soil levels of TCDD in pastures where cattle graze might have to be lower because of the potential for bioaccumulation (CDC, 1984).

Sediment from Kellner Creek, Icehouse Creek, Pinal Creek, and Blue Tank (a stock tank just downstream of the area where the herbicides were applied) were also sampled for TCDD (dioxin). At detection limits of 1.0 to 3.0 ppt, TCDD was not detected in any of the sediment samples. Wildlife were taken and tissue samples shipped to U.S. EPA laboratories for high-resolution testing for TCDD. Species sampled were coyote, black rattlesnake, deer, javelina, glossy snake, Gambel's quail, garter snake, a toad, and leopard frogs. TCDD was not detected in any of the animal tissues. They concluded that detectable levels of TCDD persist for at least 15 years where mixing and loading occurred, but that dioxin was not detected in stream sediment or wildlife samples.

In 1991, the Arizona Department of Environmental Quality conducted tests for presence of Silvex, 2,3,7,8-TCDD, and isomers of these chemicals in private wells in Kellner Canyon, in sediments from Kellner Creek, and in sediments at two helipads used for herbicide mixing during the spray operation in 1969. Their tests detected no herbicides or their metabolites in the well samples or creek sediments. Silvex and TCDD were detected at the helipads, on ridges above Kellner Canyon and Russell Gulch (ADEQ, 1992).

In 1992, the Arizona Department of Environmental Quality repeated tests for presence of Silvex, 2,4-D, 2,4,5-T and 2,3,7,8-TCDD in sediments of Kellner Canyon, and in the same two private wells. They did not detect any of these chemicals, but another dioxin, OCDD was detected in both wells and in a sediment sample behind a waterfall in Kellner Canyon. OCDD is a dioxin which is several orders of magnitude less toxic than TCDD (ADEQ, 1993).

In response to an inquiry from Representative J.D. Hayworth in 1997, Dr. David Satcher of the Agency for Toxic Substances and disease Registry (ATSDR) wrote that his agency had reviewed the 1991 through 1993 reports from ADEQ on sampling of sediment and groundwater in the area of the 1969 spray project south of Globe. ATSDR agreed with ADEQ that there was no public health hazard at that time. The contaminated soil found in 1985 at three helipads was not remediated, due to their remote locations (Satcher, 1997). A memo from the Petition Screening Committee at the ATSDR in 1997 explained that they did not recommend further evaluation of a petition to conduct a public health assessment, due to the fact that residual dioxin in the soil at helicopter landing/loading sites seemed to have decreased from 1985 to 1991, and the concentration of dioxin in groundwater and in surface water was found to be below levels of health concern. This determination was based upon available sampling data (Steward, 1997).

These documents constitute the most recent documentation of herbicide residual monitoring for this area.

Current Use of Herbicides on the Tonto and Lands Surrounding the Tonto National Forest

Use of herbicides on this forest is currently limited to three types of projects: “housekeeping” type uses at Administrative and Recreation sites, a small-scale project on the Pleasant Valley Ranger Station, and treatment of noxious weeds along federal and state highways that run through the forest.

One project has been approved for application of herbicides, in the horse pasture of the Pleasant Valley Ranger Station, where a Decision Memo was signed in 2004 for a project to control yellow starthistle using prescribed fire, grubbing, and herbicide.

In 2004, a decision was made that allows application of 16 different herbicides within federal and state highway rights-of-way through all National Forests in Arizona. Up to 1,000 acres per year may be treated on the Tonto NF under this decision (U.S.F.S., May 2004).

Concerns of People with Multiple Chemical Sensitivity

Some users of the Tonto NF are afflicted with a syndrome termed “Multiple Chemical Sensitivity” (MCS). About 16 percent of the population has multiple chemical sensitivities; four percent of these are more serious cases (U.S.F.S., Feb. 2004). To this portion of the population, many substances such as cleaning supplies, house paint, new building materials, antibiotics, insecticides, and herbicides cause adverse reactions. Since there is no cure for MCS, most people create living spaces so they are not exposed to chemicals that would cause a severe reaction. This includes living in communities that are not impacted to a great degree by chemical use, and living in specially built homes. When chemicals are introduced into or near the living areas of MCS-afflicted people, they must often find a chemical-free place to live for a period of time. They may take refuge in National Forests to escape a potentially dangerous health situation.

Potential effects of herbicide use to MCS-afflicted individuals from recent projects approved for treatments along highways have been mitigated by creation of a toll-free number where they can hear a schedule for ADOT’s treatments along highway rights-of-way through Arizona national forests. In the four years this protocol has been in effect, there have been no reports of ill effects to any people. ADOT has now dropped its toll-free notification number, due to lack of use by the public.

Environmental Consequences

The analysis area for this resource is the National Forest and neighboring communities. Human health may be directly influenced when people utilize the forest, and activities on the forest may have indirect effects on adjacent inhabited areas. Human use of the forest is mainly associated with recreation, hunting and fishing, use of grazing allotments, firewood harvest and gathering of traditionally used plants. Effects to this resource can be seen in the degree to which human health is affected by implementation of the selected action.

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Workers who are applying herbicides have the highest exposure to the herbicides. Registration by the EPA confers a level of confidence that an herbicide poses low risk to the user. This is adequate for the general public, who routinely purchase and use all of the herbicides that are proposed for use by this project, with the exception of picloram, which is a restricted-use herbicide and requires certification to purchase and use. The Forest Service is obligated, for the protection of its own employees and the general public, to conduct the highest quality risk assessment they possibly can, for herbicides that have been registered by EPA.

A considerable body of information from tests on laboratory animals is available for the herbicides considered for possible use in controlling noxious weeds. Most of these tests were conducted as a requirement for the U.S. Environmental Protection Agency (EPA) for the registration process. All of the herbicides proposed for use have been subjected to long-term studies that test for general systemic effects, effects on reproductive and developmental toxicity (birth defects), mutagenicity (change in genetic material), neurotoxicity (effect upon nerve tissue), carcinogenicity (tendency to produce cancer) and immunotoxicity (effect on the immune system). NOEL measures (a laboratory-derived maximum amount of active ingredient that produces "No Observable Effect Level") are available for most types of these tests.

Extrapolating a NOEL (No Observable Effect Level) from an animal study to humans is an uncertain process. The EPA compensates for the uncertainty by dividing NOELs from test animals by a safety factor, typically 100, to derive a Reference Dose (RfD). In other words, the human RfD is $1/100^{th}$ of the NOEL for an animal study. The RfD, also known as the Acceptable Daily Intake (ADI) is defined as the daily exposure over a human lifetime (assumed to be 70 years) at which there is a reasonable certainty of no harm. The dose is expressed as milligrams of herbicide per kilogram of body weight per day (mg/kg/day). Acceptable reference doses for herbicides in this analysis are displayed in table 14. Toxicity categories are defined by the U.S. EPA as follows:

Category I – Highly Toxic-- oral LD50 up to 50 mg/kg

Category II – Moderately Toxic-- oral LD50 between 50 and 500 mg/kg

Category III – Slightly Toxic -- oral LD50 between 500 and 5000 mg/kg

Category IV – Relatively Nontoxic -- oral LD50 greater than 5000 mg/kg

Eight of the herbicides proposed for use fall within the category of "Relatively Nontoxic," the other five are in Category III, "Slightly Toxic." See table 14 for illustration of toxic amounts, as determined by extensive laboratory testing.

Table 14. Acceptable daily intake (mg/kg/day) for selected herbicides as compared with other compounds

Herbicide	Oral LD50 for rats (mg/kg) [1]	ADI/RfD[2]	Equivalent human dose	EPA Category of Use (for herbicides)
Highly Toxic Category (Category I): LD50 = 0 to 50 mg/kg				
Botulinus toxin	0.0000012	*	A taste to a teaspoonful	N/A
TCDD (a dioxin)	0.00022 to 0.1	*		N/A
Strychnine	16	*		N/A
Nicotine	50	*		N/A
Moderately Toxic Category (Category II): LD50 = 50 to 500 mg/kg				
Paraquat (herbicide)	57	0.005	A teaspoonful to one ounce	Restricted Use
Pure caffeine	192	*		N/A
2,4-D	275	0.3		General Use
Slightly Toxic Category (Category III): LD50 = 500 to 5000 mg/kg				
Triclopyr	630	0.05	One ounce to one pint	General Use
Clopyralid	3000	0.15		General Use
Dicamba	750 to 3000	0.045		General Use
Sethoxydim	2676 to 5000	0.09		General Use
Aspirin	1500	*		N/A
Table salt	3000	*		N/A
Picloram	3000 to 5000	0.2		Restricted Use
Relatively Nontoxic (Category IV): LD50 > 5000 mg/kg				
Chlorsulfuron	5,545	0.05	More than one pint.	General Use
Clopyralid	>5,000	0.15		General Use
Glyphosate	>5000	2.0		General Use
Imazapic	>5,000	0.5		General Use
Imazapyr	>5,000	2.5		General Use
Metsulfuron methyl	>5,000	0.25		General Use
Sulfometuron methyl	>5,000	0.02		General Use
Aminopyralid	>5,000	0.5		General Use

[1] ***Oral LD50 is the dose required to kill 50 percent of test animals.***

[2] ADI (Acceptable Daily Intake) and RfD (Reference Dose) = the daily exposure over a human lifetime (assumed to be 70 years) at which there is a reasonable certainty of no harm.
**** No reference dose is available or established.***
^The EPA classifies herbicides for "general use" or "restricted use." General use herbicides can be used by anyone, and if label directions are followed carefully, there is little chance of harm to humans or the environment. Restricted use herbicides are frequently more toxic than general use herbicides or potentially damaging to the environment. Only certified applicators that receive special training in handling and applying herbicides are allowed to purchase and apply restricted use herbicides.
Sources for information in table 14: Botulinus toxin: Univ. of Florida 2011; TCDD: Centre for Ecological Sciences Indian Institute of Science, Bangalore, India (2011); Strychnine, Nicotine & Paraquat: IPCS, Chemical Safety Information from Intergovernmental Organizations; Caffeine: MallinckrodtBaker, Inc; aspirin and table salt: Fisher Scientific; all other chemicals: SERA Risk Assessments.

