United States
Department of
Agriculture

Forest
Service

**Southwestern
Region**

Draft Environmental Impact Statement for the Invasive Plant Control Project

Carson and Santa Fe National Forests in Colfax, Los Alamos, Mora, Rio Arriba, San Miguel, Santa Fe, Sandoval and Taos Counties, New Mexico

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Draft Environmental Impact Statement

Invasive Plant Control Project

Responsible Agency:	**USDA Forest Service** **Southwestern Region**
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Abstract: In northern New Mexico, invasive plants are impacting natural resources on more than 7,300 acres of National Forest System lands within the Carson National Forest and Santa Fe National Forest (Forests). This draft environmental impact statement (DEIS) discloses the analysis of a "no action" alternative (Alternative A) plus three management alternatives (Alternatives B, C, and D) that would eradicate, control or contain these populations to varying degrees using different treatment methods. In addition, each alternative includes an adaptive strategy for responding to infestations that have not yet been found, as well as permitting methods to be modified as needed based on monitoring results. Alternative B, the proposed action, would employ a combination of methods including: herbicide application, biological (insect) control agents, manual, mechanical, controlled grazing with sheep or goats, and prescribed burning. Alternative C would not use any herbicides, and Alternative D would use only herbicides. Those alternatives were developed based on issues raised about herbicide use. The Forest Plan for the Santa Fe National Forest would be amended if Alternative B or Alternative D were selected in order to allow use of herbicides in a few locations currently prohibited by the Forest Plan. The preferred alternative is the proposed action (Alternative B). It provides the level of protection necessary to maintain or enhance native plant communities and other natural resources on the Forests while minimizing the risk of adverse environmental or social impacts to the extent possible.

Review Comments: Reviewers should submit their comments during the 45-day review period for this draft EIS so they may be considered in the decision-making process. The Forest Service will consider all comments received and will respond to substantive comments in the final EIS (40 CFR §1503.4). Those who submit substantive comments during the comment period will be eligible to appeal the project decision (36 CFR §215). Reviewers must structure their participation in the National Environmental Policy Act process so that it is meaningful. Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the final EIS. Comments on the draft EIS should be specific, address the adequacy of the EIS or merits of the alternatives, along with supporting rationale (40 CFR §1503.3).

Comments on this draft EIS must be received or postmarked within 45 days of the Environmental Protection Agency's publication of the Notice of Availability in the Federal Register.

Send comments to:

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Comments must be received on or before: August 30, 2004

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Summary of the Draft EIS

Purpose and Need

This section describes the proposed action (project), purpose and need for the proposed action, public involvement, and issues identified.

Introduction

In northern New Mexico's Carson National Forest and Santa Fe National Forest, more than 7,300 acres of invasive nonnative plant populations (i.e. weeds) are known to impact National Forest System lands. Although this amount represents less than 0.5 percent of the 3 million acres managed by these two forests, weed treatments are most effective when the areas affected are small and before weeds are well established. It is important to control weed infestations at an early stage, before costly large-scale treatments such as aerial spraying become necessary.

This document summarizes the "Draft Environmental Impact Statement for the Invasive Weed Control Project." It provides an overview of the proposed action; the purpose and need for the project; the public involvement effort to date; issue and alternative development; and a summary of the expected effects of alternatives on the human environment.

Proposed Action

The project focuses on controlling invasive plants designated by New Mexico as weeds. These weeds occur on the Forests in various locations. Treatments would begin in 2005. During approximately the next 10 years, each forest anticipates treating 300 to 800 acres per year, based on anticipated funding. As many as 3,000 acres could be treated in a given year (1,500 acres on each forest) if funding permits. The implementation period could extend beyond 10 years if adaptive management monitoring shows the results lie within the expected sideboards.

Activities include eradication or control of weeds that pose a threat along riparian areas, roads, trails, recreation sites, administrative sites, gas/oil pads (and pipelines), and range improvements. Areas of recent disturbance—such as the Ponil Fire complex and other burned areas on the two Forests—will also receive attention. The proposal employs the following methods:

- Hand pulling, grubbing with hand tools or hand operated power tools, mowing and disking, or plowing with tractor-mounted implements;
- Biological control using insects or plant pathogens introduced into the weed habitat;
- Controlled grazing using goats and sheep to intensively and repeatedly graze weeds;
- Herbicide application to weed populations using hand or vehicle-mounted sprayer applications; and
- Prescribed burning using limited pile or broadcast burning to eliminate seed heads and resident populations of weeds.

Cultural plant methods would also be used as a followup treatment. These methods use native or appropriate nonnative plant species to supplant target weed species.

The scope of the proposal includes treatments to existing weed infestations, as well as an adaptive strategy for responding to infestations that have not yet been mapped. The adaptive strategy would evaluate new weed threats and if the effects fall within parameters described in this DEIS, permit immediate treatment. Failure to deal immediately with these new—usually small—infestations is likely to lead to larger scale treatments with greater impacts later.

Purpose and Need for Action

The primary purpose of and need for this project is to protect the abundance and biological diversity of desired native plant communities on the Forests, which in turn will help maintain and enhance wildlife and fish habitats, soil productivity and watershed conditions. This is especially important in the riparian areas and moist valley bottoms where critical habitat exists for many plant and animal species. Without effective control, weeds will increasingly impact natural resources on the Forests in the following ways:

- Native plant communities will become more impacted as weeds gradually take over dominance of these communities. Weeds often form monocultures or greatly simplified ecosystems. Ecosystem processes become degraded, with evidence of slower nutrient cycling and lower hydrological stability. They prove less sustainable when confronted with natural disturbances such as fire. Weeds also threaten the continued existence of certain endangered, sensitive or rare plant species that occur on the Forests.
- Erosion is increased by many weed species. Knapweeds and other weeds have a single, deep taproot and drive out native grasses that have better soil-holding root systems. Native riparian plants including rushes, sedges, willows and cottonwoods maintain streambank stability better than the weed species currently spreading through the Forests' riparian zones.
- Wildlife habitat quality decreases when weeds take over native plant communities. Palatable forage for game and nongame species of wildlife decreases as weeds like thistle, leafy spurge and toadflax take over. Weeds such as black henbane, poison hemlock and yellow starthistle can poison animals. Negative impacts to wildlife magnify in riparian areas because of the important role riparian vegetation plays for a large number of southwestern species. A large percentage of the known weed infestations occur in or near riparian areas.
- Recreation opportunities are lessened when dense weed infestations limit access to streams and riparian areas. Weed species with sharp thorns and stiff stems are reducing the quality of some recreation sites for picnicking and camping purposes. Some weeds cause allergies or skin irritations. Scenic values and wilderness characteristics also typically decline as weeds reduce the abundance and diversity of native plant communities.
- Culturally important plants such as osha, wild spinach, willow, and purslane would decline where weed invasions occur. Because many of the weeds occur near roads and trails, the ability to readily collect those plants would become more limited.
- Wildland fires are known to burn more intensely and severely in areas where weed species like salt cedar, Siberian elm and Russian olive have taken over native riparian ecosystems.
- Weeds primarily occur in the following locations (based on percent of inventoried weed infestations totaling approximately 7,350 acres):
    - Riparian areas and valley bottoms: 55 percent
    - Scattered patches and along low-level roads and trails: 19 percent
    - Major road corridors and recreation sites: 14 percent
    - In or along access into wilderness: 12 percent

In terms of current weed species distribution, the most dominant weed species are the nonnative thistles, followed by the valley bottom species of salt cedar, Siberian elm, and Russian olive. The table below shows the weed species distribution by percent of inventoried weed infestations.

