United States
Department of
Agriculture

Forest
Service

June 2007

Environmental Assessment

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 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 National Forest, Arizona. (see maps, Appendix B) 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 a complete integrated vegetation management approach to the management of invasive species. Monitoring, prevention, education and cooperation with other land managers are incorporated into this alternative. The Forest would use a complete range of methods to eradicate or contain and control populations of invasive species: manual, mechanical, burning/flaming, cultural, biological control agents, and herbicides.

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 National Forest to continue. 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 would be used 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.
- Whether the project requires a Forest Plan amendment.

INTRODUCTION

Document Structure

The Tonto National Forest has prepared this Environmental Assessment in compliance with the National Environmental Policy Act and other relevant Federal and State laws to determine the most appropriate methods to implement integrated treatment of noxious or invasive weeds. For the purposes of this document, the term "weed" will refer to non-native plants in the project area whose introduction does or is likely to cause economic or environmental harm or harm to human health (Federal Register 1999). This Environmental Assessment discloses the direct, indirect, and cumulative environmental impacts of weed treatment techniques that would result from the proposed action and alternatives. These weed treatment techniques will provide the Forest with the tools to implement an integrated weed treatment program. The following information on the proposed action and alternatives is provided for comment:

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 informed the public of the proposal and how the public responded.

Comparison of 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.

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

Background

The National Invasive Species Council defines "invasive species" as a species that is 1) non-native (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).

Arizona Administrative Codes R3-4-244 & R3-4-245 (Arizona Dept of Agriculture 1999) 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 recent director of Arizona's noxious weed program uses five biological criteria to describe noxious weeds: 1) exotic, 2) invasive, 3) competitive, 4) persistent, and 5) aggressive. (Northam 2004)

Invasive weeds first came to the attention of the Tonto National Forest in the mid-to late 1980's 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 National Forest have amounted to 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. The first large-scale project was a prescribed burn of Malta starthistle along Highway 188. This infestation was possibly first introduced in the mid-1980s, and had already spread significantly beyond the right-of-way in 2003. Projects since that time have included one follow-up to this burn, other prescribed burns, and manual grubbing of weeds in many other locations. Funding levels have been very 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.

Projects of the scale and type we have conducted have not been adequate to prevent weed infestations from growing. The wet winter and spring of 2004-2005 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 districts.

The Tonto has not been intensively surveyed for noxious weeds. Populations of some noxious weeds have been known for nearly 20 years, and have spread considerably since they were first identified. Others are still being found in small infestations. Opportunities such as post-wildfire long-term rehabilitation funding have been used to complete more extensive surveys and control new infestations. Both long-term and Burned Area Emergency Rehabilitation funds have been used to conduct weed surveys in the areas of the Rodeo-Chediski, Picture, Willow, Diamond, Webber, and Cave Creek fires.

Much of the Tonto's efforts in the weed management program have been directed toward education and awareness of our own 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 common weeds on the Tonto. 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 works 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. The Tonto assisted in grant writing 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.

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 National Forest, and to prevent new infestations from becoming established. A list of species to be addressed by this action is included as Table 1. 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.

Existing Condition

While most infestations on the Tonto are at low population levels now, in very little time, they can grow beyond any control efforts, as evidenced many times in many other places. For example, spotted knapweed was introduced into Montana in the 1920's – 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 replace native grasses and forbs used by deer, turkey, elk, and many other native wildlife species, and are not used by any 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 will promote 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 invasive plant species have increased dramatically in abundance on the Tonto and in areas surrounding the Tonto National Forest over the last several years. Twenty years ago, very few acres were infested by invasive plants. At about that time, yellow starthistle and diffuse knapweed were discovered on private land in the town of Young. (Cline 2004) Today there are an estimated 10,000 acres of yellow starthistle in Gila County alone. Twenty 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 Districts. Malta starthistle has been identified growing throughout the Phoenix, Scottsdale, Cave Creek/Carefree, Tempe, Gisela, Superior, Apache Junction, Mesa, and Punkin Center areas, 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.

Although there are fewer acres of weeds on the Tonto National Forest than on many others in the west, weed populations are growing rapidly here. History has repeatedly demonstrated that invasive weed populations do not remain small for long. Growth rates are typically exponential, with an apparent lag time between initial infestation and subsequent extensive infestations that are beyond control.

Maps with known locations of noxious and invasive plants are included as Appendix B.

Invasive Plant Species

The following are names and descriptions of plant species that are invasive on the Tonto National Forest, or that grow nearby and are likely to infest the Tonto over the next 10 years.

Nomenclature 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).

For definitions of weed categories, refer to the explanation in the caption of Table 1.

Table 1. List of Invasive Plant Species for the Tonto National Forest

Latin name	Common name	AZ Dept. of Agriculture Weed List*	APHIS Weed List	On neighboring states' weed lists?	Tonto category**	AZ-WIPWG class ***
Acroptilon repens	Russian knapweed	P, Res.		CA, CO, NM, NV,UT	A	H
Aegilops cylindrica	Jointed goatgrass	P, Res.		CA, CO, NM	B	L
Ailanthus altissima	Tree of heaven				C	
Alhagi maurorum	Camelthorn	P, Res.		CA, CO, NM, NV,	A	M
Arundo donax	Giant reed				B	H
Asphodelus fistulosus	Onionweed		x	NM	A	L
Avena fatua	Wild oats			CO	C	M
Brassica nigra	Black mustard				B	
Brassica tournefortii	Asian mustard				C	M
Bromus catharticus	Rescuegrass				C	
Bromus diandrus	Ripgut brome				C	M
Bromus japonicus	Japanese brome				C	
Bromus rubens	Red brome				C	H
Bromus tectorum	Downy brome			CO	C	H
Cardaria draba	Globe-podded hoary cress	P, Res.		CA, CO, NM, NV UT	A	M
Cardaria pubescens	Hairy white-top	P		CA,	A	M
Carduus acanthoides	Plumeless thistle	P		CA, CO	A	
Carduus nutans	Musk thistle			CA, CO, NM, NV, UT	A	M
Cenchrus echinatus	Southern sandbur	P, Reg.		CA,	A	
Cenchrus spinifex	Field sandbur	P, Reg.		CA,	A	
Centaurea biebersteinii	Spotted knapweed	P, Res.		CA, CO, NM, NV, UT	A	M
Centaurea diffusa	Diffuse knapweed	P, Res.		CA, NM, NV, UT	B	M
Centaurea melitensis	Malta starthistle			NM, NV	C	M
Centaurea solstitialis	Yellow starthistle	P, Res.		CA, CO, NM, NV, UT	C	H
Chondrilla juncea	Rush skeletonweed	P		CA, CO, NV	A	M
Chorispora tenella	Blue mustard			CA, CO	A	
Cirsium arvense	Canada thistle	P		CA, CO, NM, NV, UT	A	M
Cirsium vulgare	Bull thistle			CO, NM	C	