In evaluating the potential impact of herbicides, it must be kept in mind the small amount that is typically used on National Forest System lands. This is normally less than two pounds per acre. Some products are applied at an ounce per acre.

Direct effects for workers are usually those that may occur from direct contact (dermal exposure) with an herbicide (Durkin, 2007). Applications will be by backpack and ground based mechanical methods, and the area treated per day will be dependent on the specific site and the type of application. The proposed noxious weed treatments fall within the typical scenario for herbicide use including proposed application rates and acres treated per day per worker in specific risk assessments, discussed below. The conditions when an herbicide is applied will affect the exposure, and implementation of the mitigation measures covered in appendices D and G will reduce possible exposures. Also, using personal protective equipment, as covered in the Safety and Spill Plan (Appendix E) will lower exposure of workers by as much as 68 percent (U.S.F.S., 1992), since most application exposure is through the skin.

Worker doses for the herbicides proposed for use are likely to be well below the RfD if reasonable safety precautions are followed. The risks would be further reduced because the applicator would likely be exposed for a few weeks per year, at most. The RfD assumes a lifetime of daily doses.

In addition, since 1998, updated Human Health and Ecological Risk Assessments have been prepared for herbicides commonly used by the Forest Service by an independent company, Syracuse Environmental Research Associates, Inc. (SERA). SERA's Risk Assessments have been meticulously researched and documented for all of the herbicides proposed for use. Each risk assessment uses an extremely thorough literature review of environmental and human effects to create a model. In these documents, the process of risk analysis is used to quantitatively evaluate the probability that a given pesticide use might impose harm on humans or other species in the environment. This model can be used with default settings, which are described in detail, or can be modified to portray more closely a specific situation for a Forest Service project. Worksheets are filled out on the computer, and the model run to determine whether effects qualify as acceptable risks (hazard quotient less than 1.0), or risks that either must be mitigated in some way or eliminate use of that herbicide for the project. These risk assessments can be obtained on a Forest Service web site (http://www.fs.fed.us/foresthealth/pesticide/risk.shtml). A list of SERA Risk Assessments is found in appendix F. All of these risk assessments are incorporated by reference.

The Risk Assessment has three parts:

- **Exposure Analysis**. This analysis estimates the range of possible doses to workers, the general public, aquatic organisms, etc. A variety of scenarios and exposure pathways are examined that could result in dermal and oral exposures.
- **Hazard Analysis**. Tests and data related to the toxicity of herbicides are reviewed under this analysis. Data are reviewed to indicate the doses at which toxic effects occur and, conversely, levels at which no toxic effects are seen (NOEL).
- **Risk Analysis**. Under this analysis, the dose levels calculated in the exposure analysis are compared to the NOEL levels to determine the effects of herbicides.

Concern has been raised about the collection and consumption of native herbs, medicinal plants, berries, etc., that could be inadvertently sprayed. The main concern appears to center on the increased risk of cancer that could result from exposure to low levels of an herbicide. All of the herbicides being considered for use have undergone testing for cancer, and all have been classified as Group E – chemicals that are conclusively non-carcinogenic, with the exception of triclopyr, which is Group D – not classifiable as to carcinogenicity. There are no epidemiology studies or case reports that demonstrate or suggest that exposure to any of the herbicides proposed for use in this document leads to cancer in humans (Durkin, 2001, 2003a &b; Klotzbach & Durkin, 2004a, b & c; Durkin & Bosch, 2004; & Durkin & Follansbee, 2003, 2004a, b & c).

The Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab and Prescott national forests, chapter 4, has a comprehensive section on herbicide impurities, surfactants, adjuvants, inert ingredients and dyes. It concludes none of these will have significant adverse effects on human health in the context, quantities and situations they will be used on the National Forests. With the exception of sethoxydim, the herbicides proposed in this EA are similar to those listed in the EIS for the Coconino, Kaibab, and Prescott national forests. Therefore, this document adopts the discussion in the EIS by reference (U.S.F.S., Feb 2004).

Most of the herbicides that will be used can cause skin and/or eye irritation, if not washed off after contact and if contact occurs before the products have biodegraded.

Studies by the California Environmental Protection Agency, Department of Pesticide Regulation, for tribal people who gather plant materials for food, medicinal, ceremonial, or basketry purposes show that triclopyr and glyphosate were detectable on buckbrush shoots and manzanita berries at 36 weeks after spraying (Segawa, et al., 2001). This study showed a low incidence of off-site movement of herbicide applied from backpack sprayers, with no residue from these two herbicides 80 feet from a treated area. Plants that are harvested by tribal communities will not be targets of herbicide applications, but they may be within a limited drift range of 80 feet. Prior to treatments being done, information on the timing and location of spraying will be provided upon request to individuals who want to avoid these areas. The Tonto NF will work with tribes to determine what type of notification each would like for projects involving the use of herbicides.

There is the possibility that a small percentage of the population in Arizona will be hypersensitive or allergic to one or more of the herbicides proposed for use. Symptoms exhibited by these individuals are caused by specific immunological reactions of the body that are triggered by exposure to very low doses of certain chemicals. Allergic or immunologic reactions result when the body’s normal immune system defenses overproduce antibodies to specific foreign substances. Allergenic or hypersensitive reactions occur by different mechanisms than toxicity. Toxic reactions result when chemical doses become high enough to interfere with normal physiological functions of cells and tissues. Individuals who have allergic reactions or hypersensitivity are generally aware of their sensitivities and such people would not be permitted to work on spray crews. In addition, signing of treatment sites and public notices would be done to allow concerned members of the public to avoid any possibility of exposure from the proposed herbicide applications.

In summary, the risk or probability of harm to humans from the proposed herbicides applications is not completely zero, but it is reasonable to expect that the human health impacts would be insignificantly small.

Comparison with Herbicide Projects from the 1960s

In reference to herbicide aerial spray projects that were conducted on the Tonto NF in the mid to late 1960s (discussed earlier in this section, "Short History of Herbicide Use on the Tonto NF"), several very important things have changed. First of all, the Environmental Protection Agency came into being in 1970. The EPA regulates pesticides under authority of the *Federal Insecticide, Fungicide and Rodenticide Act* (FIFRA). FIFRA was amended in 1972, with significant changes in how pesticides were to be regulated in the U.S. The 1972 amendment called for registration of all pesticide products used in the U.S., regular inspections of manufacturing establishments, the ability of the EPA to stop sales of hazardous pesticides, to conduct research on pesticides and monitor pesticide use and presence in the environment, and provided for certification of applicators and cooperative enforcement with the states. The EPA has banned two of the chemicals that were used in these spray projects – 2,4,5-T and Silvex. 2,4-D was also used in the 1965 to 1969 Pinal Mountain projects, and is one of the most common herbicides used in the U.S. today. It is not proposed for use in this project.

The *National Environmental Policy Act of 1969* (NEPA) created a requirement that all federal actions were to be evaluated in a process open to public review (see definition of NEPA in appendix B). Under NEPA, federal land management agencies must now conduct activities by formally analyzing the human and environmental consequences, asking the public for comments, and notifying the public of decisions.

Cumulative Effects

Over the nearly three million acres of the Tonto NF, a maximum of 9,000 acres (less than a third of one percent) will be treated with herbicide in any one year. Amount of herbicide that will be applied, in comparison with amounts applied in surrounding communities, by homeowners, local parks and private lands such as golf courses, is miniscule.

In the greater Phoenix area alone there are nearly 200 golf courses (Golf Publisher Syndications, 2005). In communities around the Globe RD, there are 15. There are four golf courses in Payson. One study, summarizing a survey of 77 golf courses in 2004, estimated that a total of approximately $4.7 million was spent for pesticides ($2.1 million of this was for herbicides) for the year 2004 (Schmitz, 2005). Another survey that requested more detailed information about types of herbicides used by golf courses in Arizona, was conducted in 1995 by the University of Arizona. Forty-seven golf courses responded to this questionnaire. Results showed these 47 courses used 9,425 pounds (active ingredient) of pre-emergent herbicides, and 3,598 pounds (active ingredient) of post-emergent herbicides, for a total of 13,023 pounds active ingredient annually (Merrigan, 1996). The most common herbicides used were glyphosate and 2,4-D products. Extrapolating these typical application amounts to the 219 golf courses in the approximate watershed area of the Tonto NF, 60,127 pounds of herbicide active ingredients would be applied in one year.