Table 1. Weed Distribution by Species

Thistles (biennials and perennials)	67%
Salt cedar and Siberian elm	28%
Knapweed	3%
Toadflax	2%
Hoary cress, field bindweed, leafy spurge and poison hemlock	<1%
Perennial pepperweed, black henbane, and yellow starthistle	<0.5%

Public Involvement and Issues

In 1996-1997, the Forests met with other Federal, State and county land management agencies to discuss the threat of weeds. From 1998-2000, the weed control proposal was developed and various methods were used to inform and involve the public about the proposed project. These included a newspaper supplement, public meetings held in Taos and Española, and a scoping letter sent to approximately 450 individuals, agencies, tribal governments and organizations to inform them about the proposal. At that time, the Forests were conducting independent environmental assessments of similar proposals. As a result of the March 2000 scoping efforts, a decision was made to combine the environmental analysis efforts of the two forests and write a single EIS. In December 2000, the Forests sent another scoping letter and published a Federal Register notice of intent to prepare an EIS. At the request of local citizens, a public field trip was conducted to discuss and visit weed impact sites on the Tres Piedras Ranger District of the Carson National Forest.

Issues were identified from comments received during scoping. The primary issues revolved around concerns about how herbicides might affect human health, wildlife, fish and desired plant communities. On the other hand, there was an important concern that where non-herbicide methods were used, there would be less effectiveness and the potential for weeds to spread at a faster rate than they can be controlled. As they become more dominant on the landscape, they have greater resource impacts and become more costly and difficult to treat in the long run.

Alternatives Considered in Detail

This section summarizes the four alternatives considered in detail in the DEIS, the adaptive management strategy, treatment objectives and decision criteria, mitigation and monitoring requirements, and associated Forest Plan amendment.

> **Alternative A - No Action.** This is the baseline for comparing the other alternatives and is the alternative where proposed weed control actions would not occur on the Forests. Weed control would be limited to those actions previously approved on the Forests and those conducted by other jurisdictions and landowners in and around the Forests.
>
> **Alternative B - Integrated Strategy.** This is the agency's proposed action as previously described, developed to fully meet the purpose and need for action while minimizing the risk of adverse impacts through mitigation measures and monitoring requirements.

Alternative C - No Herbicides. This alternative eliminates herbicide use and was developed in response to public concerns raised about potential effects of herbicides on human health, fish/wildlife, and nontarget native vegetation.

Alternative D - Herbicides Only. This alternative exclusively relies on herbicides and was developed in response to the cost effectiveness issue associated with proposed non-herbicide treatments.

All action alternatives would employ the adaptive strategy to provide for timely response to newly discovered weed infestations, as well as changes to treatment methods as technology advances or as monitoring results indicate a need for change.

Adaptive Strategy

The action alternatives employ an adaptive strategy—especially Alternative B, but Alternatives C and D to a lesser extent. Using this adaptive strategy, weed treatments would be monitored, evaluated and modified as necessary to improve effectiveness of future treatments and/or reduce the potential for adverse effects to people and natural resources. This strategy also allows for applying the same weed control treatments to new weed infestation sites as long as the actions and effects (including decisionmaking criteria and limitations on treatments) are within the scope of the EIS and Record of Decision.

While Alternatives C and D would also employ the adaptive strategy, changes in methods would be limited to the nonherbicide or herbicide-only methods (respectively). For those two alternatives, methods could be slightly modified as needed to improve efficiency or reduce negative impacts, such as by altering the timing, equipment, herbicide type or application rate. The adaptive strategy would also be used to treat newly discovered infestations.

The adaptive strategy would cover weeds found in additional locations as well as new species found on the Forests. The Forests propose an adaptive strategy with the following actions:

- Annually inventory portions of the Forests that are likely to have new infestations (e.g. areas burned by wildfires or recently disturbed) and map new weed infestations. Budgets will govern the extent of these inventories.
- Identify the weed treatment objective, priority and methods to use for newly mapped infestations, based on the specific criteria described in the DEIS.
- Monitor the effectiveness and effects of weed treatment activities and associated mitigation measures.
- Evaluate and disclose monitoring results, and use those results to determine appropriate modifications in treatment prescriptions, mitigation measures or implementation practices.
- Implement modifications or other feasible and appropriate treatment methods based on monitoring results, as long as the action and its effects are considered by an interdisciplinary team and determined by the responsible official to be within the scope of actions and effects evaluated in the EIS (in accordance with Forest Service Handbook FSH 1909.15, Sec.18).

Treatment Objectives and Decision Criteria

Specific treatment objectives for a given weed species fall into one of the following categories:

- Eradication (elimination)
- Control (reducing the population over time)
- Containment (preventing the population from spreading).

Eradicating or controlling every weed infestation in 1 or 2 years is beyond the budget and personnel resources of the two forests. Therefore, a system for setting priorities is proposed so that treatment concentrates on species that have the greatest impact on the resource base, and those that become more difficult to control if action is delayed. Weeds become much more difficult to control once they have spread. Thus, the highest priority is to eradicate new species occurrences on the Forests, and then to keep existing populations from spreading or increasing in size.

In addition, new weed infestations found in the following locations would be considered for a possible elevated priority ranking:

- Areas that are now relatively weed free and have little or no road access, such as areas designated as wilderness, roadless recreation or semi-primitive non-motorized, including the road corridors and trails that lead to those areas;
- Areas that are now relatively weed free that provide unique and desirable wildlife habitat, such as recovery habitat for threatened or endangered species, deer and elk winter range; and riparian habitat;
- Areas on the Forests with weed populations adjacent to other land ownerships where land managers have active weed control programs;
- Areas of high human use, including but not limited to administrative sites, developed recreation sites such as campgrounds, scenic viewpoints, interpretive sites, and trailheads.

Schedules for implementing weed treatments would be based first on the priorities just described, and spread out over time based on levels of funding and staffing on the Forests.

Selection of treatment method is based to a large extent on the priority ranking of the weed species and the objective for a particular site, which is dictated by factors such as proximity to water or roads (which increases chance of spread), and the size of the weed infestation (small sizes are easier to eradicate).

In addition to using treatment objectives, priority rankings, and infestation size, other specific site conditions would prescribe treatment method limitations. Where present, these conditions will dictate use of methods that have a low risk to the resource factor of concern:

- Areas of high human use such as a recreation site, administrative site, or area where people often collect plants.
- Areas with a shallow water table (less than 6 feet deep) and soil with a high permeability rate, where there may be a risk of an herbicide leaching through the soil to the ground water.
- Riparian areas or next to live water bodies containing aquatic species (fish and insects).
- Presence or proximity of threatened, endangered or sensitive plant species.

- Presence or proximity of threatened, endangered or sensitive wildlife species.
- Wilderness and designated non-motorized areas.

Mitigation and Monitoring

The DEIS lists mitigation measures and monitoring requirements for all action alternatives. The mitigations were developed specifically for this project in order to avoid or minimize the risk of adverse project-related impacts to people or natural resources on the Forests, including potential impacts to human health and safety, native plants, special status plants or wildlife, soil, water, riparian and aquatic resources, and heritage resources. The bullets that follow summarize mitigation measures that are described in more detail in the DEIS.

- Human Health/Safety and General Mitigations: These govern herbicide application and use, public notification, traffic control, and other health/safety protection measures.
- Native Vegetation and Treatment Effectiveness: These direct the treatments so that they have a minimal impact on native vegetation. They include cleaning equipment, revegetation (or mulching as appropriate), and use of proper seed to revegetate.
- Threatened, Endangered and Sensitive Plants: These require survey and/or avoidance of occupied habitat. For Holy Ghost ipomopsis (the only Federally listed species in the project area), buffers apply to treatments such as grazing, mowing, prescribed burning and spraying herbicides.
- Wildlife, Including Threatened, Endangered and Sensitive Species: Depending on the level of protection required by law, regulation and policy, these measures require surveys and/or avoidance, and use of seasonal restrictions to reduce impacts during breeding periods. For example, controlled grazing with sheep or goats is prohibited in Rocky Mountain bighorn sheep habitat.
- Air, Soil, Water, Riparian and Aquatic Resources: These measures restrict types of treatments in certain places, such as slope restrictions for mechanical treatments and herbicide use restrictions near water or high water table locations. Although most herbicides would be permitted near water if registered for such use by the EPA, no direct application of herbicide to water (e.g. for aquatic plants) is permitted as part of this project. Procedural restrictions also apply. These include complying with smoke management for prescribed burns, and evaluating watersheds for total herbicide use before proceeding. Potential for accidental spills of herbicides, gasoline or other chemicals associated with treatments would be minimized by restrictions on where these chemicals can be handled. Spill prevention and cleanup plans and other established procedures also reduce the impacts to soil, water, and aquatic resources.
- Heritage Resources: A programmatic agreement among the Forests, State Historic Preservation Office and Advisory Council was developed for this project to ensure that heritage resources would be protected in accordance with applicable law, regulation and policy. The programmatic agreement spells out the requirements for conducting heritage resource inventories and evaluations for this project prior to implementation. It requires development of appropriate mitigation measures to avoid adverse impacts to heritage resources. Measures include limiting use of vehicles and other machinery that could disturb soil in sensitive areas, limiting herbicide use near certain sites, limiting controlled grazing near certain sites, and avoiding controlled fire within certain sites. Tribal consultation and pretreatment notification is included as an essential element. It describes

requirements for consultation with the State and application of additional mitigation measures if adverse impacts cannot be avoided while meeting project objectives.