Latin name	Common name	AZ Dept. of Agriculture Weed List*	APHIS Weed List	On neighboring states' weed lists?	Tonto category**	AZ-WIPWG class ***
Convolvulus arvensis	Field bindweed	P, Reg.		CA, CO, NM, UT	C	M
Dimorphotheca cuneata	White bietou				A	
Dipsacus fullonum	Common teasel			CO, NM	B	
Eleagnus angustifolia	Russian olive			CO, NM	A	H
Elymus repens	Quackgrass	P, Res.		CA, CO, UT	B	L
Eragrostis curvula	Weeping lovegrass				C	L
Eragrostis Lehmanniana	Lehmann's lovegrass				C	H
Euphorbia esula	Leafy spurge	P		CA, CO, NM, NV, UT	A	H
Euryops subcarnosus	Sweet resinbush				A	H
Isatis tinctoria	Dyer's woad	P		CA, CO, NM, NV, UT	A	
Kochia scoparia	Kochia				A	
Leucanthemum vulgare	Oxeye daisy			CO	A	L
Linaria dalmatica	Dalmatian toadflax	P, Res.		CA, CO, NM, NV	A	M
Linaria vulgaris	Yellow toadflax			CO, NM, NV	A	M
Lythrum salicaria	Purple loosestrife	P		CA, CO, NM, NV, UT	A	
Melilotus officinalis	Yellow sweetclover				C	M
Nerium oleander	Oleander				B	
Oncosiphon piluliferum	Globe chamomile				B	
Onopordum acanthium	Scotch thistle	P, Res.		CA, CO, NM, NV, UT	B	L
Peganum harmala	African rue	P		CA, CO, NM, NV	A	
Pennisetum ciliare	Buffelgrass	P, Reg.			C	H
Pennisetum setaceum	Fountain grass				C	H
Pentzia incana	Karoo bush				A	
Polygonum cuspidatum	Japanese knotweed			CA,	A	
Potentilla recta	Sulfur cinquefoil			CO, NV	A	
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	

Latin name	Common name	AZ Dept. of Agriculture Weed List*	APHIS Weed List	On neighboring states' weed lists?	Tonto category**	AZ-WIPWG class ***
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	Salt cedar			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.

Description and other information about these plants can be found in Appendix A.

Desired Condition

The following narrative was developed to describe the desired condition for the Forest at the end of 10-year term of the program:

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

Consistency with Forest Plan Goals and Objectives

The Tonto Land and Resource Management Plan (USDA Tonto National Forest 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 National Forest 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 not adapted to frequent fires, 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 star thistles, 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 out-compete native wildflowers, 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 (2005-2015).
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 to 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, enhance riparian ecosystems."

Soil stability, water quality and quantity 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 U.S.C. 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 also 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 U.S.C. 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 Non-native Invasive Plant Management" (U.S.D.A. 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. (Fed. Reg. 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 appears to anticipate such use by establishing approval standards at 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.

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 National Forest is within Gila, Maricopa, Pinal and Yavapai Counties, and comprises a total of 2,873,300 acres. Known noxious weed infestations cover only a small percentage of the total National Forest acres, but new infestations could be found anywhere within the nearly 3 million acres of the Forest.

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, 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

The proposed invasive plant management program provides direction for noxious weed management activities on the Forest for the next 10 years using an adaptive management approach. Adaptive management is a strategy that allows decision makers to take advantage of new information as it becomes available after a decision has been made.

Weed infestations are dynamic; even the most complete inventory will never cover the actual infested area 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 all the usual vectors of spread, and will be detected through monitoring. 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. The Forest would respond to these new infestations by completing a site specific review 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 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 product is available, the new product could be considered for use. Analysis would be accomplished to determine whether 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 the original 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 would 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 focuses on 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 category column).

There will be three types of monitoring, described below:

Implementation Monitoring
Annual reports will be submitted to the Regional Office to verify that actions are taking place as described in this environmental document. 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 things 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 report to the Regional Office.

Project Effectiveness Monitoring
Monitoring of weed spread and/or suppression will be aided by analysis of an existing 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 compare against future acreage calculations to document the effectiveness of each type of treatment. Yearly treatment summaries will be used to assess weed spread. After 5 years, inventories will be reviewed to compare with the inventory at project initiation. 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 persons with multiple chemical sensitivity who have provided comments and would like followup contact, 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 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 will be evaluated in Chapter 4 and in Risk Assessments..

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 would be applied to minimize the 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 whether biocontrol agents are able to survive and successfully reproduce under the environmental conditions of the project area.

Decision Framework

Given the purpose and need, the Forest Supervisor of the Tonto National Forest 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 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.

Whether 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 Forest Supervisor will document the decision and rationale for selection.

Public Involvement

The proposal has been listed in the Schedule of Proposed Actions 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's proposal to use integrated vegetation management, including the Arizona Native Plant Society, Association of Four-Wheel-Drive Clubs, Arizona Horseman's Association, 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, and the Gila County Board of Supervisors. The Tonto's Noxious Weed Program Manager also participates in meetings of Southwest Vegetation Management Association, Central Arizona Weed Management Area, 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'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 stated that if there were no impact to acorns and pinyon in the Forest, they supported the project. 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 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) NEPA regulations 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 surfactants, and use of herbicides other than those registered by the EPA.

Human exposure risks have been evaluated in a number of risk assessments, including the Risk Assessment for Herbicide Use in Forest Service Regions 1, 2, 3, 4 and 10 and on the Bonneville Power Administration Sites (USFS 1992), and the series of Risk Assessments written by Syracuse Environmental Research Associates, 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 to will be 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 a number of risk assessments, including the Risk Assessment for Herbicide Use in Forest Service Regions 1, 2, 3, 4 and 10 and on the Bonneville Power Administration Sites (USFS 1992), and the series of Risk Assessments written by Syracuse Environmental Research Associates, which are incorporated herein 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's invasive species list was considerably increased to include species such as yellow sweetclover and Russian thistle, and also other species that are not currently on the Tonto but are very 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 what led to infestations in the first place led to the section on vectors. Another suggestion was to increase the number of acres treated annually. This was changed in the proposal. 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. 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.

Incorporation by Reference

Regulations implementing the National Environmental Policy Act (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 Assessment for Herbicide Use in Forest Service Regions 1,2,3,4, and 10 and on Bonneville Power Administration Sites (USFS 1992)

Risk Assessments for 2,4-D, 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. (McDonald 2004)

Final Environmental Impact Statement for the Integrated Treatment of Noxious Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests. (USDA Forest Service Feb. 2004)

Environmental Assessment for the Invasive Exotic Plant Management Program. Coronado National Forest. (USDA FS Coronado NF 2004)

Recommended Protection Measures for Pesticide Applications in Region 2 of the U.S. Fish and Wildlife Service. (White 2004)

ALTERNATIVES, INCLUDING THE PROPOSED ACTION

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 National Forest is within Gila, Maricopa, Pinal and Yavapai Counties, and comprises a total of 2,873,300 acres. Known noxious weed infestations cover only a small percentage of the total National Forest acres, but new infestations could be found anywhere within the nearly 3 million acres of the Forest.

This program will be reviewed and updated after 10 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.
- Implement Regional weed-free hay and mulch closure order.

- 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 5 years following treatment.
- Monitor all known populations at least every 3 years noting density and area of infestation.

Restoration

- In areas where there are large concentrations 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.

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 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 to ensure weeds found are treated so as 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 – digging by hand, using hand tools, selectively removing noxious weeds from a native plant population. This method is very labor-intensive, and ineffective on some types of weeds. It is a very effective method to quickly control new infestations of many weeds. This control method will be used on up to 400 acres each year.

Mechanical – Using motorized equipment to mow, clip, till or burn. 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 very effective method to remove large quantities of seed of annual weeds. It can be used very 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 2000 acres each year.

Cultural – Seeding with plants that prevent infestation by invasive plants. Establishing 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 will be included in some revegetation projects to increase establishment success. This method will be used on up to 2000 acres each year.

Biological – Use grazing animals, approved insects and pathogens to control weeds. Biological treatments are usually 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.

Herbicidal – Application of approved chemicals to noxious weeds. Herbicides would be used to treat up to 10,000 acres per year (0.3% of the National Forest); mechanical and prescribed burning treatments will involve additional areas. Amount of treatment 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. The majority of treatments will occur along roads and other travel corridors.