In 2000, there were 20,140 households in Gila County (Fedstats, 2005). In the 2000 Census, there were 1,048,526 households in large cities in the Phoenix metro area (Phoenix, Mesa, Apache Junction, Scottsdale, Tempe, and Gilbert). The EPA Annual Report of Pesticide Usage for 2001 (Kiely, 2004) documents that each household in the U.S. used approximately 1.7 pounds of herbicides (active ingredient) that year. Assuming each household only applied the average for home and garden use (which is probably an underestimate, since many homes are in rural settings), a total of 34,238 pounds of herbicide active ingredient were applied in Gila County in 2001; 1,782,494 pounds were applied in the Phoenix metro area. Not counting any public facilities or agricultural herbicide use, at least 1,876,859 pounds of herbicide active ingredient were applied in the area of watersheds of the Tonto NF in 2001. This does not include off-forest uses in adjacent communities in Pinal, Yavapai and Maricopa counties. By contrast, if the Tonto NF applied herbicides to the maximum acreage of 9,000 acres, the amount of active ingredient would range from 4,500 to 18,000 pounds, depending upon herbicide used. It is unlikely that 18,000 pounds of active ingredient of herbicides or more would be purchased in any one-year period due to practical considerations such as budget constraints.

With respect to safety of fire fighters, and toxicity of smoke to employees and the public from prescribed and wildfires in sites where herbicides have been applied, there have been several articles written recently. Studies conducted of the composition of smoke resulting from both wild and prescribed fires in areas that have been treated with a variety of pesticides indicate that, even under conditions of smoldering fires, no significant human health risks occur for pesticides incorporated into or on forest fuels. In fact, studies have found that naturally occurring chemical by-products of combustion are a far greater risk to human health (Bush, et al., 2000).

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

Currently human health on the forest is not influenced by either the spread of invasive plant species or efforts to control them. Minor skin irritation or allergic reactions may result from contact with thorny species. Though some people may be allergic to the pollen produced by invasive plants, it is unlikely that invasive plants have been the primary source of seasonal or long-term allergies.

Under this alternative, herbicides may still be used in small amounts in campgrounds, administrative sites, and Forest Service facilities, as determined in previous decisions. This use would be very limited, and sites scheduled for herbicide application would be posted five days prior; therefore, there would be minimal exposure to chemically-sensitive people. Prescribed fire would be conducted only for very small areas of less than ten acres; smoke production and its associated health effects under this alternative would be minimal.

The primary effect of the no action alternative will be the continued spread of invasive plants within the forest. This is expected to have little direct effect on human health and safety. In terms of indirect effects, an increase in the potential for wildfires can be predicted as buffelgrass, fountain grass and cool-season annual forbs and grasses continue to spread onto the forest and surrounding lands. A more frequent fire occurrence would result in indirect human health effects in the form of smoke in the inhabited areas within and around the forest, including the Phoenix metropolitan area.

Cumulative Effects

This alternative would probably add very little impact to human health to any other actions that are ongoing or likely to occur in the near future.

Alternative 2: Integrated Vegetation Management Except for the use of Herbicides

Direct and Indirect Effects

Impacts to human health and safety from mechanical and cultural treatments are likely to be minor. Possible effects include cuts, burns, allergies, and skin irritation to individuals performing the work. Skin irritations may result from contact with the sap or spines on the plants. Due to the uneven terrain in the vicinity of many of the treatment sites, minor injuries or falls may result. The use of personal protective equipment such as gloves, long sleeves, and boots should minimize this risk. The effects of smoke described under alternative 1 would likely occur under this alternative, except that larger prescribed burns would produce more smoke. Effects of this would be mitigated by following prescriptions in the burn plan written for each prescribed burn.

Effects to chemically-sensitive people and people gathering vegetation products from the forest would be basically the same as for alternative 1, except for the increase in acres of prescribed burns over that in the proposed action. A larger acreage (5,000 acres versus 2,000 acres in the proposed action) would result in more smoke put into the air.

Cumulative Effects

Same as for alternative 1, except increased use of prescribed fire to treat weeds may compete with forest health projects for days the Forest Service is allowed to burn and still meet air quality standards.

Heritage Resources

Affected Environment

The area of potential effect for heritage resources under this proposed action would be those archaeological and historic properties or sites that would be located within areas to be treated to control or eliminate noxious weeds.

There are approximately 9,000 recorded heritage sites on the Tonto NF, representing human occupation and use of the forest over a period of about 12,000 years. Hundreds more are being recorded every year, but it is estimated that these sites represent no more than ten percent of the total number present.

The range of site types on the Tonto NF is extensive and includes everything from surface artifact scatters representing temporary activities and sites with buried architectural features to ruined surface structures of adobe and stone masonry and standing historic structures. Inventory efforts over the last several years have identified weed infestations on or near several of them. Inevitably, more will be identified as inventory efforts expand.

The forest also contains a number of heritage sites and places that reflect traditional use by neighboring Tribes, particularly the Tonto, White Mountain, and San Carlos Apache Tribes and the Fort McDowell Yavapai Nation, and others with historic affiliation to the forest, such as the Yavapai-Apache Nation. As with the archaeological and historic sites, only a small percentage of these places are recorded and many of the locations are confidential. The Tribes have also identified a number of native plants available on the forest that are still used for food, medicine, and religious purposes, including Emory oak, piñyon, several agave species, various yuccas, sotol, yerba santa, and others. No specific places used for such plant collection were identified during scoping for this proposal, but efforts are ongoing to identify these sites through consultation with the affiliated tribes and through ethnohistoric research being conducted in partnership with the Tribes. Properties or sites having traditional cultural or religious significance to Tribes are considered heritage resources by the Forest Service and are accorded the same protections under the *National Historic Preservation Act* (NHPA) as archaeological or historic sites.

Environmental Consequences

Native American Plant Gathering Traditions

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Traditional tribal use of native plant species for medicinal and economic purposes is not generally considered public information by the practitioners, particularly when such plants and the locations where they may be collected or used are involved in sacred practices or ceremonies. Some information regarding these practices has been entrusted to the Forest Service only with the understanding that it is not disclosed to the public. As a result, such uses and the species involved are not discussed extensively here. That being said, in general, the removal of invasive species and the restoration of native plant communities will have a beneficial effect for Native American plant gathering activities, since traditional uses are, almost by definition, based on native species. However, traditional plant gathering sites may have a potential risk of impacts from herbicidal and fire-based treatments, if for no other reason than the relatively large scale of operations that could be undertaken under the proposed action. Conflicts with traditional practitioners and concerns for their safety in and around treatment areas may become important, though plant harvesting typically takes place during different seasons than those when herbicidal treatment is most effective, so such conflicts will be minimal. However, as more roads are targeted as vectors for the spread of invasives and may be closed seasonally or permanently, the potential for conflict in the form of denying access could develop.

The potential for impacts to traditional plant resource species from herbicidal treatments depends largely on the specificity of the chemical agents being used and the method(s) of application. Application of non-specific defoliants or herbicides, for example, may indiscriminately kill traditional economic species, but this will be minimized as more information is acquired about traditionally important species, allowing treatment planning to be adjusted so as to protect them. The potential for effects on the traditional practitioners themselves will depend on the toxicity of the chemicals to humans, but, given the chemical agents proposed for use and the mitigation measures required for their application, as discussed above, the risks are insignificantly small.

Most herbicides proposed for use are in the least toxic category rated by the EPA – "Relatively non-toxic." Some sites will be treated by broadcast sprays from ground vehicles; others will receive spot treatments from backpack spray units. In areas of known importance for traditional plant gathering, spot treatments could avoid certain plants and target others. Prescribed burns can also destroy traditionally used species depending on how they are designed and conducted. Properly done, however, prescribed fire can be used to both eradicate weeds and enhance the health and recruitment of traditionally important species, several of which are known to return in greater abundance after a fire.

While the viability of other medicinal and economic species may or may not be enhanced by fire, the reduction of competition with non-native species that can be achieved through the use of fire, manual removal, and biological, cultural and mechanical methods will increase the availability of species important to the Tribes in those areas where invasion by noxious weeds has taken hold.

Cumulative Effects

Cumulative effect on Native American traditional gathering activities is directly related to historic changes in the numbers and distribution of economically or religiously significant plant species. While specific changes to gathering sites over the last century or so since the indigenous occupants of the forest were relocated to reservations are not currently known, largely because such areas have never been fully inventoried or documented, it can be assumed that a variety of management activities and land uses have contributed to such change. Logging, grazing, mining, reclamation, land exchanges, homesteading, and construction of roads and trails all may have contributed to changes in the type, distribution, and access to traditional vegetation resources on the forest. Until additional information becomes available, it must be assumed that there has been some level of cumulative effect to traditional gathering areas.