- Monitoring and Adaptive Management**:** Weed inventories and mapping will be conducted annually. Treatment of newly found populations will be identified and prioritized. Treatments will be monitored for effectiveness and effects to other resources. If the treatments initially prescribed in the EIS are not effectively meeting the given treatment objective, another method may be used as long as the action and effects are within the scope of effects considered in the EIS. The evaluation and decision by the responsible official regarding consistency with the EIS will be documented in the project record.

Forest Plan Amendment

Alternatives B and D would require an amendment to the Santa Fe National Forest Plan in order to be approved as written. These alternatives propose use of herbicides in places and under conditions that were not foreseen when the existing Forest Plan standards and guidelines were developed. The Forest Plan (page 76) currently prohibits herbicide use within municipal watersheds, in areas of human habitation, on soils with low regeneration potential or less than moderate cation exchange capacity (USDA FS 1987). The proposed amendment would modify these standards in order to allow herbicides to be used where necessary in those situations, with specific limitations. The Santa Fe National Forest Plan also prohibits herbicide use if an environmental analysis shows that it is not “environmentally, economically or socially acceptable,” which is an ambiguous standard and subject to variable interpretations. The amendment would modify that standard so it is more consistent with environmental analysis requirements under NEPA.

To meet the purpose and need for this project and protect ecosystem diversity and sustainability in the long term, it may be necessary to occasionally apply herbicides within those areas if they are infested with weed populations that cannot be effectively treated with other methods. The proposed amendment would continue to maintain adequate protection for municipal watersheds, soil productivity, and human health and safety. For instance, soil erosion rates would still be required to remain within tolerance levels based on the Terrestrial Ecosystem Survey data, in order to maintain long term soil productivity. The Forest Plan standard regarding cation exchange capacity is outdated and would be deleted from the Forest Plan, as that measurement is no longer used by the Forest Service. Table 2 uses ***italics*** to show the specific language changes in Forest Plan direction.

Table 2. Proposed Santa Fe National Forest Plan Amendment

Existing Forest Plan Direction	Proposed Forest Plan Direction
Chemical treatments may be applied: - When determined through an environmental analysis to be environmentally, economically, and socially acceptable. - On areas outside municipal watersheds and areas of human habitation. - On soils with moderate or high revegetation potential.	Chemical treatments may be applied: - When determined through an environmental analysis to ***have no long-term adverse environmental, economic, or social impacts.*** **- *Within municipal watersheds only when the municipality concurs with the proposed treatment prescription and mitigation measures to be implemented.*** **- On *any soils provided that effective ground cover is quickly restored and soil erosion on that site is not reduced to below the tolerance level identified in the Terrestrial Ecosystem Survey for the affected soil unit.***

Environmental Consequences and Comparison of Alternatives

This section provides a comparative summary of the alternatives in terms of the most significant issues or effects anticipated, based on the analysis in the DEIS. The DEIS describes the affected environment and environmental consequences, including analysis methods, in detail.

Environmental Consequences Summary

The most noticeable consequences from weed treatment Alternatives B, C, and D would be the long-term beneficial improvements to native ground vegetation such as grasses, forbs and shrubs. Riparian vegetation such as rushes, sedges, willows and cottonwoods would particularly benefit from this project. Protecting and improving native plant communities would have positive effects on soil and water conditions, as well as wildlife and aquatic habitats (particularly due to enhancing riparian vegetation).

Negative effects to native vegetation, soil, water and aquatic organisms would be minor and of short duration. The minor, short-term increases in sediment (more with Alternative C) and herbicide delivery to streams (Alternatives B and D) would have no significant consequences. There would be a low risk of adverse impacts to fisheries, including Rio Grande cutthroat trout (a sensitive fish species) or other aquatic organisms based on application of mitigation measures, risk assessment and EPA guidelines, and maintaining herbicide levels well below impact thresholds established in the analysis for each watershed. Alternative C would cause more ground disturbance and associated impacts to soils, especially on soils with severe erosion hazard rating. However, all alternatives would remain with soil erosion tolerance levels needed to protect long-term soil productivity. Soils with low revegetation potential would receive herbicide treatments in Alternatives B and D, while reestablishing native vegetation would take longer under Alternative C. Mitigation requirements for all alternatives would ensure that vegetative ground cover is adequately reestablished. With the required mitigation measures, all soil and water quality standards would be met.

Differences between alternatives in their effects to air quality, heritage resources, livestock grazing, recreation, wilderness and visual resources were expected to be negligible, such that they would not be given weight in the decisionmaking process. There would be minor increases in noise and traffic, although generally within background levels.

By controlling the spread of weeds and protecting native plant communities, habitats and watershed conditions on the Forests, Alternatives B and D would maintain or enhance social or economic conditions, particularly for local rural communities in northern New Mexico who typically rely on the Forests' natural resources for their livelihood, traditional culture and quality of life.

Comparison of Alternatives

The alternatives are compared in terms of the significant issues, as well as how well they meet the purpose and need (objectives) for the project. Table 3 provides the comparison of alternatives, based on the detailed environmental analysis documented in the DEIS. The comparison table is intended to provide a clear basis for choice between alternatives.

Table 3. Comparison of Alternatives by Issues and Objectives (Purpose and Need)

Significant Issues and Objectives	Alternative A	Alternative B	Alternative C	Alternative D
Issue 1: Herbicides and Human Health	No risk of health impacts from herbicide exposure (0 acres treated with herbicides).	Low risk of health impacts from using herbicides, to workers or general public, based on EPA ratings, risk assessments and other mitigation measures. Higher risk to people with multiple chemical sensitivities, although public notification requirement allows for avoidance of treated areas. Approx. 70 percent of treatments include herbicides (5,150 acres).	No risk of health impacts from herbicide exposure (0 acres treated with herbicides). Slightly increased risk of exposure to smoke from prescribed burning.	Same as Alt. B but slightly higher risk of exposure for people with chemical sensitivities. One hundred percent of treatments include herbicides (5,435 acres).