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

PLANT TREATMENT BY SPECIES

Refer to Table 1 for classification of each species, in the following discussion.

Russian knapweed
Acroptilon repens (L.) DC.

Cultural control/Use of prescribed fire:
Seeding competitive, perennial grass species after Russian knapweed has been stressed by other control measures is essential (Colorado State 2005). The most effective treatment includes cultural control 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. 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 2004). Herbicides that could damage grasses should not be used, because competition from grasses is known to stress Russian knapweed (Beck 2004). 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, *A. repens* is relatively free of parasites and is not extensively attacked by generalist feeders (Watson and Harris 1984). 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. 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.

Jointed goatgrass
Aegilops cylindrica Host

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% of jointed goatgrass seed that has passed through a cow's rumen is still viable (Lyon et al 2003). Thus, it is important to require weed-free feed for livestock on the National Forest.

Jointed goatgrass is often a weed of wheat fields, so most control measures are related to this situation, and not control in a wildland setting.

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, however, so a follow-up plan is needed for the year after the burn (CDFA 2005).

Mechanical/hand control:
Mowing can be an effective method of reducing seed production. However, the 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:
Dr. Ralph Whitesides, Extension Weed Scientist at Utah State University, has investigated the use of imazapic herbicide to eliminate emerged jointed goatgrass while keeping the native grass species. Overseeding desired species can then be done in early fall to fill in where jointed goatgrass once thrived. Preliminary results show this practice to be promising, but additional research is necessary to determine the long-term effects of the herbicide treatment and the effects of subsequent jointed goatgrass germination events (White 2005). Sethoxydim is an herbicide that controls annual and perennial grasses, and may be effective for treating jointed goatgrass.

Herbicide should be applied prior to flowering.

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.

Tree of heaven
Ailanthus altissima (P. Mill.) Swingle

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.

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 2005).

Cutting alone is usually counter-productive 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 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 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).

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 want to eradicate these trees that provide shade for their houses and yards. Removal efforts on the Tonto will emphasize detection of outlier infestations, such as the few saplings near the confluence of Pinal Creek and the Salt River, and eliminating them.

Camelthorn
Alhagi maurorum Medik.

Cultural control/Use of prescribed fire:
Measures which prevent introduction are the only cultural control methods for this aggressive species: requirement for weed-free hay on the National Forest, cleaning of 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 are administrative actions that can prevent infestations.

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.

Giant reed
Arundo donax L.

Cultural control/Use of prescribed fire:
Prescribed burning, either alone or combined with herbicide applications, may be effective if conducted after flowering. Once giant reed has been reduced sufficiently, native plants may be seeded or transplanted at the treated site. (Benton et al 2005)

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 reestablishment.

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 (CNF & SFPWMA 2001)

Systemic herbicides, such as glyphosate (e.g., Rodeo), 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. It is not an extremely aggressive invader. There are many established small populations of this plant in Camp Verde. It is possible that after a scouring flood that removes large amounts of *Phragmites* from along the Verde River, *Arundo* may become established in its place. The two species occupy similar niches in riparian communities; with the exception that *Arundo* can live on drier sites. River rangers should be educated so they are able to distinguish between the two species, and efforts to control Arundo should be made if we begin to detect plants becoming established along the river. *Arundo* infestations that begin moving onto the Forest from private lands should be eliminated.

Onionweed
Asphodelus fistulosus L.

Cultural control/Use of prescribed fire:
This plant is sometimes sold as an ornamental. An effort 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.

Wild oats
Avena fatua L.

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

Mechanical/hand control: Researchers in annual grasslands in California used selective herbicides to remove annual weedy grasses, followed by mowing and seeding of native bunchgrasses along roadsides (Bugge et al 1991). They were successful in initial stages of replacing weedy annual grasses with native perennial bunchgrasses. Bugge 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, but a consequence of wild oats being associated with crops that are routinely sprayed with herbicide has created herbicide-resistant strains of oats (Friesen et al 2000).

Biological control:
Biocontrol of wild oats (Avena fatua), 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 glass. Crown rust may be an effective biocontrol agent when used in a suite of management tools (Sands et al. 2000).

Tonto NF Goals & Strategy:
Wild oats are extremely widespread on the Tonto and neighboring Forests. Our goal is to prevent new infestations by requiring state lab testing of any seed to be used for revegetation, using the Tonto'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 (L.) Koch

Cultural control/Use of prescribed fire: Prevention of new infestations by state lab testing of all seed mixes 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:
As with Asian mustard, 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. Revegetation seed mixes were not tested for this species. This is easily corrected. Existing infestations, which are in disturbed areas, will be removed, given opportunities. New infestations will be prevented by requiring lab-testing of all seed to be used for revegetation projects.

Asian mustard
Brassica tournefortii Gouan

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

Establishment of a dense cover of grasses appears to suppress growth of Asian mustard.

Mechanical/hand control:
Manual methods are effective for small infestations, where seed banks have been suppressed.

Herbicidal control:
Extremely early winter/spring growth of this annual lends it to effective herbicide control, without herbicides affecting later-growing native plants. (Sanders & Minnich 2005).

Biological control:
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's strategy for this species is to control it beginning from its farthest extent from disturbed sites, limiting it to its previous habitat of disturbed roadsides. The Tonto 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.

Red brome, rescuegrass, downy brome, Japanese brome, ripgut brome
Bromus rubens L., B. catharticus Vahl., B. tectorum L., B. japonicus Thunb., B. diandrus Roth

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.

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

Herbicidal control:
Some herbicides are effective on these grasses, and they can be targeted without damage to many other plants because 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 can cause a fire hazard. They are particularly abundant after wet winters – thus, livestock could be brought in during December through early to mid-February to graze.

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

Globe-podded hoary cress, hairy white-top
Cardaria draba (L.) Desv., *C. pubescens* (C.A.Meg) Jarmolenko

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

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

Herbicidal control:

Herbicides are the most sure 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. Small infestations are to be eradicated when they are discovered.

Plumeless thistle
Carduus acanthoides L.

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

Mechanical/hand control:
Well-timed mowing, during early flowering will prevent seed production, but 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 on the soil from germinating.

Herbicidal control:
Several herbicides are effective for control of plumeless thistle: chlorsulfuron, dicamba, clopyralid, glyphosate, picloram and combinations of these 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*) will feed on the growing tip of the thistle rosette, and adult weevils 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 when it infests 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. New infestations will be eradicated.

Musk thistle
Carduus nutans L.

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 very small populations, prior to seed maturity (Remalay 2005). Soil disturbance should be minimized to prevent seeds on the soil from germinating

Herbicidal control:
Herbicides 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.

Southern & Field sandbur
Cenchrus echinatus L., *C. spinifex* Cav.

Cultural control/Use of prescribed fire:
Requirement for routine cleaning of equipment brought in for fire suppression and used for construction projects will prevent new infestation.

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 also increase seed germination by burying seeds on the soil surface that have not already germinated due to light-inhibition. Even deep tillage is not effective in controlling sandbur, as seeds can germinate from depths of 4 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. ADOT should be made aware of the location of the Tonto's infestation and infestations on Highway 60 under other ownership, in order to take measures to avoid spreading seeds with 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 are frequently growing in cropped areas.

Biological control:
There are no biological controls for sandbur.

Tonto NF Goals & Strategy:
There is currently only one known site infested with sandbur on the Tonto. It is near extensive patches of sandbur on the Fort Apache Reservation. Treatment of this plant must be coordinated with our neighbor before any treatment on the Forest would be effective. Our goal is to eliminate this plant from the right-of-way on Highway 188.