The primary potential impact to traditional gathering areas resulting from the treatment of weed infestations would be the inadvertent loss of native species that might result from the use of prescribed burning or the application of non-specific herbicides. The effects would necessarily add to the cumulative effect of all previous use and management of forest vegetative resources. Once a stand of traditionally-valued native species is lost, the value of a gathering site is lost. Cumulative effects to these resources can thus be seen in terms of both deterioration of individual sites by reducing the number and diversity of plants located there and loss of actual numbers of sites. However, as long as appropriate safeguards are taken to identify and avoid these potential effects, the Proposed Action should not add to the cumulative effect on this resource in any way.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

Because the forest is still in the process of acquiring information, it is not yet known if the numbers or distribution of traditional plant gathering sites have been affected by weed infestations, but if such infestations are allowed to continue to grow, some displacement and replacement, especially of medicinal herb species, will be inevitable, thereby affecting the Tribes' ability to conduct traditional economic or religious activities on the forest. Also, as with the proposed action, traditional plant-gathering places can be significantly impacted by both herbicidal and fire-based treatment, depending on the specificity of the chemical agents being used and the method(s) of application. However, no known or suspected traditional gathering sites are located within the few areas identified under this alternative as acceptable for the application of herbicidal controls. Otherwise, the direct and indirect effects under this alternative are similar to those under the proposed action.

Cumulative Effects

As traditional gathering areas become infested, the potential for deterioration or loss without treatment grows over time. The obvious cumulative effect in this case would be to add to the historic loss of such areas and restrictions on the ability of Tribal practitioners to continue the use of traditional resources. Likewise, fire-based and herbicidal treatments have the potential to reduce the number and quality of such areas, but given the restricted use to which either treatment would be used under this alternative, the cumulative effect would be negligible.

Alternative 2: Integrated Vegetation Management Excluding Herbicides

Direct and Indirect Effects

Since the only significant difference between this alternative and the proposed action is the elimination of herbicidal treatments not already authorized and identified in alternative 1, the potential for impacts to traditional uses is reduced accordingly, but since these potential impacts are minimal, the effect is not significantly different from that for the proposed action.

Cumulative Effects

Cumulative effects under this alternative would be similar to those under the Proposed Action and alternative 1.

Archeological Resources

Affected Environment

Archaeological and historic sites are irreplaceable and individually unique. Their integrity is wholly dependent on the contextual relationship between artifacts, architecture, and the environment in which they are found. Once this context is disturbed, it cannot be recreated or restored. Prehistoric and historic archaeological sites are also, by their very nature, the result of a history of effects, the transformation processes of erosion, decay, and other disturbances that have reduced them from their original pristine state. Any effect to heritage resources, therefore, is cumulative; they cannot grow back and their populations cannot rebound. The effects of continued, untreated weed infestation in this context can be relatively minor. The most common direct effect is from root growth; it can be argued that invasive species have a potential to disrupt and destroy buried cultural deposits through root action. Obviously, native vegetation can also result in disturbance of this nature. On the face of it, then, this would seem minor and no different from the effects of native vegetative cover, but some of the invasive species of concern tend to have deep taproots and thus a greater potential for disruption than many shallow-rooted native species. The degree to which a weed infestation creates a significantly greater impact is therefore relative, depending on the density and nature of the vegetation and the characteristics of its root growth patterns. Often, the primary effect of weed infestation itself is indirect; changing the environmental context of prehistoric and historic site by replacing native species with invasives can indirectly affect their eligibility for nomination to the *National Register of Historic Places* by lowering their historic integrity. In many cases, the direct effect is negligible and short term because weed infestations can come and go and native species can recover or be reintroduced.

The same cannot always be said regarding the significant Tribal places used for traditional Native American plant-gathering activities. As weed infestations grow and crowd out native species, the opportunities to practice traditional gathering will become fewer and fewer until some or all have been lost. Because the forest is still in the process of acquiring information, it is not yet known if the numbers or distribution of traditional plant gathering sites have been affected by weed infestations, but if such infestations are allowed to continue unchecked, some displacement and replacement, especially of medicinal herb species, will be inevitable, thereby affecting the Tribes' ability to conduct traditional religious of economic activities on the forest. Nevertheless, determining the effect on traditional plant collection sites is situational and depends on the history of plant species composition and viability at each location. It is known, however, that some traditional gathering sites are associated with forest system roads, many of which pass through significant stands of economically or religiously significant species that are collected directly along the roadside. Based on the types of treatment proposed, conflicts may arise where such roads might be targeted for treatment.

Treatment of weed infestations can be equally situational and highly variable in effect. Some large-scale treatments covering many acres and multiple archaeological sites, such as prescribed burning, may have no effect at all. In other cases, even where the direct effect of a treatment is negligible and short term, such as in the case of hand pulling of small plants, repeated treatments may result in the complete disruption of a site's surface and near-surface cultural deposits. Nevertheless, as long as reasonable care is taken in their application, the effects of such treatments are considered to be minor in regard to prehistoric and historic archaeological sites. For this reason, Region 3 has developed a specific Protocol with specific measures for the protection of heritage resources during treatments for noxious weeds. This Protocol has been adopted herein as appendix H.

Environmental Consequences

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Based on thirty years observation of wildfires and prescribed burns, fire-based treatments such as those that would be allowed under this alternative cause no significant direct effects to archaeological or historic sites (Wood, 2005). The only exception would be those sites identified as "fire-sensitive," particularly historic sites containing or constructed of combustible materials such as wood. Such sites are routinely identified and protected whenever prescribed fires are planned. Indirect effects may result in an increased risk of erosion from temporary loss of ground cover; they are typically limited to artifact displacement and minor damage to surface structures during short term erosional episodes resulting from the loss of ground cover. However, this is generally a problem only when large areas are denuded as a result of the treatment, which is unlikely given the relatively limited extent of most infestations on the forest.

Mechanical or manual treatments, even the minor ones such as hand pulling and digging with hand tools allowed under the proposed action, probably have the highest potential to impact archaeological sites, especially when those sites consist of only surface artifact scatters and buried features. Mechanized treatments, especially those with heavy machinery, clearly have the potential to disturb the surface of such sites, displacing or damaging artifacts and architectural features, though the degree of impact depends on the type of machinery, type and density of vegetation, and soil conditions at the time of treatment. Even grubbing and digging up plants, especially those with deep taproots, with hand tools has the same potential to impact sites. Hand pulling of individual plants also has the same potential for impacting sites by displacing surface artifacts and disturbing near-surface buried cultural deposits; but generally, depending on the plant species and the specific soil conditions on site, for a one-time application of this method, the level of impact is considered to be more or less equivalent to the damage done from root growth of the many weed species if left untreated.

Herbicide controls, even at the relatively large scale of operation that would be allowed under the proposed action, have not been shown historically to impact archaeological and historic sites. Indirect effects can result from such actions where defoliants are used to reduce large area populations of brush species. As with fire-based treatments, they are typically limited to artifact displacement and minor damage to surface structures during short-term erosional episodes resulting from the loss of ground cover. However, just as with fire-based treatments, this is generally a problem only when large areas are denuded as a result of the treatment, which is unlikely given the relatively limited extent of most infestations on the forest.

Biological controls such as live insects or plant pathogens are not expected to have any effect at all upon any heritage resources.

Cultural treatments pose a threat to Heritage sites only when they might significantly alter their visual or biological context, that is, the vegetative landscape with which they are associated. Given the small scale of such treatments as are proposed here and the fact that they will tend to repair damage done to that context by the presence of invasives by replacing them with native species, such treatments are not expected to have any effect on heritage resource sites.

Targeted grazing by sheep and goats, a combination of biological and mechanical control methods, can have little or no effect on heritage resources or it can be devastating to them, depending on the intensity and duration of the application. At low intensities, there is little to recognize of their passing, but at high intensities these animals can strip areas bare of all vegetation, including desired native species, initiate gully erosion from repetitive hoof action, displace surface artifacts, disrupt architectural features, and even completely obscure sites under a dense mat of fibrous organic waste.

Cumulative Effects

Given that all prehistoric and historic archaeological sites represent a history of cumulative effects, any additional effect to such sites necessarily contributes to their overall cumulative effect. Because of this sensitivity and the irreplaceability of this resource, archaeological, and historic sites are protected from surface disturbing activities by avoidance or mitigation, typically by excavation/data recovery. Data recovery results in the destruction of the physical presence of the resource; it remains only “on paper” as collected artifacts and recorded information. Every site excavated adds to the cumulative loss of this resource. The preferred means of protection, therefore, is avoidance since it protects sites from immediate direct impacts and does not add to the cumulative effect on the resource as a whole. Indirect effects, primarily in the form of erosion, may result even for sites that have been avoided by the primary activities of a project. Nevertheless, since most projects are designed with various protections against large-scale erosion, this is generally considered only a minor addition to the cumulative effect of all projects on heritage resources.