Significant Issues and Objectives	Alternative A	Alternative B	Alternative C	Alternative D
Issue 2: Herbicides and Wildlife	No risk of herbicide impacts to wildlife. Weeds would degrade native plant habitats, especially riparian areas important to numerous species.	Low risk of herbicide impacts to wildlife based on EPA ratings, risk assessment, and mitigation measures. Native wildlife habitat quality (especially riparian habitat) would improve as weeds are eradicated and controlled.	No risk of herbicide impacts to wildlife. Less improvement in wildlife habitat.	Same as Alt. B
Issue 3: Herbicides and Native Plant Communities	No short-term impacts from herbicides. In the long term, weed-caused decline in abundance and diversity of native plant communities, especially native riparian plants.	Short-term reduction in some nontarget plant species. Long-term improvement in abundance and diversity of native plant communities, especially riparian plants.	Similar short-term reduction in nontarget plants. Low to moderate long-term improvement in native plant communities. Weed spread rate may equal or exceed control rate without herbicide use.	Same as Alt. B
Issue 3: Continued- Rare or Sensitive Native Plant Species	No risk of treatment-related impacts. In the long term, weeds may cause a decline in Federally listed or sensitive plant species.	No impact to threatened or endangered plants due to mitigation measure. For sensitive plants, treatments “may impact individuals but are not likely to result in a trend toward Federal listing or loss of population viability,” due to mitigation measures and species locations.	Same as Alt. B	Same as Alt. B

Significant Issues and Objectives	Alternative A	Alternative B	Alternative C	Alternative D
Issue 4: Cost and Treatment Effectiveness (based on level of effort to meet objectives)	No cost effectiveness. Would incur much higher costs in future.	Moderately cost effective; $1,313,000 relative cost.	Least cost effective; $1,585,000 relative cost.	Most cost effective; $550,000 relative cost.
Objectives: Protect native plant communities, soil and water quality, wildlife habitat, and long-term ecosystem health	No protection; no effectiveness. Weed-related impacts to vegetation, soil, water, riparian habitat, etc. would continue.	Highest level of treatment effectiveness and resource protection from weed impacts due to combination of treatments including herbicides.	Lowest level of effectiveness and resource protection from weed impacts. Fewer acres treated annually for a given budget due to need for repeat treatments on the same acreage.	High level of effectiveness and resource protection from weed impacts. Not quite as effective as herbicides combined with other methods.

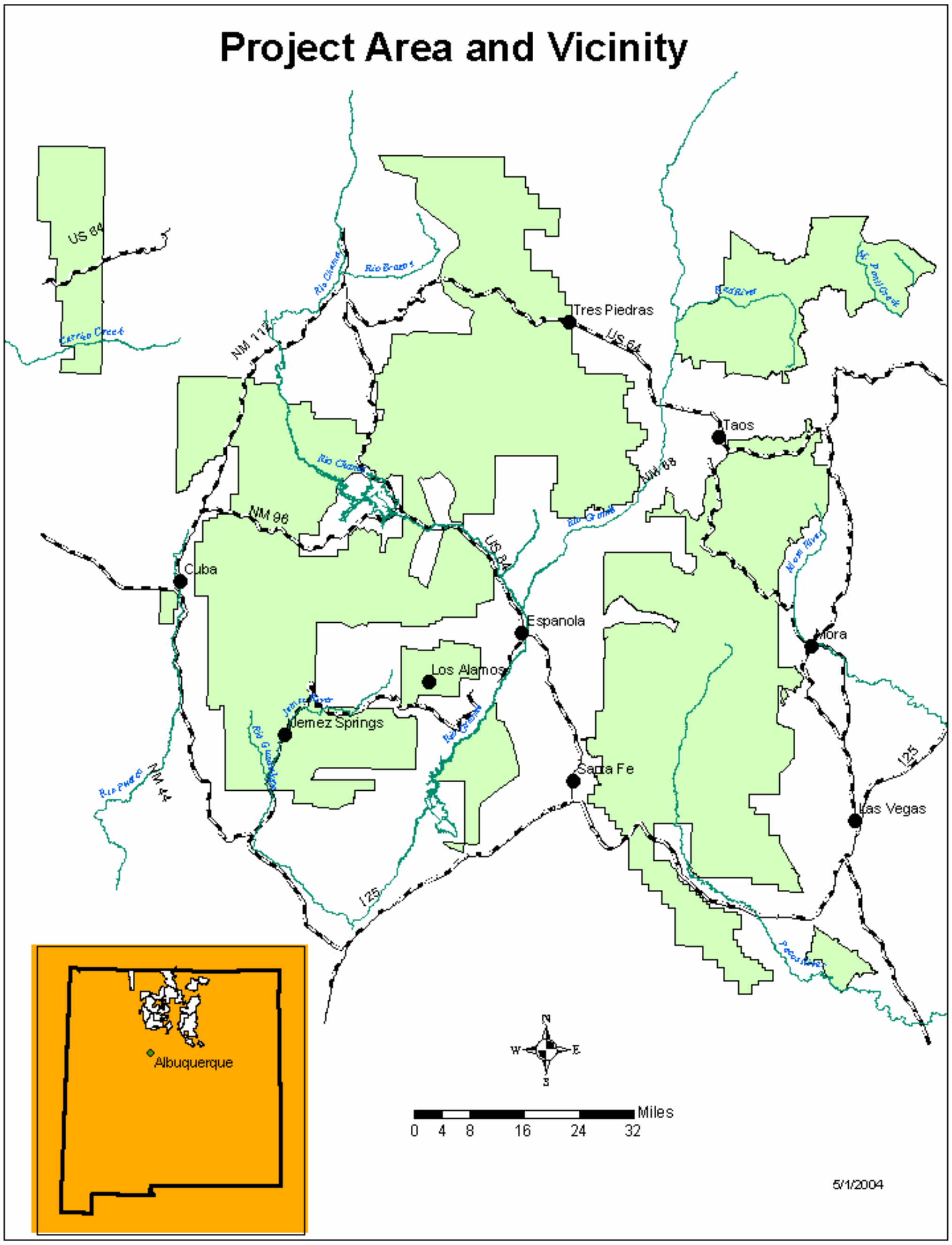


Figure 1. Project Area and Vicinity

Chapter 1 • Purpose and Need

Introduction and Setting

This draft environmental impact statement describes how the Carson and Santa Fe National Forests (Forests) propose to control the spread of invasive, nonnative plants (hereafter referred to as weeds) on National Forest System lands within the Forests boundaries. This document was prepared in accordance with the National Environmental Policy Act and its implementing regulations (40 CFR 1500-1508), as well as other environmental laws and regulations, to evaluate and disclose the effects of weed control treatment activities. Additional documentation, including more detailed analyses of project-area resources, may be found in the project record, available for review upon request from the supervisor's offices for either of the Forests.

The Forests are located adjacent to one another in north-central New Mexico. Figure 1 is a map of the project area and vicinity. The physiography of the two forests is highly varied, consisting of mountains, mesas, hills, valleys, canyons and grasslands. The Forests are within the Southern Rocky Mountain physiographic province and Rio Grande Subsection of the Basin and Range Province (Williams 1986). The Sangre de Cristo, San Juan, Jemez, and San Pedro mountain ranges are dominating features of the landscape. Elevations range from approximately 6,000 feet in the grasslands to 13,000 feet at the summit of Wheeler Peak. Many peaks exceed 9,000 feet in elevation.

The climate varies from arid, semiarid highland, and humid to subtropical depending upon the elevation. Precipitation ranges from 10 to 35 inches per year with higher amounts received at higher elevations. Precipitation comes primarily in the form of short duration, high intensity storm events during July and August, along with winter snow accumulations at the higher elevations. Air temperatures vary from approximately 95 ^{o}F in the summer to –25 ^{o}F in the winter (USDA FS 1986)**.**

Purpose and Need for Action

The purpose of and need for controlling or eradicate weed infestations on the Forests is to maintain or improve the diversity, function and sustainability of desired native plant communities on the Forests. Protecting the abundance and diversity of native plant communities will also help maintain or enhance other natural resources that can be impacted by weeds and the loss of desired plant communities. Weeds are aggressive, undesirable plants that are a serious threat to the Forests. Weeds typically out-compete native plants for space, water, and nutrients, as they have characteristics that give them a competitive advantage over native plant species. They demonstrate high reproductive capacity through prolific seed production and root sprouting. If left uncontrolled, they tend to dominate areas and reduce the diversity and sustainability of native plant populations. In some areas, weeds have increased so dramatically that they create a monoculture by entirely taking over large areas.

The Forests have a narrow window of opportunity to initiate effective and cost-efficient actions to protect native plants and animals, and soil and water resources before the infestations become much more difficult and costly to control. Controlling the spread of weed species is now a regional and national priority in the Forest Service and other land management agencies.

In general, weed invasion and spread results in a loss of natural diversity and reductions in the quality of wildlife habitat, soil stability and water quality. Weeds can alter ecosystems by changing the frequency and intensity of wildfires (Quigley and Arbelbide 1997, Tu et al. 2001). More specifically, where weeds occur and continue to spread over native grasslands, riparian areas, rare plant areas, and other sites on the two forests, they are causing a reduction in the abundance and variety of native plants. This in turn impacts the abundance and diversity of wildlife species that depend on those native habitats. In addition, the root systems of some weed species do not hold the soil in place as well as native plants, resulting in increased soil erosion and streambank instability (Lacey et al. 1989). Some weeds, such as salt cedar (also known as tamarisk) reduce water quantity, which is particularly critical to the arid lands in New Mexico.