Spotted knapweed
Centaurea biebersteinii DC.

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. Care should be taken to wear gloves 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 (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. The larvae of these species reduce seed production by as much as 50% by feeding on spotted knapweed seed heads and causing the plant to form galls. 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.

Diffuse knapweed
Centaurea diffusa Lam.

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 2-4 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 very labor intensive and may not always be feasible.

Herbicidal control:
Herbicides can be used to control existing stands of *C. diffusa* and *C. biebersteinii* 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 are most effectively used in combinations that affect different life stages of the thistle.

The gall-forming flies *Urophora affinis* and *U. quadrifasciata* are seed head 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 seed head, along with any other insects that are in that seed head. Roots are damaged by the larvae of the buprestid beetle *Sphenoptera jugoslavica*, the weevil *Cyphocleonus achates*, and the moths *Pterolonche inspersa* and *Agapeta zoegana*. *Sphenoptera* has been found to be especially effective on hot dry sites during studies in California (Joley & Woods 1996).

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 et al 1996).

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 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.

Malta starthistle
Centaurea melitensis L.

Cultural control/Use of prescribed fire:
Addition of this plant to the State's list of regulated plants, 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".

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 et al 2005) 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 10 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%, 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%, and cover of yellow starthistle was reduced by 91%. 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 & Rafferty 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 – 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 not adhered to. 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.

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. This has been very effective on the strip that was sprayed.

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).

Tonto NF Goals & Strategy:
The Tonto, in partnership with Arizona Dept. of Transportation, has been using 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 District.

Partnering with neighboring land owners 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" of high use.

Yellow starthistle
Centaurea solstitialis L.

Cultural control/Use of prescribed fire:
Burning can provide control if implemented before seed is produced. (CDFA 2005, DiTomaso et al 2005) 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 2-5% of the total population of seed heads is in bloom. Mowing too early can result in increased seed production (CDFA 2005)

Herbicidal control:
Clopyralid and picloram are the most effective herbicides for fall season control of yellow starthistle. Unlike most postemergence 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%. They do not, by themselves, provide sustainable management of starthistle, but can be an important component of an integrated approach (DiTomaso 2001).

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

Tonto NF Goals & Strategy:
Yellow starthistle is a "C" species, as it is very common on private lands and is becoming a common weed on the Payson and Pleasant Valley Ranger Districts. 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.

Rush skeletonweed
Chondrilla juncea L.

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% of 5- to 7- week-old seedlings can regenerate from root fragments (Cuthbertson 1972).

Mowing reduces seed production, and through time, may reduce the plant's ability to send up new rosettes from adventitious root buds (McLellan 1991).

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 2003)

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 2003). 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 soon as possible.

Blue mustard
Chorispora tenella (Pall.) DC.

Cultural control/Use of prescribed fire:
Blue mustard is often dispersed as a seed contaminant. Following the protocol of having all seed lots tested at a state lab prior to use could save much time and money later in removal of new infestations.

Mechanical/hand control:
Cultivation is very 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. Any new infestations are to be recorded, then eradicated.

Canada thistle
Cirsium arvense (L.) Scop.

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 over a season and over 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:
One native North American insect, the larva of 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 and adults feed on the foliage; and the thistle stem gall fly (*Urophora cardui*), whose larvae develop within the stem, 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 – 80% of new shoots (Brosten and Sands 1986). 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 very uncommon on the Tonto. All infestations should be eradicated when found, using a combination of treatments listed above.

Bull thistle
Cirsium vulgare (Savi) Tenore

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 the best deterrent to infestation by thistles.

Mechanical/hand control:
Cutting flower and seed-heads off the plant 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, 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 stream banks, 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 seed head weevil *Rhinocyllus conicus* prefers thistles of the genus *Carduus*, but will also attack *Cirsium* 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. 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 District YCC crews work on Canyon Creek as one of their summer projects.

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.

Field bindweed
Convolvulus arvensis L.

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 (Callihan *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. It has not been a problem weed in wildland situations, but may be locally abundant on disturbed sites, or historically disturbed sites. It has fairly 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.

Bride's bouquet, white bietou
Dimorphotheca cuneata (Thunb.) Less.

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, though.

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.

Common teasel
Dipsacus fullonum L.

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 are on the Tonto. 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 had success in killing infestations (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 using sharp spades, burning and herbicides is an effective treatment for common teasel (WDNR 2004).

Russian olive
Eleagnus angustifolia L.

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

Mechanical/hand control:
Mowing, followed by removal of cut vegetation is another option for eradication (Muzika & Swearingen 2005).
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 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 (L.) Gould

Most of the literature about control methods for this species involve 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 (Batcher 2002) reported that the use of herbicides was extremely effective in controlling quackgrass. Chemicals he used were Roundup (glyphosate), and Fusilade (fluazifop), which is a grass-specific herbicide. He noted that if spraying is done early enough in the season (quackgrass is a cool-season grower), then warm-season grasses are not affected.

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. Spot infestations away from major highways should be eradicated if small (under 1 acre); contained (work to remove plants from outer edges of the site toward the inside) if large (over 1 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 non-native grasses. All seed that is to be used on National Forest land should be inspected by a certified seed-testing lab for both species of lovegrass.

Mechanical/hand control:
Treatments such as chopping or mowing would only mimic a grazing animal, something which lovegrasses are well-adapted to withstand (Crisp 2001).

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 (Moser & Crisp 2003). 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, this would 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. They are extremely widespread due to past practices of including them in revegetation seed mixes. Current strategy is to not introduce more by requiring checking of all seed mixes to be used on the Forest, for presence of *Eragrostis* seeds. If it is accidentally introduced, immediate measures will be taken to eradicate new populations.

Leafy spurge
Euphorbia esula L.

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 will prevent new infestations of leafy spurge (Lajeunesse et al 1999). Requiring clean equipment brought in for fire suppression and other ground-disturbing activities will also prevent this weed from infesting the Tonto.

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. Mowing does little for long-term control.

Herbicidal control:
Several systemic herbicides have been found to be effective if applied in June, when the flowers and seeds are developing, or in early to mid-September, 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*). (Thunhorse & 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 3 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, with sheep grazing in the spring, removed during egg-laying of the beetle, 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.

Sweet resinbush
Euryops subcarnosus DC. ssp. *vulgaris* B. Nord

Cultural control/Use of prescribed fire:
Prescribed burning has been tried to treat sweet resinbush. Burns were not successful due to lack of fuels to carry the fire (Schalau 2001).

Mechanical/hand control:
Hand grubbing of very small infestations on the Tonto National Forest has eradicated some of them.

Herbicidal control:
Recent aerial application of herbicides to an infestation near Safford, Arizona has had 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 3 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.

Dyer's woad
Isatis tinctoria L.

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).

Hand-pulling is best done after the plant bolts, but before it sets seed. It is easily visible at this time, with bright yellow distinctive flowers. There is only a 4-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 2-3 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 preemergence or postemergence to seedlings and rosettes (CDFA 2005).

Biological control:
The native rust *Puccinia thlaspeos* is a fairly newly 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 seed; seedlings and rosettes are often killed.

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

Kochia
Kochia scoparia (L.) Schrad.

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 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 are recommended control methods (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. Our goal is eradication.

Oxeye daisy
Leucanthemum vulgare Lam.

Cultural control/Use of prescribed fire:
Areas that are cultivated should be revegetated with desirable native seed. Deep mulching (3-4 inches deep) with rice straw has eradicated ox-eye 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 .25 acre). Shallow cultivation (less than 6 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 them open to invasion by other invasive species, of course.