The cumulative effects of continued weed infestation are considered to be minor compared to the full range of transformation processes that have affected these resources over the course of hundreds to thousands of years. Treatment of these infestations, unlike most other potentially disturbing activities that are designed to avoid heritage resources, may be called for within actual site boundaries.

Mechanical treatments within site boundaries, which would be limited to minimal impact procedures under this alternative, are not seen as having any more per-treatment impact than the effects of root growth if the weeds are left unchecked. Multiple treatments, however, have the potential to result in observable levels of surface disturbance and artifact displacement, but careful application of the procedures and employment of appropriate protection measures called for in the Heritage Resources Protocol would prevent even repeated treatments from contributing appreciably to the cumulative effect.

Fire-based treatments are among the few that are ever authorized within site boundaries. The reason for this is that they have little if any direct effect on most heritage resources; the cumulative effect of repeated burning would be minimal at best. Where fire-sensitive sites are involved, as long as they are protected during treatment, there is no cumulative effect. If they are affected by a fire-based treatment, it is usually the last effect that fire could have; burning them again will not constitute further damage. Fire-based treatments do have the potential to alter vegetative contexts of sites and produce indirect effects such as erosion, but on the scale of treatment proposed under this alternative, even the cumulative effect would be negligible.

Herbicidal treatments have the potential for contributing indirect effects such as erosion only from very large-scale application. Given the limited extent of treatment under this alternative, the potential for contributing to the cumulative effect to heritage resources is negligible.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

The same potential effects accrue to heritage resources under this alternative as under the proposed action. However, the much smaller scale of application for herbicide and prescribed burning treatments proposed under this alternative creates essentially no risk for post-treatment or indirect effects, such as increased erosion from large-scale removal of canopies and ground cover.

The fire-based treatments such as those that would be allowed under this alternative to control or eliminate weeds along SR 188, other system roads on the forest, and on the Pleasant Valley Administrative Site evidence no significant direct effects to archaeological or historic sites. The only exception would be those sites identified as “fire-sensitive,” particularly historic sites containing or constructed of combustible materials such as wood. The only known “fire-sensitive” sites within the specified treatment area under this alternative are the historic buildings that comprise a large part of the Pleasant Valley Administrative Site; these would be protected, since they are still in use. Indirect effects are also limited to an increased risk of erosion from temporary loss of ground cover; again, this is a problem only when large areas are denuded as a result of the treatment, which is unlikely given the restrictions on fire use under this alternative.

Herbicide controls at such a limited scale as those that would continue to be allowed under this alternative along state highways and in the Pleasant Valley Administrative Site, have not been shown historically to impact archaeological and historic sites. Indirect effects from such treatments are unlikely, given the small areas defined as acceptable for this form of control under this alternative.

Mechanical treatments, even the low-impact manual techniques such as hand pulling and digging with hand tools allowed under this alternative, probably have the highest potential to impact archaeological sites, especially when those sites consist of only surface artifact scatters and buried features. While no mechanized treatments are authorized under this alternative, hand grubbing and digging up plants – especially those with deep taproots - with hand tools has the same potential to impact sites, though perhaps at a smaller scale. Hand pulling of individual plants also has the same potential for impacting sites by displacing surface artifacts and disturbing near-surface buried cultural deposits but generally, depending on the plant species and the specific soil conditions on site, for a one time application of this method, the level of impact is considered to be more or less equivalent to the damage done from root growth of the many weed species if left untreated and is therefore not significant.

Cumulative Effects

Cumulative effects under this alternative would be similar to those under the Proposed Action.

Alternative 2: Integrated Vegetation Management Excluding Herbicides

Direct and Indirect Effects

Since the only significant difference between this alternative and the proposed action is the elimination of any herbicidal treatments not already authorized and identified in alternative 1, the potential for impacts to heritage resources is reduced accordingly. However, since archaeological and historic sites are not directly impacted in any way by the use of herbicidal treatments, the only potential reduction in effect levels lies in the area of indirect effects, as from increased erosion. Since those effects are already considered minimal under the proposed action, the overall potential for direct and indirect effects from this alternative is not significantly different from that for the proposed action.

Cumulative Effects

Cumulative effects under this alternative would be similar to those under the proposed action.

Developed and Dispersed Recreation Including Motorized Recreation

Affected Environment

Recreation on the Tonto NF began in the 1800s with the discovery of the Tonto Natural Bridge near Payson. Early visitors were using the lower Salt River as a popular recreation site in the 1890s. By 1920, a full-scale resort hotel had been built on the Verde River at Verde Hot Springs. As early as 1920, camping, hunting, and fishing activities were popular recreation activities on the Tonto NF due to the increased availability of motor vehicles and construction of better roads and new campgrounds.

Reclamation activities on the Salt and Verde Rivers brought new recreation opportunities as lakes were created behind newly constructed dams. Today, visitors to these areas can enjoy outdoor recreation facilities and services such as resorts, marinas, hunting and fishing guides, river running, horseback riding, off-highway touring, and tube rentals and shuttle services.

There are over 26,000 acres of man-made lakes in the desert portion of the Tonto NF. Roosevelt, Apache, Canyon, and Saguaro lakes are on the Salt River. Bartlett and Horseshoe lakes are on the Verde River. Seeking refuge from the summer heat, visitors flock to these rivers and lakes, as well as the trout streams and cool shades of the tall pines in the Mogollon Rim Country. Each year more than 8 million people visit the Tonto NF.

There are over 87 developed recreation sites on the Tonto NF. Each is managed for a variety of recreational activities including overnight camping, picnicking, fishing, and boating. Commercial and some non-commercial activities in both developed and dispersed recreation areas require a special use permit. This includes non-commercial group (groups of 75 or more people) and organized recreation events.

Outfitter/guides are required to have a special use permit when operating on Forest System lands. Along with the permit they are required to work with the forest officer to develop an Operating Plan that will guide their use of the lands. Highlighted in the Operating Plan are specific rules for operating in wilderness areas, basic field ethics, use of livestock, use of dogs, use of vehicles, overnight camping regulations, and campfire use. Operating Plans also inform the outfitter and guide of specific special orders pertaining to the areas they will be visiting.

Horseback riding is one of the most popular adventures enjoyed on the Tonto NF. Tonto NF trail crews maintain trails from wilderness areas to urban interface boundaries between the forest, counties, cities, and towns. During the summer months, outfitter/guides move to the tall pine country of the Mogollon Rim, which offers them year-round opportunities for horseback vacations and day ride services.

Mountain biking can be enjoyed year-round on the Tonto NF. High country routes afford beautiful views and escape from summer heat. Desert routes provide scenic variety and are well used during the winter months. Cyclists are required to ride on designated routes only and are encouraged to practice the land ethics included in the *Leave No Trace* program. There are hundreds of miles of roads on the Tonto NF that are suitable for mountain biking. They range from fairly-smooth one-lane roads to wheel tracks no longer suited for motor vehicles. Many roads have been or are in the process of being closed to motorized vehicles in order to protect certain wildlife and vegetation habitats. In many cases, these roads are accessible to bikers.

There is an extensive system of trails in some parts of the forest; however, most are steep and rocky and may not be suitable for biking. Many trails are located within designated wilderness areas where vehicular access of any type is prohibited.

Lower Salt River Recreation Area

One unique recreation area on the Tonto NF is the Lower Salt River Recreation Area. Phoenicians seeking a reprieve from the extreme summer heat flock to the cool waters of the Lower Salt River to enjoy a day of leisure.

The Lower Salt River is located approximately 16 miles east of Mesa, Arizona. It flows through the southern edge of the Tonto NF and the Salt River Indian Reservation near Fort McDowell. It is easily accessible as a day trip. A plethora of recreation activities can be enjoyed on this desert oasis consisting of 14 miles of navigable waters commencing at Stewart Mountain Dam and ending at Granite Reef Dam. It is rated a Class I to II River. The river meanders through a Sonoran Desert and riparian landscape and can be navigated year-round by paddling rafts, kayaks, or canoes. However, during the summer months thousands of people converge on the river to enjoy a day of fishing, floating the river on inner-tubes, and picnicking along the river and outer banks.

The season of day-use is typically from late April through late September. Overnight camping is allowed in designated recreation sites only from October through March. No motorized boats are allowed on the river.

Brome grasses, fountain grass, buffelgrass, saltcedar, and Malta starthistle are known to occur in the Lower Salt River Recreation Area.

Motorized Recreation

As the fifth largest forest in the United States and the second most visited forest, the Tonto NF has heavy motorized usage. The Tonto NF is situated directly north and east of Phoenix, the sixth largest city in the United States with approximately 1.5 million people and growing rapidly. The Tonto NF hosts a large portion of these people every weekend. Motorized recreation uses include: hunting, photography, camping, trail riding, scenic driving, wildlife viewing, accessing other recreational activities, and just getting away.