In New Mexico, the occurrence of weed species is increasing exponentially. At the current rate of increase, several new weed species are projected to appear per year (Renz 2004). While the number of known weed infestation sites on the Forests is relatively small, occupying less than half of one percent of the 3 million acres of land on the Forests, there are likely many more weed infestation sites that have not yet been discovered, and weeds typically spread at a rate of between 5 and 30 percent per year, depending on the plant species and site-specific conditions (Tu et al. 2001).

Without effective control treatments, the continued spread of weeds is likely to result in the following environmental impacts:

- Ecosystems dominated by invading plants tend to be lower in productivity, slower in nutrient cycling, less stable hydrologically, and less sustainable when confronted with natural disturbances such as fire. Monocultures of single weed species replace natural, diverse ecosystems. The establishment and spread of weeds often signals the ecological decline of entire watersheds because of the detrimental impact of their spread on the diversity of plant communities (FICMNE, 1998).
- Soil quality and stability are impacted by weeds. The Forests have areas of highly erodable soils, which are currently stabilized by vegetation such as bunch grass. Knapweed invasion in these sites has the potential to replace the fibrous rooted grass species that provide high soil retention with a plant that has a single, deep taproot, thus reducing the soil holding capacity of the vegetation (Lacey 1989). In addition, Russian knapweed and diffuse knapweed populations are found in scattered locations near campgrounds and along roads, which can lead to their rapid spread.
- Water quality is impacted by weeds. Across the two forests, more than 4,000 acres of known weed populations are found in valley bottom lands and along streamsides. Also as vegetation cover changes to one or more weed species, the amount of surface water runoff and stream sedimentation is likely to increase as well. Weeds that have been found to displace native rushes and sedges along streams typically reduce the soil stability of those streambanks. Water quality can become degraded from these changes in plant composition along streams. Previously approved treatments to remove salt cedar, Russian olive and Siberian elm from riparian areas along the lower Jemez River on the Santa Fe National Forest are showing good success in restoring native riparian vegetation such as willows, cottonwoods, sedges and rushes.
- Riparian areas that should provide excellent nesting habitat to wildlife species such as Southwestern willow flycatcher are dominated by salt cedar and Russian olive, which provide usable, but poor nesting habitat. The U.S. Fish and Wildlife Service found that the flycatcher "sometimes nests in salt cedar, but does so at lower densities, and apparently at lower success rates than native vegetation (Hunter et al. 1988, Sogge et al. 1993, Muiznieks et al. 1994 in 60 FR 10699). Therefore, salt cedar invasion likely represents replacement of native habitat with lower quality habitat, rather than an

increase in habitat availability" (60 FR 10699). For the flycatcher and similar riparian-dependent species, continued decline in the native riparian plant species may have a detrimental impact. Salt cedar also reduces water availability in riparian habitats by as much as four times that of natural vegetation such as willow and cottonwood. In addition, salt cedar has a deep root system (as deep as 100 feet compared with cottonwood's root depth of 6 feet) that allows it to spread quickly away from the immediate riparian area and into more terrestrial vegetation, where it can replace relatively dry site grasses (Carpenter 1998, DeLoach 1997, DeLoach 2000, Weeks 1987).

- Weeds impact the recovery and maintenance of threatened and endangered plants. The Holy Ghost ipomopsis is an endangered plant that occurs along a road on the Pecos/Las Vegas Ranger District. The road is a popular access route to the Pecos Wilderness, as well as other recreation activities. Without weed control treatment, populations of bull thistle and scotch thistle are likely to invade the site where Holy Ghost ipomopsis grows. Because these weeds prefer similar conditions as the ipomopsis plant, an infestation would be a detriment to the Holy Ghost ipomopsis population. The threat of weeds taking over sites currently comprised of rare plant species is also of particular concern in designated botanical special interest areas on the Santa Fe NF.
- Wildlife habitat is degraded or lost when weeds cause a decline in native ground vegetation that provides nesting cover, seed-producing foods, and habitat for small mammals. Large areas of weed infestations would likely lead to a reduction in populations of deer, elk and nongame wildlife populations (FICMNE 1998). Palatable forage for game and nongame wildlife species decreases as weeds take over. The North Ponil area on the Carson NF has more than 1,000 acres of bull thistle, along with small populations of knapweed and leafy spurge, threatening this area's habitat quality. In addition, grazing and foraging animals (livestock, elk, deer, etc.) can be injured or die from weeds that are poisonous to animals that feed on them, such as black henbane and poison hemlock (FICMNE 1998). Yellow starthistle can induce a neurological disorder in wild or domestic horses that is usually fatal.
- Weeds impact the quality of recreational activities on the Forests. Along trails, hikers encounter thistles and knapweeds that have spiny flowers and leaves. Dead weed stalks are known to impede access to meadows and riparian areas, or discourage return trips (FICMNE 1998). Increased weed spread is expected along popular recreation use corridors such as State Highway 38 (Questa Ranger District), State Highway 4 (Jemez Ranger District) and State Highway 63 (Pecos/Las Vegas Ranger District). The North Ponil area of the Questa Ranger District demonstrates this growing conflict as bull thistle populations spread through the Ponil Fire burned area. Salt cedar is becoming so dominant along some streams that it is limiting public access to those popular streamside areas (USDA FS 1999). In addition, forest visitors and workers may come in contact with some weeds such as leafy spurge which poses a health threat.
- Areas of high scenic value are becoming degraded as weeds tend to occur and spread along the sides of popular and visible roads and trails, as well as in riparian areas and grassy meadows. As single species weed monocultures continue to develop and replace a diverse composition of native plants, aesthetic or scenic values of these areas diminish.
- Wilderness characteristics are threatened as weeds spread into these areas and form monocultures, reducing the natural diversity and integrity of native plants and animals. These changes in plant composition lead to detrimental changes in ecological processes and functions. Although the wilderness areas on the two forests do not show high

numbers of infestations (about 25 acres found so far), routes into the wilderness areas exceed 800 acres and have a high potential to spread into the wilderness areas.

- Culturally important plants such as osha, quelites (wild spinach), willow, chimaja, or purslane tend to decline where weed invasions occur (Bremer 2003). Because many of the known weeds occur near roads and trails where weed spread is most common, their availability will become increasingly more limited.
- Local economies can be indirectly impacted as weeds, which cause declines in habitat quality for game animals and fish, reduce revenues from hunting and fishing. Declines in habitat and forage quality also reduce the economic value of our rangelands and pastures. In addition, weeds that cause a decline in native plants impact people who use native plants for making dyes and baskets.

The Forests are in a good position to deal with these plants now because the weed problem on the Forests has not reached an epidemic level where it would take large-scale, costly efforts to solve. If the problem is treated in this early stage, using an integrated approach, it can be managed much more quickly, with less ground and habitat disturbance, and without the use of aerial herbicide spraying.

Background: Existing Condition

The New Mexico Department of Agriculture (NMDA) established a list of 32 weed species considered to be "noxious" and known to occur or with potential to occur within the State[1] (NMDA 1999). The NMDA categorizes the weeds into three classes:

- **Class A weeds** have very limited distribution in New Mexico, and include species threatening to invade the State;
- **Class B weeds** have distribution limited to a particular area of the State; and
- **Class C weeds** are distributed throughout the State.

Of the 32 weeds listed with the State, the Forests targeted 19 species that are known to occur, and 5 species that have potential to occur on the Forests. Some species were removed from the Forest lists because they are medicinal plants such as St. John's wort (*Hypericum perforatum*) and wild licorice (*Glycyrrhiza lepidota*). Table 5 lists these species and their main threat to the Forests.

Figure 6 displays the general distribution of weed species across the project area, although the points on the map do not accurately represent the size or extent of each weed infestation, and most infestations are currently relatively small.