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. Ox-eye daisy is moderately resistant to 2,4-D and dicamba, and these herbicides can damage non-target species (Alvarez undated)

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. Therefore, priority should be given to eradicating small infestations.

Dalmatian toadflax, Yellow toadflax
Linaria dalmatica (L.) P. Mill., *Linaria vulgaris* P. Mill

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 without letting up for up to 10 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:
Five insect species have been approved by the USDA-APHIS-PPQ for release as biological control agents for both toadflax species. None of these has been particularly effective to date. 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).

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.

Purple loosestrife
Lythrum salicaria L.

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 (Bender 2001).

Herbicidal control:
Broadleaf chemicals are also 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. 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 (L.) Lam.

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.

Oleander

Nerium oleander L.

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 needed.

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 (L. f.) Källersjö

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 no literature on control methods for globe chamomile. It grows densely along rights-of-way, lending itself 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, more invasive weeds.

Herbicidal control:
There is no information on specific herbicides that control globe chamomile. Various broadleaf herbicides would probably be effective.

Biological control:
There is no information on biological control agents for globe chamomile.
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Tonto NF Goals & Strategy:

Our goal is to contain, with eradication possible. Since this weed is newly discovered, we do not know the extent of infestation at this time.

Scotch thistle
Onopordum acanthium L.

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

African rue
Peganum harmala L.

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% 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 (L.) Link

Cultural control/Use of prescribed fire:
Burning stimulates growth of buffelgrass, so prescribed burning is not recommended.

Mechanical/hand control:
Most mechanical/hand control methods simulate grazing, a treatment buffelgrass is well adapted to.
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).

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

Tonto NF Goals & Strategy:
This species will be managed with a containment strategy, combined with working along rights-of-way to eliminate it. It is important to keep this grass from moving beyond the right-of-way onto the Forest.

Fountain grass
Pennisetum setaceum (Forsk.) Chiov.

Cultural control/Use of prescribed fire:
As with buffelgrass, burning is not recommended.

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.

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. Preemergent 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.

Karoo bush
Pentzia incana (Thunb.) Kuntze

Cultural control/Use of prescribed fire:
The karoo bush infestation on the Forest is limited to a disturbed area. 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 whether Pentzia sprouts from roots after it is burned.

It is unlikely infestations will occur elsewhere on the Forest, as the one population was planted long ago, and no others have been identified.

Mechanical/hand control:
Our existing infestation 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 documented infestation of Karoo bush on the Tonto is fairly small. It has hardly spread from where it was planted 70 years ago. Our goal is to contain the population to the small area it now grows in. It is a low priority for treatment.

Japanese knotweed
Polygonum cuspidatum Sieb. & Zucc.

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 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 done by education of nurseries and the public on northern Districts, where this plant would grow readily.

Sulfur cinquefoil
Potentilla recta L.

Cultural control/Use of prescribed fire:
Prescribed burning alone is not recommended, but used in combination with herbicides and seeding of native species, could be effective.

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. Finding an organism specific to *Potentilla recta* would be necessary, since there are many natives of this genus, and it is also closely related to strawberries.

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

Pyracantha
Pyracantha M. Roemer

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 help prevent new infestations also.

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 L.

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 help prevent new infestations also.

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 tried to find the best 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 L., *Salsola tragus* L.

Cultural control/Use of prescribed fire:
Requirement for clean fill dirt for projects, cleaning equipment for fire suppression and ground-disturbing projects, inspection of staging areas and other work sites to do early detection, are all practices that will prevent large infestations.

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 L.

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

Mechanical/hand control:
Small infestations can be dug out if the root is cut 2 – 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 is 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 (Wash. State 1999).

Tonto NF Goals & Strategy:
This plant is unknown on the Tonto 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 Nees, *S. barbatus* (L.) Thell.

Cultural control/Use of prescribed fire:
Fire promotes growth of *Schismus*.
At elevations higher than the Sonoran desert, encouragement of a good ground cover of perennial grasses 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 more affected.

Biological control:
As with mechanical treatments, removal by grazing animals at moderate to intense levels only tends to increase the relative biomass 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 may help control this annual grass.

Wild mustard
Sinapis arvensis L.

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.

Salt cedar
Tamarix parviflora DC., *Tamarix chinensis* Lour., *T. ramosissima* Ledeb.

Management of salt cedar requires a long term commitment to prevent reinfestation. A variety of methods have been used in the management of salt cedar, 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, but because salt cedars are fire-adapted, they readily resprout after fire. Flooding can be used to control salt cedar if root crowns remain submerged for at least three months (Muzika & Swearingen 2005).

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 1-inch 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 salt cedar, chemical control has been shown to be the most effective method. Cautious use of herbicides aids in restoration of salt cedar-infested sites by allowing repopulation by native plant species. Systemic herbicides (e.g., those that kill the plant from the root up) are recommended for salt cedar management and application methods include foliar sprays, cut stump treatments, basal bark treatments, and aerial sprays. Because tamarisk usually grows in or adjacent to streams, wetlands and other waterways, it is important to use products registered for aquatic application.

Biological control:
Fifteen insects are being investigated as potential biological control agents for salt cedar. Two of these, a mealybug (*Trabutina mannipara*) and a leaf beetle (*Diorhabda elongata*), have preliminary approval for release (DeLoach 1996). Five others are being tested within the United States and an additional eight species are under study overseas. Final approval for release of the mealybug and the leaf beetle is pending resolution of concerns regarding their potential impact to the southwestern subspecies of the willow flycatcher (*Empidonax traillii extimus*), a federally endangered bird. In parts of its range where native willows, its natural nest trees, have been replaced by salt cedar, the willow flycatcher now utilizes it for this purpose. Concern is over the possibility that, due to the environmental damage caused by tamarisk, native plant species may not be able to replace it if the biological control agents succeed in eliminating it. (Muzika & Swearingin 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 salt cedar from the Verde River, and eradicate 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 salt cedar. Salt cedar is rare along upper Cave Creek, and does not grow in dense stands on the lower part of Cave Creek on the National Forest. Eradication efforts on County and private preserves downstream will be futile unless the National Forest also acts to eradicate our populations. Our long-term goal is to eradicate salt cedar from the Cave Creek drainage and its tributaries. Southwestern willow flycatchers currently use the thickets of salt cedar 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 eradicate these thickets, or cause them to shift upstream. It is problematical whether native riparian species could survive with the greatly fluctuating water levels that result from operations of the dam.
The upstream end of Horseshoe Reservoir is also habitat for the Southwestern Willow Flycatcher. With radically fluctuating lake levels, salt cedar has become established in the same area as cottonwood and willow, and in recent years the Southwestern Willow Flycatcher has nested in salt cedar (Todd Willard 2006). In the long term, the flycatcher would benefit from removal of salt cedar if a sustainable cottonwood/willow vegetation community is still possible, due to the high flammability of salt cedar thickets.

Management of these populations will be to limit their spread upstream beyond the area influenced by changing lake levels.

Siberian elm
Ulmus pumila L.

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, it 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 L.

Cultural control/Use of prescribed fire:
Homeowners with homes and special use permits on the National Forest should be prevented from planting this species.

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.

Mowing or cutting is not recommended, as it encourages sprouting.

Herbicidal control:
Glyphosate works well if plants are cut first, then sprayed immediately afterward. Cutting with a weed whip breaks through the waxy cuticle, allowing better penetration of the herbicide. In Ramsey Canyon, a 5% glyphosate solution provided 100% control. A surfactant is recommended. (Drewitz 2005).