The Tonto NF has 3,476 miles of roads authorized for motorized recreation (Tonto NF, 2012). Of the Tonto NF's six ranger districts, four (Cave Creek, Globe, Mesa, and Tonto Basin) limit motorized usage to National Forest System roads and trails; however, on the ground management has not been possible due to limited funding. The other two ranger districts (Payson and Pleasant Valley) allow cross country travel. User-created routes, while not inventoried, account for several hundred miles of additional routes. This unmanaged motorized usage has also resulted in large areas of intensive use where vegetation is very limited or destroyed. The recent Forest Servicewide *Travel Management Rule* will require all forests to designate roads, trails, and areas for motorized usage. The implementation of this *Rule* will reduce adverse impacts of motorized recreation. The Tonto NF is in the process of analyzing a range of travel management plans. This analysis is being documented and will be available for public comment.

In addition the Tonto NF has many special use permits that include motorized access and usage such as outfitter/guides, "jeep tours," and off-highway vehicle skill events. These uses are limited to system roads and trails. Recreational groups, such as off-highway vehicle clubs/organizations consisting of groups larger than 75 people, are also required to obtain a permit for activities.

Non-motorized Recreation

The Tonto NF is one of the most-visited forests in the United States, receiving approximately 5.8 million visitors annually. Elevations on the forest vary from 1,300 feet to nearly 8,000 feet and offer year-round recreation opportunities. Most recreationists that visit the non-motorized areas of the Tonto NF are residents and visitors of the Phoenix metropolitan area.

Non-motorized recreation areas on the Tonto NF include both Congressionally-mandated wilderness and non-wilderness dispersed and developed recreation areas.

Non-motorized recreation activities in these areas include photographing, hiking, hunting, fishing, camping, wildlife viewing, horseback riding, rafting, kayaking, and canoeing.

The Tonto NF is responsible for the management of seven congressionally designated wilderness areas totaling over 589,000 acres. An eighth wilderness that lies on both the Tonto and Prescott national forests is managed by the Prescott National Forest. In addition, portions of the Verde River have been designated by Congress as Arizona's first and only Wild and Scenic River Area. These wilderness areas are managed to ensure public enjoyment, while protecting the unique natural character of these special places. The primary means of transportation in these Congressionally-mandated wilderness areas is by horse, raft, canoe, or foot.

There are 52 trailheads that allow access to 900 miles of National Forest System trails on the Tonto NF. Of the 900 miles of trail 618.25 are in wilderness and 281.75 are in non-wilderness areas. Many of these trails are used year-round by recreationists seeking a quiet retreat. Dogs are allowed in all parts of the Tonto NF; owners are required to adhere to federal, state, and county laws and regulations regarding pets in the areas visited.

Environmental Consequences

Proposed Action and Alternatives

The proposed action and alternatives may result in short term closures of roads, trails, or areas to treat invasive weeds and prevent spread of those weeds. As the *Travel Management Rule* is implemented and routes and areas are selected to be added to the authorized transportation system, they will need to be monitored for invasive weeds.

The proposed action and alternatives could potentially have a short-term effect on non-motorized recreation use on the Tonto NF in that recreational use of treated areas could be limited during treatments.

Appendix C, *Guide to Noxious Weed Prevention Practices*, includes measures that will prevent introduction and spread of noxious weeds by recreational activities permitted on the forest.

Specially Designated Areas

Affected Environment

Verde Wild and Scenic River

The Verde Wild and Scenic River is a unique and important resource in Arizona. Many people visit the Verde for its outstanding recreational opportunities including boating, hunting, fishing, birding, hiking, picnicking, and photography.

The Verde River is perennial throughout both the Scenic and Wild River Areas, though flow varies considerably during the year. Flows are affected by changes in precipitation, upstream diversions, ground-water pumping, and evaporation.

Two Bureau of Reclamation storage reservoirs are located near the Verde River's terminus on the Tonto NF (Horseshoe and Bartlett reservoirs). Water is stored in these reservoirs before being discharged into the Salt River for use by downstream municipal, agricultural, and industrial entities.

The Verde Wild and Scenic River encompasses 35.7 miles of classified Wild River and 29.5 miles of classified Scenic River for a total of 65.2 miles of Wild and Scenic River. This area encompasses 5,692 acres. Of this 683 acres of the Scenic River are on the Tonto NF. The Wild portion encompasses 6,824 acres of which 6,346 are on the Tonto NF.

Virtually the entire Wild River Area is within the Mazatzal Wilderness, which is the largest wilderness area (over 250,000 acres) in the Southwest.

The following restrictions apply within this wilderness (including the Verde Wild River Area):

1. The length of stay is no longer than 14 days,
2. group size is limited to 15 persons; and
3. no more than 15 head of livestock are allowed per group.

A maximum number of outfitter/guide permits available and a maximum number of customer-days have also been established in the Tonto Land and Resource Management Plan.

The Verde River can be floated year-round; however, its primary river-running season is during March and April. Because the amount of run-off is so unpredictable, a minimum optimal flow may provide a primary river-running season of 0 to 30 days. Currently no permit is required for private parties to run this river.

The Verde River has not been completely surveyed for presence of invasive plants, but the following plants on the Tonto NF noxious weed list are known to occur within the Tonto NF's Wild and Scenic River segments: Dalmatian toadflax, yellow sweetclover, tree of heaven, saltcedar, giant reed, Russian thistle, annual brome grasses, wild oats, and fountain grass.

A Comprehensive Management Plan for the Verde Wild and Scenic River was completed by the Tonto, Prescott, and Coconino NFs, and a decision signed to implement it in June 2004 (U.S.F.S., June 2004).

The Verde Wild and Scenic River Comprehensive River Management Plan Environmental Assessment states that "invasive plants would be selectively controlled, focusing on species such as saltcedar, which have the greatest impact on native species in both the Wild and Scenic sections" (U.S.F.S., June 2004). The Verde Wild and Scenic River Comprehensive River Management Plan further states that district rangers are responsible for inventory and mapping of invasive vegetation species along the river. It also states that an integrated pest management plan that identifies direction and priorities for inventory, management, and monitoring of invasive plant species will be initiated in 2006. The Coconino National Forest has begun a control program for *Arundo* and saltcedar on the Upper Verde River (mostly the Scenic reach).

Fossil Creek Wild and Scenic River

Fossil Creek is Arizona's second and newest designated Wild and Scenic River; of its nearly 18 mile length from its mouth at the Verde upstream to the confluence of Calf Pen and Sand Rock Canyons, 9.3 miles are designated "Wild" and 7.5 miles are designated "Recreational". From the early 1900s until 1999, power was generated by the constant 43 cfs flow of Fossil Springs and a system of flumes, a lake and a surge tank. Arizona Public Service shut down the power plants at Irving and Childs in 1999; in 2005 the hydropower plants were decommissioned and flow restored to the creek (USFWS, 2011b). Fossil Creek was designated Wild and Scenic by legislation in 2009 (U.S. Congress, 2009). Fossil Creek forms a portion of the boundary between the Tonto and Coconino NFs. A coordinated resource management plan is scheduled for completion in 2012 (Red Rock Country, 2011).

Arundo has been identified growing in the creek. The Coconino has controlled this invasive reed on their side of the creek. There are clumps of *Arundo* on the Tonto NF side that have not been controlled.

Wilderness

All wilderness areas on the Tonto NF have management plans. Each management plan addresses "non-indigenous" plants, a category of plant that includes invasive weeds. All of the Tonto NF's list of invasive plants are nonnative, but not all non-indigenous plants are invasive; thus the wilderness plans are describing a much broader category of plants.

Every wilderness management plan states that non-indigenous species can alter natural ecological process. Implementation actions to address nonindigenous plants are the same for all plans:

- Nonindigenous plant species not established at the time of the area's designation as wilderness shall not be brought into or introduced into the wilderness.
- Ongoing programs outside the wilderness may continue, so long as there is no invasion of nonindigenous plants into wilderness.
- Nonindigenous species now established in the wilderness will be extirpated as the opportunity presents itself. Removal methods will be compatible with the wilderness resource.

Upper Salt River Canyon Wilderness

A recent survey for invasive plants on the Upper Salt River documented only one kochia plant, which was actually on the Fort Apache Reservation, and a few tree of heaven saplings near the mouth of Pinal Creek. Saltcedar is a fairly common invasive plant along the entire Salt River (Fenner, 2005a).

According to the Implementation Plan for the Upper Salt River (dated October 31, 1985) management of recreation use on the river, will emphasize those uses which least impact the environment.

Four Peaks Wilderness

No weed surveys have been conducted in this wilderness area.

Hellsgate Wilderness

No weed surveys have been conducted in this wilderness area.

Mazatzal Wilderness

No weed surveys have been conducted in this wilderness area.

Pine Mountain Wilderness

No weed surveys have been conducted in this wilderness area.

Salome Wilderness

A management plan for this wilderness was approved by the forest supervisor in 1993.

No weed surveys have been conducted in this wilderness area.

Sierra Ancha Wilderness

A management plan for this wilderness was approved by the forest supervisor in 1993.

No weed surveys have been conducted in this wilderness area. An early management plan for the Sierra Ancha Wilderness, written in the early 1970s includes a plant species list. Plants on the Tonto NF noxious weed list found at that time are: Russian thistle, field bindweed, black mustard, wild oats, Japanese brome, red brome, cheatgrass, and yellow sweetclover. Puncturevine, a weed on the state noxious weed list, was also found.