In a broad sense, a weed may be thought of as simply a plant out of place. A plant may be desirable in one place and undesirable in another: For example, grass in a lawn compared with grass in a garden; or a Russian olive tree decorating a suburban home compared with invading a wildland riparian area. In land management terms, a more precise definition is "plants that interfere with management objectives for a given area of land at a given point in time" (Whitson

[1] In a September 20, 1999 letter to the public, Frank A. DuBois, Director of the New Mexico Dept. of Agriculture, announced the selection of plant species to be targeted as noxious weeds pursuant to the Noxious Weed Management Act of 1998.

1992). Federal law defines weeds in a similar way and provides national direction for dealing with weeds[2].

For the last several years, resource specialists on both forests have noticed weed species increasing on the Forests. Weed surveys were initiated on both forests in 1997 and have continued up to the present. The first surveys sampled a portion of each ranger district and found 16 species. The surveys completed to date were primarily roadside surveys and did not cover the entire forest. Not all disturbed sites (such as recent fires) have been completely surveyed, but these areas serve as likely places for weeds to gain a foothold. As summarized in Table 4 and displayed in Figure 6, of the 3 million acres comprising the two forests, there are approximately 7,350 acres of known weed infestations in a wide range of sizes and a broad distribution. The size of each infestation currently varies from less than one acre to several hundred acres. Most infestations (more than 75 percent) are less than an acre in size. Appendix 7 provides a list of each mapped infestation, including weed species, infestation size, and location. It is important to note that the existing weed inventory probably represents a small sample of the acres where weed infestations may be found on the Forests.

The mapped weed sites do not reflect the density of weeds within each site. Most of the mapped weed sites include patches without weeds that would not be treated. Therefore, not all 7,350 acres would be treated. On the other hand, most weed-infested sites require repeat treatments on the same area in order to meet the treatment objective.

Most of the weed populations on the Forests are along roads, in developed or dispersed (undeveloped) recreation sites, in valley bottoms and along streams. Weed infestations also occur on the roads and at trailheads leading into wilderness areas on the Forests and a few weeds have already spread into the wilderness.

Table 4. General Groups of Weeds

Infested Areas	Estimated Acres	Minimum Size	Maximum Size	Average Size
Along Roads/Trails	1,052	0.01	74.00	3.80
Valley Bottoms/Riparian Areas	4,032	0.01	1,035.00	10.40
Scattered	1,380	0.10	65.70	5.60
Well Pads (Jicarilla Ranger District)	12	0.20	0.40	0.30
Wilderness	25	0.10	5.60	0.90
Wilderness Boundary Roads/Trailheads	871	0.10	100.00	8.20

Bull thistle is the most abundant weed on the Forests, covering a total of about 2,540 acres and ranging in population size from a few hundred square feet up to a 130-acre patch on the Questa Ranger District of the Carson NF. The combination of Canada thistle and musk thistle are quite common, with 1,930 acres found so far on the Forests.

[2] The Federal Noxious Weed Act of 1974 defines weeds as “any living stage (including but not limited to seeds and reproductive parts) of any parasitic or other plant of a kind, or subdivision of a kind, which is of foreign origin, is new to or not widely prevalent in the United States, and can directly or indirectly injure crops, other useful plants, livestock, or poultry or other interests of agriculture, including irrigation or navigation, or the fish or wildlife resources of the United States, or the public health.”

Smaller populations of weed species (or groups of species) are, in order of abundance: knapweeds (200 acres), toadflaxes (63 acres), hoary cress/field bindweed (54 acres), leafy spurge (42 acres) and poison hemlock (22 acres). Less than an acre each of yellow starthistle and perennial pepperweed are found on the Forests. Although small in size and number, these populations pose a threat because of their ability to take over a vegetation community and their potential to spread. Once they become established across large areas, these species become difficult to eradicate. Also, these weed survey results underestimate actual weed infestations on the Forests, since many areas have not been surveyed.

In valley bottoms or in riparian areas, the salt cedar/Siberian elm/Russian olive/bull thistle complexes predominate (about 2,000 acres), along with populations of bull thistle, Canada thistle and musk thistle (about 2,100 acres of pure stands and intermixed thistle complexes). Hoary cress (29 acres), knapweeds (45 acres), leafy spurge (39 acres), yellow toadflax (47 acres) and poison hemlock (22) pose a special threat, even though the numbers are small, because of their ability to take over plant communities.

Wildlife species depend heavily on these riparian areas in the arid southwest, and so the weeds' ability to reduce native plant diversity has a magnified impact on the Forest's wildlife habitats. Along travel corridors, more than 5,000 acres of weeds are found that pose a threat of spreading into other places that have not yet been infested[3]. Bull thistle (470 acres) and Canada thistle (266 acres) are the most likely to spread, but small populations of leafy spurge found along Hwy. 285 and Hwy. 64 near Tres Piedras also pose a threat of spread.

Away from valley bottoms, riparian areas, and main travel routes, Canada thistle/musk thistle (1,320 acres) and bull thistle (1,300 acres) pose the largest threat of spreading because of their wide distribution. The largest concentration of known bull thistle lies in the Ponil Fire burn area in the Valle Vidal (1,250 acres). On the Jicarilla Ranger District, infestations of scotch thistle/musk thistle are found at natural gas wellheads and along roads leading to these facilities. Although the amount of scotch thistle is relatively small, the potential for spread is high because of the intermingled nature of land ownership and use in this area. Cooperation among all the land management agencies is particularly important in order to control this threat. Along the Rio Tusas drainage, the amount of leafy spurge is relatively small, but when the threat is seen in the context of infestations on adjacent private land, the threat increases.

Weeds are projected to increase annually in the United States at a rate of 8 to 12 percent per year without treatment (FICMNE 1998). Projections on the two forests predict that the spread is expected to be between 5 and 30 percent annually, slightly lower than the national average for some species and conditions based on arid southwestern growing conditions. Salt cedar found in riparian areas is expected to increase at a slower rate, and leafy spurge would likely increase at the higher rate. For purposes of this analysis, an estimate of 8 percent per year is used in order to account for growth without overstating the estimates in the face of the variable nature of the species and other conditions.

Table 5 gives a brief description of known weed species. For a more detailed discussion, see Appendix 2, "Weed Species Ecology and Impacts."

[3] Some weed infestations along roads are also found near riparian areas and so total acres are not additive.