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. Strategy is to remove it where opportunities exist, where it is found, normally on or near old homesteads. Time should not be spent controlling this species unless it is spreading to undisturbed lands or poses some type of problem.

[Insert Map for Alternative]

Figure 1. Invasive Plants on the Tonto National Forest.

Alternative 1: No Action

This alternative allows all previous decisions regarding treatment of noxious weeds on the Tonto National Forest 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 (USDA FS 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. (USDA FS Tonto NF 3/2004)
- Use of hand tools and hand-pulling to remove weeds Forest-wide. (USDA FS Tonto NF 2005b)
- Use of prescribed fires less than 10 acres in size, within 50 feet of Forest System Roads. (USDA FS Tonto NF 2005b)

- Use of herbicides by Arizona Department of Transportation along all federal and state highways through the Tonto National Forest. 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. (USDA FS 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 20 acres would be treated with herbicides under projects already approved, up to 200 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, 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: Integrated Management Excluding the Use of Herbicides

This alternative provides for use of all integrated vegetation management tools except for herbicides. 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 2000 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 2000 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 2000 acres would be treated by mechanical methods, and up to 5000 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).

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 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 Animal Plant Health Inspection Service (APHIS) for use on that species.
- If restoration of treated areas includes establishing new plants, this would be accomplished by broadcast seeding of native species or non-persistent, non-native cover crops.
- All seed used for revegetation will be tested for the Tonto'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. A monitoring plan will be prepared as 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 after it has been 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 insuring 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.
- BMPs will be followed.
- All requirements of a Safety and Spill Plan 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 is delegated to the District Ranger. Approval for the use of herbicides in Wilderness cannot be delegated beyond Regional Forester.
- Treatment areas will be signed to alert the public of the herbicide application.
- Landowners within ½ 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 will be followed.

Permits and Agency Approvals Required

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

- Prior to burning, obtain a burn permit from Arizona Department of Environmental Quality.
- Consult and obtain concurrence or a biological opinion 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.
- If applicable, consult and obtain concurrence from the Arizona State Historic Preservation Officer regarding identification, evaluation, and determination of effect of the project on heritage resources.
- If required, obtain a discharge permit either through the Arizona Department of Environmental Quality or the Corps of Engineers prior to application of any herbicide along navigable waters.

- Obtain a 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.
- 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.

Comparison of Alternatives

This section provides a summary of the effects of implementing each alternative. Information in the table is focused on activities and effects where different levels of effects or outputs can be distinguished quantitatively or qualitatively among alternatives.

Table 2: Comparison of Alternatives

CRITERIA/ISSUES	
MEETS THE PURPOSE AND NEED FOR THE ACTION	
Proposed Action	Yes. Authorizes the most effective treatments for all invasive species across the Forest.
Alternative 1	No. Invasive species would not be effectively managed.
Alternative 2	In part. Would not authorize the use of herbicides, therefore would limit effectiveness of treatments.
CONSISTENT WITH FOREST PLAN	
Proposed Action	Yes. Hazardous conditions caused by noxious weeds (desert wildfire, toxic forage for animals) are reduced by using an effective suite of control methods; maintains or enhances the visual resource; provides for habitat for species diversity; 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.
Alternative 1	No. Allows for uncontrolled spread of invasive species.
Alternative 2	Yes. However, reliance on cultural 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	
Proposed Action	Yes. Responsive to the Farm Bill of 1990, Forest Service Manual 2080, Forest Service National Strategy, and Executive Order 13112.
Alternative 1	Not responsive to laws and regulations.
Alternative 2	No. Ineffective management results in dissatisfaction of cooperators and does not effectively prevent an increase in size of many invasive plant infestations.
EFFECT OF THE ACTION ON HUMAN HEALTH – BOTH PUBLIC AND EMPLOYEES	
Proposed Action	Little effect on human health. Risks associated with exposure to herbicides will be insignificant to the public at large. 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 wildfire fighting and conducting routine prescribed burns.
Alternative 1	Little effect on human health. Increase in wildfire potential in the Sonoran desert, which may lead to indirect effects from smoke.

Alternative 2	Effects similar to Alternative 1. Additional slight risk for injury to personnel performing prescribed burns.

EFFECT OF THE ACTION ON THE ENVIRONMENT – SOIL AND WATER QUALITY, NATIVE VEGETATION AND WILDLIFE

Proposed Action	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 will 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. Herbicide exposure risks to wildlife are minimal. Long-term restoration of native plant communities will increase habitat capability in infested areas.
Alternative 1	No possibility of herbicide contamination of vegetation, wildlife, soil or water. Increases in tap-rooted species increase surface runoff in some areas. Increased distribution and density of annual and perennial exotic invasive grasses will increase wildfire occurrence, size, and impacts. Native plant communities would 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 will probably suffer from habitat degradation. This alternative results in highest level of degradation of forage and wildlife habitat.
Alternative 2	Invasive species continue to spread, but not as fast as in Alternative 1. Prevention measures proposed will slow introduction of invasives, but manual and small-scale 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.

LITERATURE CITED

Alvarez, Maria. Undated. Report on Leucanthemum vulgare on Cal_IPC website. http://ucce.ucdavis.edu/datastore/detailreport.cfm?usernumber=59&surveynumber=182.

Arizona Dept. of Agriculture, Plant Services Division, Arizona Administrative Code, Title 3, Chapter 4. 1999. R3-4-244 Regulated and Restricted Noxious Weeds; R3-4-245 Prohibited Noxious Weeds. Pages 47-51.

Arizona Department of Transportation (ADOT) website. 2005. http://www.azdot.gov/Highways/NResources/Priority_Weeds.asp

Arizona-Sonora Desert Museum website, "Invaders of the Sonoran Desert Region" 2005. http://www.desertmuseum.org/invaders/invaders_onionweed.htm

Batcher, Michael S. 2002. Element Stewardship Abstract for *Elytrigia repens var. repens.* The Nature Conservancy. On the website http://tncweeds.ucdavis.edu/esadocs/arundona.html

Beck, K.G. 1994. Diffuse and spotted knapweed: biology and management. *Colorado State University Cooperative Extension 3.110*. 2pp

Beck, K.George. 1999. Biennial Thistles. In Biology and Management of Noxious Rangeland Weeds, Roger L. Sheley & Janet K. Petroff, eds

Beck, K.G. 2004. Russian Knapweed. Colorado State University Cooperative Extension – Natural Resources. Available on the website: http://www.ext.colostate.edu/pubs/natres/03111.html

Bender. J. 2001. Element Stewardship Abstract for *Lythrum salicaria.* The Nature Conservancy. At http://tncweeds.ucdavis.edu/esadocs/lythsal.html

Benton, Nancy, Gary Bell & Jil M. Swearingen. 2005. Alien Plant Working Group of the Plant Conservation Alliance website. Fact Sheet on Giant Reed. http://www.nps.gov/plants/alien/fact/ardo1.htm

Brosten, B.S., and D.C. Sands. 1986. Field trials of *Sclerotinia sclerotiorum* to control Canada thistle. Weed Science 34: 377-380.

Bugge R.L., L.H. Anderson, J.W. Menke, K. Crompton and W.T. Lanini. 1991. Perennial grasses as roadside cover crops to reduce agricultural weeds. Components Newsletter, University of California Sustainable Agriculture Research and Education Program. Available at http://www.sarep.ucdavis.edu/newsltr/components/v2n1/sa-11.htm

CDFA (California Department of Food and Agriculture) 2005. Encycloweedia. Available at http://www.cdfa.ca.gov/phpps/ipc/encycloweedia/encycloweedia_hp.htm.