Superstition Wilderness

A management plan for this wilderness was approved by the forest supervisor in 1992.

No weed surveys have been conducted in most of this wilderness area. Fountain grass is invading the National Forest from the area of Lost Dutchman's State Park. As of 2008, this infestation was moving up a drainage and was very near the wilderness boundary.

A 1972 Wilderness Management Plan included a list of plant species. Plants on the current Tonto NF noxious weed list, that were found in the Superstition Wilderness at that time include: red brome, cheatgrass, weeping and Lehmann's lovegrass, yellow sweetclover, saltcedar, Mediterranean grass, and Russian thistle. Puncturevine, a forb on the Arizona state noxious weed list was also found.

Sierra Ancha Experimental Forest

The Sierra Ancha Experimental Forest is a field facility of the Rocky Mountain Forest and Range Experiment Station. The Station Director in Fort Collins, Colorado, is responsible for all research on the Experimental Forest. This 12,820-acre area was designated in its present conformation in 1938, and has been used for various forest-related research studies, including watershed, chaparral, and range management, soils, plant physiology, and animal and plant ecology studies (Tonto NF 1932 & 1938). It is now managed under a Memorandum of Understanding with the Arizona Board of Regents to share responsibility for the facility with Arizona State University (Tonto NF, 1983). Any undertaking regarding treatment of invasive plants would need to be coordinated with both Arizona State University and Rocky Mountain (Gottfried, 2005).

Three Bar Wildlife Area and Experimental Watersheds

The Three Bar Wildlife Area, on the east side of the Mazatzals, west of Tonto Basin, was created, and excluded from domestic grazing in 1947. The Three Bar Experimental Watersheds (there are four of them, each less than 100 acres), within the Wildlife Area, were established and instrumented in 1956 by the Rocky Mountain Forest and Range Experiment Station, in order to study the ecology and hydrology of the chaparral vegetation type. Their research mission was to determine effects of chaparral conversion to grassland on water yield, erosion, and game populations. Hydrologic evaluations on the Three-Bar watersheds were discontinued in 1983. The

Three-Bar Wildlife Area remains ungrazed and provides a study site for wildlife studies and for monitoring by the Arizona Game and Fish Department (RMFRES, n.d.).

Research Natural Areas

In the 1970s and 80s, the forest selected certain areas for designation as Research Natural Areas (RNAs) to contribute to a series that "illustrates or typifies for research or educational purposes the important forest and range types in each forest region, as well as other plant communities that have special or unique characteristics of scientific interest and importance" (*36 CFR 251.23*) A November 4, 2005, FSM amendment gives "Protection and Management Standards" for these areas. FSM 4063.3 (1) states that maintenance of natural ecological processes and conditions are the prime consideration in managing RNAs. "To the extent practical, protect RNAs against human activities that directly or indirectly modify the integrity of the ecological processes." More specifically, with regard to exotic plants and animal life, "Remove exotic plants or animals to the extent practicable. Where pest management activities are prescribed, they shall be as specific as possible against target organisms and induce minimal impact to other components of the ecosystem. The release of biological control organisms for exotic species control should be carefully considered to avoid the introduction of other exotic species" (FSM 4063.3(4).

Buckhorn Mountain RNA was designated in 1988 to provide an example of Arizona chaparral for the series of forest and range types in the RNA system. It is 2,810 acres west of Roosevelt Lake, near the top of the watershed divide and above the Three Bar Wildlife Area. The area has been closed to grazing since 1946, and rough terrain precludes motorized use or fuelwood harvest. Two thirds of the area is within the Four Peaks Wilderness (Tonto NF, 1988).

Bush Highway RNA is 488 acres approximately one mile east of the Bush Highway and one mile south of the Beeline Highway. It was designated in 1973 by the Chief of the Forest Service to represent typical palo verde-cactus shrub vegetation type. It is located within the Sunflower Grazing Allotment, which has been grazed by livestock since the 1870s. Although it has not been grazed in recent years due to drought, it is not closed to grazing.

Haufer Wash was selected as an example of relatively undisturbed semi-desert grassland and desert scrub vegetation. This 680-acre RNA is located within the fenced Three Bar Wildlife Area, and has been excluded from grazing by domestic livestock since the early 1930s. The Decision Notice that created this RNA was signed by the Chief on November 17, 1993. A plant survey conducted for purposes of environmental assessment in the spring of 1985 identified Malta starthistle as being present.

Blue Point Botanical Area is 475 acres located 2 miles upstream of the Salt/Verde River confluence, mainly in the Salt River floodplain. The river terrace is occupied by a mesquite bosque. Cottonwood, saltcedar, cattail, and arrowweed occupy the floodplain. A bursage/saguaro/palo verde community grows in the northern portion of the Botanical Area. The grazing allotment that surrounds this area discontinued grazing in 1978, and has now been formally closed to grazing. Prior to 1978, it had been heavily grazed by cattle, since the late 19th century (Tonto NF, 1979). Management objectives are to manage an area where natural processes are dominant, enhance rare and endangered species of plants and animals, maintain a high quality botanical area, and provide for scientific and educational studies of plants, animals, and ecological relationships. Seasonal grazing may be used as a tool to achieve the area's objectives (Tonto NF, 1979).

Inventoried Roadless Areas

The Tonto NF has identified six percent of the forest as Inventoried Roadless Areas, approximately 170,000 acres. These areas are managed to protect roadless values and characteristics and may be considered for recommendation for permanent wilderness designation. These unique areas provide both motorized and non-motorized recreational opportunities. Since these areas may be considered for permanent wilderness designation, the roadless characteristics must be maintained along with other possible wilderness characteristics. Proposed road work (maintenance, construction, etc.), timber harvesting, or roads associated with minerals is under the authority of either the regional forester and/or the Forest Service Chief.

Environmental Consequences

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

All wilderness management plans state that control of "non-indigenous" plants will be done using methods compatible with the wilderness resource. Prescribed fire is not allowed in wilderness areas. Use of herbicides in wilderness areas must be approved by the regional forester. No large infestations are known at this time, so control actions are expected to be very limited manual methods or spot herbicide applications.

Cumulative Effects

Other activities on the forest are bound to eventually bring in invasive plants. Under the proposed action, infestations will be detected and controlled early enough such that extensive treatments would not be necessary. Prevention and education are key components of Integrated Vegetation Management that are especially appropriate to wilderness areas. Implementation of a weed-free hay order would help to prevent new infestations from this vector.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

The forest will monitor wilderness areas for invasive plants, as funding allows. Any weeds would have to be treated by hand. If these weeds are perennial plants, manual control may not be very successful, and infestations would grow.

Cumulative Effects

Same as for the proposed action, except manual treatments alone may not be adequate to control some invasive species.

Alternative 2: Integrated Vegetation Management, Excluding Use of Herbicides

Direct and Indirect Effects

Effects would be the same as for alternative 1.

Wild and Scenic River (and also the Salt River, Evaluated for Designation as Wild/Scenic)

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Saltcedar is the main invasive plant growing along both the Salt and Verde rivers. Use of the cut-stump herbicide method of control will leave evidence of treatment for up to 3 years following treatment.

On the Verde River, removal of saltcedar, which grows as occasional sapling trees within a healthy cottonwood/willow riparian community, will not affect visual quality. In fact, control of saltcedar on the Verde River will not be evident to the casual river runner.

Most of the Upper Salt River does not have floodplain habitat adequate for development of native riparian trees such as cottonwood and willow. High concentrations of salt in this river may also be a factor that precludes native riparian trees such as cottonwood and willow from establishing. Removal of saltcedar would have little positive effect here for releasing habitat for native vegetation. Native vegetation along the Salt River is less dense than saltcedar, and also does not extend as far from the water's edge away from the river. Most benefit would be realized from making campsites more accessible to boaters.

Cumulative Effects

Control of saltcedar on either river would need to be coordinated with upstream land managers, in order to be successful.

Removal of saltcedar from both the Upper Salt and Verde rivers will result in a lowered risk of wildfire in the riparian area. Southwestern willow flycatchers that nest at the inlet to Horseshoe Lake on the Verde River have nested mainly in both saltcedar and in native willows. Removal of saltcedar in that area will lessen risk of wildfire in this endangered bird's nesting habitat. Removal of saltcedar at the mouths of Tonto Creek and the Salt River into Roosevelt Lake is not feasible, due to the fact that it is nesting habitat for the Southwestern willow flycatcher and there is no suitable native vegetation there to replace it, if removed. Nesting areas in saltcedar thickets are extremely vulnerable to damage or loss from wildfire, but fluctuating lake levels create a situation where native riparian trees will not establish and grow to create flycatcher nesting habitat.

A biocontrol agent for control of saltcedar, *Diorhabda elongata*, has spread into northern Arizona from introductions in Utah. This beetle is moving faster than originally thought, is working its way down the Virgin and Colorado Rivers, and has now been identified in the Little Colorado River. It is probably only a matter of time until it reaches large rivers with saltcedar on the Tonto NF. It may be prudent to begin a program of removing saltcedar in a slow and controlled fashion so that native species can gradually move in to replace them and ecosystems will not suffer undue disruption when the beetle arrives.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

Manual removal of saltcedar along rivers is futile due to the nature of saltcedar reproduction and extensive root system. Saltcedar growing along the Verde River will become denser, eventually crowding out native riparian vegetation. Conditions along the Upper Salt River probably will not change.