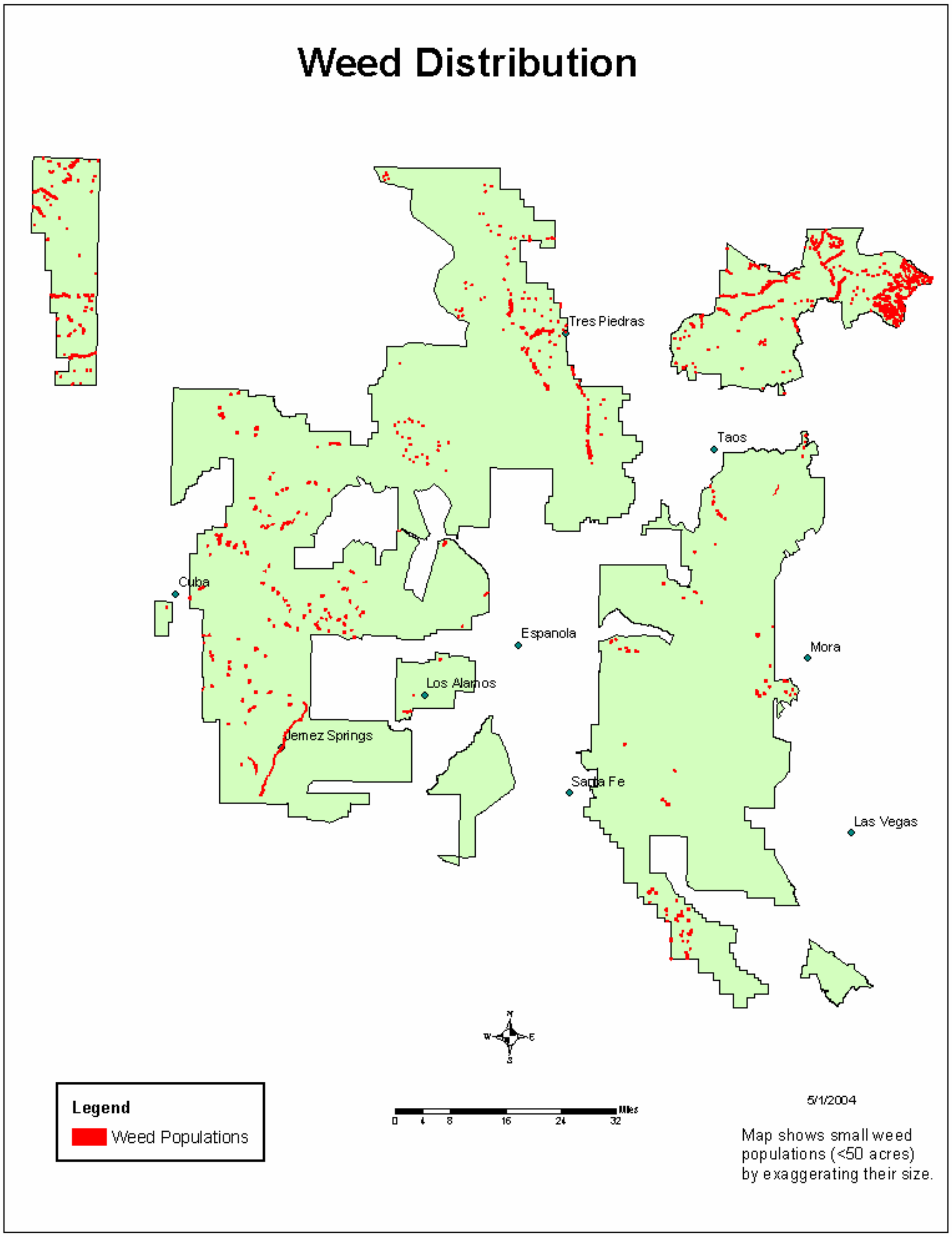
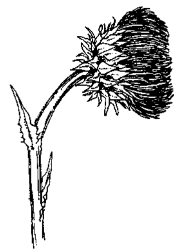
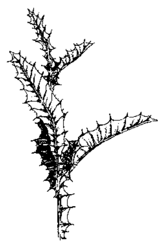


Figure 2. Weed Distribution

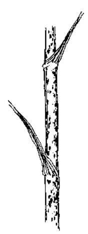
Table 5. Weed Species: Locations and Impacts

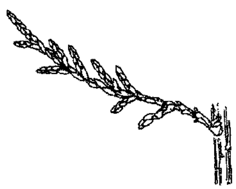
	Weed Species	Life Cycle[4]	Location	Impact
	Black henbane (*Hyoscymas niger*) HYNI	Biennial	Found in pastures, fence rows, roadsides, and riparian areas.	Poisonous to livestock and a health threat to humans.
	Bull thistle (*Cirsium vulgare*) CIVU	Biennial/annual or short-lived perennial	Grows on heavy, fertile soils and can dominate openings quickly. Often found in association with musk thistle.	Reduces forage in natural areas by replacing usable forage with spiny, inedible vegetation.
	Canada thistle (*Cirsium arvense*) CIAR4	Perennial with root sprouting	Found almost anywhere. Often found in association with musk thistle.	Competes with and displaces native vegetation. Decreases species diversity and changes the structure and composition of some habitats to reduce the effectiveness for native animal species.

[4] Perennial plants persist year round and so have a high capacity to spread. Annuals grow and die after a year and so can reproduce fast, but are more vulnerable to actions that disrupt this pattern. Biennials take 2 or more years to complete their life cycle and so are the most susceptable to efforts that disrupt their reproductive pattern. These characteristics in combination with a plant species reproduction means (seed, root sprouting or both) factor in how fast weeds can take over a site and spread to new places, and how well it can be controlled.

	Weed Species	Life Cycle[4]	Location	Impact
	Musk thistle (*Carduus nutans*) CANU4	Biennial or annual	Found in association with a number of other thistles. In disturbed areas but can invade native grasslands. Grows best in moist alluvial soils, but tolerates a wide range of conditions.	Chemically alters soil to inhibit germination and growth of other species. Weakens other species. Replaces forage with inedible vegetation.
	Scotch thistle (*Onopordum acanthium*) ONAC	Biennial or short-lived perennial	Roadsides/well pads on the Jicarilla Ranger District.	Reduces productivity and strongly competes with native plants for resources. Replaces desirable species.
	Dalmation Toadflax (*Linaria dalmatica*) LIDA yellow toadflax (*Linaria vulgaris*) LIVU2	Perennial	Found along road, in pastures along fences, rangelands and clearcuts.	Pushes out native grasses and other perennials to change the species composition of natural communities. Seedlings are less effective at competing for nutrients and moisture than developed plants.
	Diffuse knapweed (*Centaurea diffusa*) CEDI3	Annual, biennial, or short-lived perennial.	Rights-of-way, farm roads. grasslands, shrub lands and riparian communities.	Forms dense colonies that reduce population of native species and serve as precursors to other weeds (like leafy spurge).

	Weed Species	Life Cycle[4]	Location	Impact
	Spotted knapweed (*Centaurea biebersteinii*) CEBI2	Biennial or short-lived perennial.	Prefers disturbed areas to establish but can spread into undisturbed areas once in a site.	Highly adapted to capturing moisture and nutrients so it can spread and choke out native species. Decreases the water storage capacity of soil and can increase soil erosion potential by replacing native plants' network root system with taproot.
	Yellow starthistle (*Centaurea solstitalis*) CESO3	Annuals	Open grasslands	Uses more water than native species and out-competes for it. Reduces wildlife habitat and forage. Can kill horses if ingested.
	Field bindweed (*Convolvulus arvensis*) COAR4	Perennial vine	Wide range	Takes nutrients and water to reduce the abundance and vigor of native plants and habitats
	Hoary cress (white top) (*Cardaria draba*) CADR	Perennial	Grows in nonshaded, disturbed areas, including roadsides, and watercourses (ditches).	Displaces native forage species and reduces forage quality because it is toxic to livestock.

	Weed Species	Life Cycle[4]	Location	Impact
	Leafy spurge (*Euphorbia esula*) EUES	Perennial	Pasture	Displaces all other vegetation in pastures, rangelands and native habitats. Hillsides and prairies. Can displace all forbs and grasses in natural areas. Root system allows persisting even after treatment. Chemically changes the soil to eliminate other competing plants.
	Perennial pepperweed (*Lepidium latifolium*) LELA2	Perennial	Riparian areas, wetlands and marshes.	Creates monoculture that displace native plants and reduces habitat effectiveness for native animals.
	Poison hemlock (*Conium maculatum*) COMA2	Biennial or annual	Roadsides, field margins, and ditchbanks.	Displaces native species after disturbance. Degrades habitat quality quickly. Poisonous to humans
	Russian knapweed (*Acroptilon repens*) ACRE3	Perennial	Found in grass and shrub lands as well as riparian forests.	Reduces desired vegetation such as perennial grasses. Chemically alters sites to eliminate competition.

	Weed Species	Life Cycle[4]	Location	Impact
	Russian olive (*Elaeagnus angustifolia*) ELAN	Perennial shrub/tree	Found in or near riparian vegetation.	Creates dense, monoculture stands that out-compete native vegetation, modifies vegetation structure and displaces native wildlife. Alters nutrient cycling and system hydrology by spreading through woodlands and connecting lowland riparian forests with more open, upland areas. This has an impact on long-term establishment of native riparian species, such as cottonwood.
	Salt cedar (tamarisk) (*Tamarix* spp) TAMAR2	Perennial shrub	Riparian areas	Replaces native wood species such as cottonwood, willow, and mesquite. Chemically alters the soil to eliminate competition from native species to reduce the habitat effectiveness for native wildlife species. Uses more water than native species and changes the flood/sediment deposition regime so that native species such as cottonwood cannot regenerate
	Siberian elm *Ulmus punila*) ULPU	Perennial tree	Near moist areas, riparian	Can out-compete native trees species such as cottonwood and willow.