Callihan, R.H., C.V. Eberlein, J.P. McCaffrey, & D.C. Thill. 1990. Field bindweed: Biology and Management. University of Idaho, Cooperative Extension System, College of Agriculture Bulletin #719.

Callihan, Robert H. and Timothy W. Miller. 1999. Idaho's Noxious Weeds.

Carpenter, Alan and Thomas Murray. 1998. Element Stewardship Abstract for *Linaria genistifolia ssp. Dalmatica and Linaria vulgaris.* The Nature Conservancy. Available at http://tncweeds.ucdavis.edu/esadocs/linadal.html

Carpenter, Alan T. and Thomas Murray. 1999, updated 2004. Element Stewardship Abstract for *Bromus tectorum* L. The Nature Conservancy. Available at http://tncweeds.ucdavis.edu/esadocs/documnts/bromtec.rtf

Carpinelli, Michael, USDA-ARS, Burns, OR. 2005. Alien Plant Working Group of the Plant Conservation Alliance website. Fact Sheet on Spotted Knapweed. http://www.nps.gov/plants/alien/fact/cebi1.htm

Cline, Francis, President of Tonto Weed Management Area. 2004. Personal communication.

Coconino National Forest and San Francisco Peaks Weed Management Area. (CNF & SFPWMA) 2001. Invasive Plant Fact Sheets.

Colorado State University, Cooperative Extension Website June 2005. http://www.ext.colostate.edu/pubs/natres/03111.html

Crisp, Debra. 2000. Species management plan for purple loosestrife. http://www.usgs.nau.edu/swepic/factsheets/lysa2sf_plan.pdf.

Crisp, Debra. 2001. Species management plan for exotic grasses with origins in Africa On file at Coconino National Forest Supervisor's Office.

Cuthbertson, E. G. 1972. *Chondrilla juncea* in Australia. 4. Root morphology and regeneration from root fragments. Australian Journal of Experimental Agriculture and Animal Husbandry. 12: 528-534.

Davison J., and M. Wargo. 2001. Recognition and Control of African Rue in Nevada. Fact Sheet # FS-01-45. University of Nevada Cooperative Extension, Reno Nevada. 4 pp.

DeLoach C.J., M.J. Pitcairn, and D. Woods. 1996. Biological control of Saltcedar in Southern California. In: Joe DiTomaso and Carl E. Bell, Eds., Proceedings of the Saltcedar Management Workshop, Rancho Mirage, California, pp. 30-31.

DiTomaso, Joe. 2001. Element Stewardship Abstract for *Centaurea solstitialis*. The Nature Conservancy. Available at http://tncweeds.ucdavis.edu/esadocs/documnts/centsol.rtf

DiTomaso, Joseph M., Matthew L. Brooks, Edith B. Allen, and Ralph Minnich. March 2005. The Use of Fire as a Tool for Controlling Invasive Weeds, Draft Report. A Project completed for the Center for Invasive Plant Management, Bozeman, MT.

Donaldson, Susan & Dawn Rafferty. 1986. Identification and Management of Malta Starthistle (*Centaurea melitensis* L.) University of Nevada Fact Sheet FS-02-86

Drewitz, Jennifer. 2005. Report for *Vinca major*. California Invasive Plant Council. Available at http://ucce.ucdavis.edu/datastore/detailreport.cfm?usernumber+88&surveynumber=182.

Durkin, Patrick. 2001. Sethoxydim – Human Health and Ecological Risk Assessment – Final Report. Syracuse Environmental Research Associates. New York. 182 pages.

Durkin, Patrick. 2003a. Glyphosate – Human Health and Ecological Risk Assessment – Final Report. Syracuse Environmental Research Associates. New York. 281 pages.

Durkin, Patrick. 2003b. Triclopyr – Human Health and Ecological Risk Assessment – Final Report. Syracuse Environmental Research Associates. New York. 264 pages.

Durkin, Patrick and Steve Bosch. 2004. Dicamba – Human Health and Ecological Risk Assessment – Final Report. Syracuse Environmental Research Associates. New York. 179 pages.

Durkin, Patrick and Mark Follansbee. 2003. Picloram – Human Health and Ecological Risk Assessment – Final Report. Syracuse Environmental Research Associates. New York. 133 pages.

Durkin, Patrick and Mark Follansbee. 2004a. Clopyralid – Human Health and Ecological Risk Assessment – Final Report. Syracuse Environmental Research Associates. New York. 154 pages.

Durkin, Patrick and Mark Follansbee. 2004b. Imazapic – Human Health and Ecological Risk Assessment – Final Report. Syracuse Environmental Research Associates. New York. 110 pages.

Durkin, Patrick and Mark Follansbee. 2004c. Imazapyr – Human Health and Ecological Risk Assessment – Final Report. Syracuse Environmental Research Associates. New York. 149 pages.

Endress, Bryan A. and Catherine G. Parks. 2004. Element Stewardship Abstract for *Potentilla recta* L. The Nature Conservancy. On the website http://tncweeds.ucdavis.edu/esadocs/poterect.html

Federal Register Feb 8, 1999. Vol. 64, Number 25. Executive Order 13112.

Friesen, Lyle R., Tammy L. Jones, Rene C. Van Acker, and Ian N. Morrison. 2000. Identifiction of *Avena fatua* populations resistant to imazamethabenz, flamprop, and fenoxaprop-P. In Weed Science: Vol. 48, No. 5, pp. 532-540.

Graham, Jessica and Wayne S. Johnson. 2004. University of Nevada Cooperative Extension. Fact Sheet FS-04-27.

Hager, Aaron. 2001. Emerging Weed Problems in Illinois. Available at http://cropsci.uiuc.edu/classic/2001/Article3/index.cfm

Hasan S, R. Sobhian and F. Herard. 2001. Biology, impact and preliminary host-specificity testing of the rust fungus, *Uromyces salsolae*, a potential biological control agent for *Salsola kali* in the USA. Biocontrol Science and Technology 11, 677-689.

Howe, H.F. 1995. Succession and fire season in experimental prairie plantings. Ecology 76(6): 1917-1925.

Howery Larry D., Bruce D. Munda, Dan G. Robinett, and Harry H. Buck. 2003. Sweet Resin Bush on the Santa Rita Experimental Range: An Eradication Effort. In USDA Forest Service Proceedings RMRS P-30.

Joley, D.B. and D.M. Woods. 1996. Biological control of diffuse knapweed, *Centaurea diffusa*. In: D.M. Woods (ed.) Biological Control Program Annual Summary, 1996. Calif. Dept. Food and Agric. Div. of Plant Industry, Sacramento, CA.

Lacey, J., P. Husby & G. Handl. 1990. Observtions on spotted and diffuse knapweed invasion into ungrazed bunchgrass communities in Western Montana. Rangelands 12:30-32.

Lajeunesse, Sherry, Roger Sheley, Celestine Duncan, and Rodney Lym. Leafy spurge. 1999. In Biology and Management of Noxious Rangeland Weeds. Sheley and Petroff, eds.

Lovich, Jeffrey. Undated. Report on *Pennisetum setaceum* on Cal-IPC website. http://ucce.ucdavis.edu/datastore/detailreport.cfm?usernumber=66&surveynumber =182.

Lyon, DJ, Klein, RN, Wicks, GA 2003. Controlling Jointed Goatgrass. Available as http://www.ianr.unl.edu/pubs/Weeds/g1252.htm

Lyons, Kelly E. 1998. Element Stewardship Abstract for *Convolvulus arvensis* L. The Nature Conservancy. Available at http://tncweeds.ucdavis.edu/esadocs/documnts/convarv.rtf

McDonald, Charlie. 2004. 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. USDA Forest Service, Southwestern Region.