Cumulative Effects

Current grazing management along the Verde River allows for nesting habitat for all types of subtropical migratory birds to develop between scouring flood events. If saltcedar is not removed, it provides a seed source that readily seeds new silt bars created by flooding. Dense saltcedar thickets will increase flammability of riparian vegetation along the river, decreasing native riparian vegetation communities.

Alternative 2: Integrated Vegetation Management, Excluding Use of Herbicides

Same effects as for alternative 1.

Research Natural Areas, Blue Point Botanical Area, and the Sierra Ancha Experimental Forest

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Since these areas were designated to represent various vegetation communities, it is essential to control invasive species, if they are to retain the characteristics for which they were selected. This action is the most effective for removal of invasive species in all vegetation types. It allows for the best custom-fit of treatments for specific weeds in specific vegetation types.

With an emphasis on early detection, removal of infestations when they are first found and hopefully small in size, management actions will have no impact on native vegetation. If infestations are not found in a timely manner, restoration with native species will be done.

Cumulative Effects

Studies being conducted in RNAs could be affected by invasive plant management actions. Prior to conducting any weed management actions, the Tonto NF will communicate with appropriate personnel at Rocky Mountain Forest and Range Experiment Station, to determine if there are any ongoing studies in the area that is proposed for treatment. Forest activities within RNAs are limited, so cumulative effects are limited to effects of the proposed action and alternatives on invasive weed infestations.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

Character of RNAs may be modified by infestations of invasive weeds, rendering the RNAs unsuitable as representative areas for various vegetation communities. Current management has proven to be inadequate to control some species, such as starthistles and Russian knapweed.

Extensive wildfires that have burned large areas of Sonoran Desert in the last few years will eventually change the character and species composition of the Sonoran Desert, if management of invasive species continues at its current slow pace.

Cumulative Effects

Studies being conducted in RNAs could be affected by invasive plant infestations. On the other hand, studies could also be affected by invasive plant management actions, as for the proposed action. Cumulative effects are limited, as discussed in the cumulative effects section for the proposed action.

Alternative 2: Integrated Vegetation Management Excluding the Use of Herbicides

Direct and Indirect Effects

While this alternative offers more options for controlling invasive plants than alternative 1, there are some species of plant that will only respond to herbicidal treatment. Perennial plants may be set back by biological controls and actions such as repeated burning, mowing, or grubbing; but unless a systemic herbicide kills underground root reserves of carbohydrates, the plant will survive. Repetition of these control methods may change the vegetation community, since prescribed fire may not target the invasive plant as well as an herbicide might. Also, with fire or mechanical control methods, erosion may be increased, resulting in a loss of soil productivity, and ultimate change in the plant community.

Cumulative Effects

Same as for alternative 1.

Inventoried Roadless Areas

Environmental Consequences

As with motorized recreation, the proposed action and alternatives may result in short term closures of trails or areas to treat invasive weeds and prevent spread of those weeds.

Environmental Justice

Affected Environment

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, requires federal agencies to identify and address any disproportionate adverse human health or environmental effects of its projects on minority or low-income populations. According to this Executive Order, each federal agency must conduct its programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons or populations from participation in, denying persons or populations the benefits of, or subjecting persons or populations to discrimination because of their race, color, national origin, or income level.

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, directs federal agencies to identify and assess environmental health risks and safety risks that may disproportionately affect children.

Table 15. Minority population and persons living below poverty level in the area of the Tonto National Forest

Location	Minority persons (% of entire population)	Persons living below poverty level (% of entire population)
Gila	22.2	17.4
Maricopa	22.6	11.7
Pinal	29.6	16.9
Yavapai	8.1	11.9
State of Arizona	24.5	13.9
United States	22.9	12.4

Environmental Consequences

Proposed Action: Integrated Vegetation Management

Direct and Indirect Effects

Many people in Gila and Pinal Counties live a rural lifestyle; a number of those people have livelihoods that depend upon productivity of their land and public lands on which they have permits. They are by no means the majority of people in Gila County or of any other county on the Tonto NF; but these Executive Orders were enacted to protect minorities such as these. Inaction on the part of either the Forest Service or adjacent landowners with regard to invasive plant control extends the life of invasive plant populations and lowers ecological values on both sides of the fence. The proposed action addresses environmental justice for that minority of people, whose living is made from public and private land.

Alternative 1: No Action (continue ongoing treatments)

Direct and Indirect Effects

The result of implementing this alternative is that weeds will continue to grow out of control. Invasive plants will spread onto private lands in spite of private landowners' efforts to control them.

Alternative 2: Integrated Vegetation Management Excluding the Use of Herbicides

Direct and Indirect Effects

This alternative will not effectively suppress spread of some weeds. Effects of implementation of this alternative are intermediate between the proposed action and the "No Action" alternative.

Chapter 4 - Consultation and Coordination

The following Forest Service employees served on the interdisciplinary team to complete the analysis for this project:

ID Team Members:

Name	Title	Responsibility
Patti Fenner	Forest Noxious Weed Program Manager	ID Team Leader, Invasive plants, herbicides, federally-listed plants, effects to human health, environmental justice
Norm Ambos	Forest Soil Scientist	Soils, Vegetation communities
Bob Calamusso	Forest Fisheries Biologist	Aquatic wildlife species
Emily Garber	Forest Special Uses Specialist	Special Uses
Karyn Harbour	Forest Mineral Specialist	Mining activities
Mike Henderson	Pleasant Valley Ranger District Fuels Program	Fire
Connie Lane	Recreation/Lands Staff, Globe Ranger District	Non-motorized recreation, wilderness
Steve Lohr	Forest Wildlife Biologist	Wildlife
Don Luhrsen	Forest Range Program Manager (fall 2005 to 2009)	Range management
Buck McKinney	Forest Range Program Manager (through fall 2005)	Range management
Kathy Nelson	Forest Watershed Assistant	Water quality
Vinnie Picard	Forest Public Information Officer	Public involvement plan
Tammy Pike	Forest OHV Specialist	Motorized recreation, Inventoried Roadless Areas
Mike Ross	Forest Wildlife Biologist (retired 2005)	Wildlife, federally-listed species
Scott Wood	Forest Archeologist	Cultural and archaeological resources
Candy Luhrsen	Forest Writer-editor	

The Forest Service consulted the following individuals, federal, state and local agencies, tribes and non-Forest Service persons during the development of this environmental assessment:

Federal and State Officials and Agencies

City of Apache Junction Parks & Rec. Dept.
Town of Carefree
Town of Cave Creek
Town of Fountain Hills
City of Globe
Town of Miami
Town of Payson
Pleasant Valley Community Council
City of Scottsdale
Town of Superior
Tonto Hills Community Association
Chino Winds Natural Resource Conservation District
East Maricopa Natural Resource Conservation District
Tonto Natural Resource Conservation District
Winkelman Natural Resource Conservation District
Arizona Assoc. of Conservation Districts
Apache County Development & Community Services Dept.
Gila County Board of Supervisors
Gila County Cooperative Extension
Gila County Planning/Zoning
Gila County Sheriff's Department
Maricopa County Board of Supervisors
Maricopa County Cooperative Extension
Pinal County Board of Supervisors
Verde Natural Resource Conservation District
Yavapai County Board of Supervisors
Yavapai County Cooperative Extension
Arizona Assoc. of Counties
Central Arizona Council of Governments
Arizona Dept. of Agriculture
Arizona Commission of Agriculture & Horticulture
Arizona Dept. of Environmental Quality
Arizona Game & Fish Department
Arizona House of Representatives
Office of Governor Napolitano
Office of the Attorney General
Office of Senator John Kyl
Office of Senator John McCain
Arizona Dept of Transportation
Arizona State Parks
Arizona State Land Department
Arizona State University
University of Arizona
University of Arizona at NAU
Arizona Office of Tourism
Arizona State Mine Inspector
Arizona State Treasurer
Boyce Thompson Arboretum
Agua Fria National Monument
Animal & Plant Health Inspection Service
Bureau of Indian Affairs
Bureau of Land Management
Bureau of Reclamation
Tonto National Monument
U.S. Army Corps of Engineers
U.S. Fish & Wildlife Service
Federal Highway Administration
International Assoc. of Fish & Wildlife Agencies
Arizona Public Service
Central Arizona Project
Salt River Project

Tribes

Ak-Chin Indian Community
Fort McDowell Yavapai Nation
Gila River Indian Community
Hopi Tribe
Salt River Pima-Maricopa Indian Community
San Carlos Apache Tribe
Tohono O'odham Nation
Tonto Apache Tribe
White Mountain Apache Tribe
Yavapai-Apache Nation
Yavapai-Prescott Indian Tribe
Zuni Pueblo

Others

Scoping list available upon request.

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