McLellan, Paul William. 1991. Effects of mowing on the efficacy of the gall mite, *Eriophyes chondrillae*, on rush skeletonweed, Chondrilla juncea. Pullman, WA: Washington State University. 59 p. Thesis

McReynolds, Kim. 2005. University of Arizona Cooperative Extension. Wilcox, AZ. Personal communication.

Moore, R.J. 1975. The biology of Canadian weeds. 13: *Cirsium arvense* (L.) Scop. Can. J. Plant Science 55: 1033-48.

Morishita, Don W. 2003. Canada Thistle. In Biology and Management of Noxious Rangeland Weeds. Roger L. Sheley & Janet K. Petroff, eds.

Moser, L. & D. Crisp. 2003. San Francisco Peaks Weed Management Area fact sheet on *Eragrostis lehmanniana*. Coconino National Forest.

Muzika, Rose Marie and Jill M. Swearingen. 2005a. Alien Plant Working Group of the Plant Conservation Alliance website. Fact sheet on Russian Olive. http://www.nps.gov/plants/alien/fact/elan1.htm

Muzika, Rose-Marie & Jil M. Swearingen. 2005b. Alien Plant Working Group of the Plant Conservation Alliance website. Fact sheet on Saltcedar. http://www.nps.gov/plants/alien/fact/tama1.htm

Nordenstam, Bertil. 1968. The Genus Euryops. Part I. Taxonomy. Opera Botanica 20. Gleerup, Lund, Sweden.

Northam, Dr. Francis E. 2003-2005 Personal communication.

Olson, B.E. and R.T. Wallander. 1999. Oxeye daisy (*Chrysanthemum Leucanthemum* L.). In: Sheley, R.L. and J.K. Petroff, Eds. Biology and management of Noxious Rangeland Weeds. Oregon State University Press, Corvallis, Oregon.

Peachey, Ed. Et al. 2007. Pacific Northwest Weed Management Handbook. Oregon State University.

Piper, G.L., S.S. Rosenthal, J.M. Story, and N.E. Rees. 1996. Diffuse knapweed (*Centaurea diffusa*). In Biological control of weeds in the West. West. Soc. Weed Sci., USDA Agric. Res. Serv., Montana Dept. Agric., and Montana State Univ., Bozeman

Remaley, Tom, Great Smoky Mountains National Park, Gatlinburg, TN. 2005b. Alien Plant Working Group of the Plant Conservation Alliance website. Fact sheet on Musk Thistle. http://www.nps.gov/plants/alien/fact/canu1.htm

Sanders, Andrew & Richard Minnich. Undated. Report on *Brassica tournefortii* on Cal_IPC website. Available at http://ucce.ucdavis.edu/datastore/detailreport.cfm?usernumber=12&surveynumber=182.

Sands, D. C. ; Johnston, M. R. ; Carsten, L. D. 2000. Control of Wild Oats, Avena fatua, on San Clemente Island Using the Fungal Leaf Pathogen Puccini a Coronata, Causal Agent of Crown Rust of Oats. On the Defense Technical Information Center website: http://www.dtic.mil/

Schalau, J. 2001. Sweet Resinbush Invading Cottonwood. Backyard Gardener, Arizona Cooperative Extension. Available from: http://cals.arizona.edu/yavapai/anr/hort/byg/archive/sweetresinbush.html

SWEPIC (South West Exotic Plant Information Clearinghouse) 2005. Available at: http://www.usgs.nau.edu/SWEPIC/swvma/

Swearingen, Jil M & Phil Pannill. 2005. Alien Plant Working Group of the Plant Conservation Alliance website. Fact sheet on Tree of Heaven. http://www.nps.gov/plants/alien/fact/aial1.htm

Thunhorst, Gwendolyn & Jil M. Swearingen. 2005a. Alien Plant Working Group of the Plant Conservation Alliance website. Fact sheet on Canada Thistle. http://www.nps.gov/plants/alien/fact/ciar1.htm

Thunhorst, Gwendolyn & Jil M. Swearingen. 2005b. Alien Plant Working Group of the Plant Conservation Alliance website. Fact sheet on Leafy Spurge. http://www.nps.gov/plants/alien/fact/eues1.htm

Tu, Mandy. 2003. Element Stewardship Abstract for *Eleagnus angustifolia.* The Nature Conservancy. On the website http://tncweeds.ucdavis.edu/esadocs/elaeang.rtf

USDA Forest Service. 1992. Risk Assessment for Herbicide Use in Forest Service Regions 1, 2, 3, 4, and 10 and on Bonneville Power Administration Sites. FS 53-3187-9-30.

USDA Forest Service. 1998. Stemming the Invasive Tide: Forest Service Strategy for Noxious and Nonnative Invasive Plant Management.

USDA Forest Service. May 2004. Environmental Assessment for Management of Noxious Weeds and Hazardous Vegetation on Public Roadways on National Forest Service System Lands in Arizona

USDA FS Coronado National Forest. September 2004. Environmental Assessment for the Invasive Exotic Plant Management Program. Coronado National Forest.

USDA FS Tonto National Forest. 2004. Arizona Zone Terrestrial Ecosystem Survey of the Tonto National Forest, In Progress. USDA Forest Service Southwestern Region.

USDA FS Tonto National Forest. March 2004. Decision Memo for Pleasant Valley Ranger Station Noxious Weed Treatment Project, Pleasant Valley Ranger District, Tonto National Forest.

USDA FS Tonto National Forest. October 2004. Decision Memo for Noxious Weeds Prescribed Burn along Highway 188. Tonto Basin Ranger District, Tonto National Forest.

USDA FS Tonto National Forest. 2005b. Decision Memo for Noxious Weed Treatment Projects on the Tonto National Forest, Gila, Maricopa, Pinal, and Yavapai Counties.

USDA FS Southwestern Region Tonto NF. 1985b. Tonto National Forest Plan.

USDA, Natural Resources Conservation Service. 2004. The PLANTS Database. Available at http://plants.usda.gov. National Plant Data Center, Baton Rouge, LA 70874-4490.

WSNWCB (Washington State Noxious Weed Control Board). 1999. Written Findings of the State Noxious Weed Control Board. Available at: http://www.nwcb.wa.gov/index.htm

Watson, A.K. and P. Harris. 1984. *Acroptilon repens* (L.) DC., Russian knapweed (Compositae). Biological control programmes against insects and weeds in Canada 1969-1980 8:105-110.

WDNR. (Wisconsin Department of Natural Resources) 2004. Common teasel. At the website http://dnr.wi.gov

White, J. A. 2004. Recommended Protection Measures for Pesticide Applications in Region 2 of the U.S. Fish and Wildlife Service. U.S. Fish and Wildlife Service. August 2004. Austin, TX.

White, Tony, PhD. 2005. Can Jointed Goatgrass Invade Pastures? National Jointed Goatgrass Research Program. An article available at thewebsite: http://www.jointedgoatgrass.org/Publications/Popular%20Press/Pages/2004/Pastures.htm

Wieseler, Susan, Minnesota Dept. of Natural Resources, Rochester, MN. 2005. Alien Plant Working Group of the Plant Conservation Alliance website. Fact sheet on Siberian Elm. http://www.nps.gov/plants/alien/fact/ulpu1.htm

Willard, Todd. 2006. Cave Creek Ranger District, Tonto National Forest Wildlife Biologist. Personal communication.