Additional species of weeds on the NMDA list with potential for introduction and spread on the Forests (USDA NRCS 2002) would be prioritized for early detection and eradication, before they become well established and are more difficult to control. These species are:

- African rue (*Peganum harmala*),
- Alfombrilla (*Drymaria arenaroides*),
- Camelthorn (*Alhagi pseudalhagi*),
- Dyers woad (*Isatis tinctoria*),
- Eurasian watermilfoil (*Eurasian spicatum*),
- Halogeton (*Halogeton glomeratus*),
- Hydrilla (*Hydrilla verticillata*),
- Jointed goatgrass (*Aegilops cylindrical*),
- Malta starthistle (*Centaurea melitensis*),
- Onionweed (*Asphodelus fistulosis*),
- Purple loosestrife (*Lythrum salicaria*),
- Purple starthistle (*Centaurea calcitrapa*), and
- teasel (*Dipsacus fullonum*).

Management Direction - Desired Condition

The Forest Plans for the Forests established broad programmatic management direction (goals, standards and guidelines) applicable to this project. The Forest Plans contain numerous standards and guidelines (i.e. management direction) for maintaining biological diversity, long-term soil productivity, water quality, stable and productive watershed conditions, habitat for rare plant and animal species, and visual quality—all resources that are threatened by continued weed infestation and spread.

The Carson National Forest Plan describes a goal to "maintain genetic and ecological diversity" for sustaining the forestlands (USDA-FS 1986, Sustainable Forests Section, p. 2), as well as a vision statement in the wildlife and fish section that emphasizes biological diversity (USDA-FS 1986, Wildlife and Fish Section, p. 1).

Several standards in the Santa Fe National Forest Plan emphasize promoting improvements in diversity and hydrologic conditions. For example, it states, "riparian areas will be enhanced through direct improvement projects," and that the forest will "achieve satisfactory condition in riparian ecosystems." (USDA FS 1987, p. 20).

The Santa Fe National Forest Plan has management direction specific to weed control treatments such as: "Select treatment methods for plant control according to the NEPA process and the following criteria." The criteria include numerous limitations for each weed control method involved in the integrated weed treatment strategy: mechanical (large equipment), prescribed fire, biological, manual, and chemical. (USDA FS 1987, pp. 75-76).

The Santa Fe National Forest Plan also describes the goal of maintaining diversity of plant communities and different ages (USDA FS 1987, p. 9). The Santa Fe Plan also states that it will "improve much of the unsatisfactory watershed condition by improving vegetative conditions (USDA FS 1986, p. 13).

In order to follow Forest Plan direction and meet the purpose and need for this project, the desired condition of the Forests is to have minimal establishment or spread of weed infestations. It would be virtually impossible to eradicate all weeds within the forest boundaries. However, to meet Forest Plan goals for resource protection, it is important to control the establishment and spread of weeds, particularly in special plant and wildlife habitats, riparian areas, wilderness areas and roads leading to them, livestock grazing allotments, recreation sites, and administrative sites.

Other Direction

Other management direction relevant to this project includes the following:

- “National Invasive Species Management Plan” (National Invasive Species Council 2000): Provides a blueprint for Federal agencies to manage invasive species. It provides guiding principles to all agencies and describes the roles and responsibilities of Federal agencies. The guiding principles as stated in the plan are: Take action now; be cautious and comprehensive; work smart, be adaptive; find balance; pull together; be inclusive and meet specific needs. The plan states that the Forest Service has broad authority to prevent the spread of invasive species on National Forest System lands and is authorized to assist Federal, State, and private entities on lands outside the lands.
- “Forest Service Manual 2080” (USDA FS 1995): This Forest Service policy regarding weeds was revised in 1995 to increase emphasis on integrated weed management in assessment and forest planning.
- “New Mexico Executive Order 00-22” (NMEO 2000): Directs State executive agencies to manage weed infestations designated by the New Mexico Department of Agriculture as Class A weed infestations on state land rights-of-way by making use of integrated pest management techniques.
- “Noxious Weed Management Act” (NMSTATS 1978): The State of New Mexico enacted this legislation to recognize the adverse economic and environmental impacts of these weeds and the need for action to reduce this threat.
- “Forest Service Manual 2100” (USDA FS 1998a): Provides additional policy requirements for use of pesticides (or herbicides).

Other laws and regulations that provide authority for the control of weeds on national forest lands are listed in Table 2.

Proposed Action

The proposed action is an integrated set of weed control actions that will eradicate, control, or contain weeds. This integrated weed management approach is described in the USDA FS Manual 2080 in managing weeds (USDA FS 1995). This approach recognizes that using only one management method is not likely to be effective, and flexibility is needed to address differences in site-specific conditions (also see Strobel 1991).

The proposal involves applying one or more of the following treatment methods to each weed infestation:

- Manual methods with hand tools or hand-operated power tools.
- Mechanical methods such as mowing to cut off plant tops, or disking to lift up roots using heavy machinery.

- Biological methods that involve releasing live insect or plant pathogens that selectively attack specific weed species.
- Controlled grazing using goats and sheep**.**
- Chemical methods using ground-based application of herbicides.
- Prescribed burning using fire to kill weed populations.
- Cultural methods using native plants, seeds and/or soil cover mulches after weeds are removed using other methods, to reestablish native vegetation.

Treatments would begin in 2005. During the next 10 years, each forest anticipates treating 300 to 800 acres per year, based on anticipated funding. Each forest expects a maximum of 1,500 acres per forest per year would be treated if funding permits.

Appendix 7 contains a list of known infestations and proposed treatments for each site-specific infestation. Newly discovered infestations would receive similar treatments following the conditions prescribed in the "adaptive management strategy."

Adaptive management in project planning is a relative recent innovation. As noted by the Council for Environmental Quality's Modernizing NEPA task force (USCEQ 2003), the term "adaptive management" was first suggested by the CEQ in 1997 as the result of an effectiveness study. In the 1997 study, the CEQ recognized that the environmental protection afforded by the traditional environmental management model—that predicts, mitigates and implements—depends on the accuracy of the predicted impacts and expected results of any mitigation. The study concluded that a "major difficulty with the traditional environmental impact analysis process is that it is a one-time event; … [requiring] research, modeling, and other computations or expert opinions [that] are analyzed… [T]he analysis of potential environmental impacts is prepared, mitigation measure are identified, and a document is released for public review." The 1997 CEQ report noted that this process does not account for unanticipated changes in environmental conditions, inaccurate predictions, or subsequent information that might affect the original environmental protections. The adaptive management model—by adding a monitoring and adaptation component—was seen as a significant improvement. (USCEQ 1997)

The adaptive management approach is particularly well suited for weed control because of the need to respond quickly to changing conditions in order to meet the purpose of weed control projects. Controlling known weed populations is only effective if it can be accomplished by quick responses when new species or new populations of existing species are found. Weed infestations change over time, and even a comprehensive inventory cannot adequately find and map all existing weed sites on the 3 million acres comprising the two forests. A single plant can produce more than 100,000 seeds, and some plants can go to seed 3 times a year. Three plants can expand to half an acre within a single growing season; a half acre can grow to 10 acres during the same period. It would take approximately a year or more for the Forests to complete an environmental assessment under NEPA for new infestations found. And new infestations and new species would usually be given the highest priority for treatment in order to quickly stop their spread. Failure to quickly treat new weed infestations leads to larger infestations requiring larger-scale, higher-cost treatments with greater environmental impacts. (USDA FS 2001b)

In order to avoid the adverse effects posed by rapid weed population expansion, this proposed project includes applying an adaptive strategy that allows for the same integrated weed control treatments analyzed in this document to be applied to newly discovered weeds in other locations on the Forests. Specific guidelines and criteria (defined in Chapter 2) would be followed to ensure that treatments applied to new sites are within the scope of the treatments and effects described in this DEIS. This strategy is consistent with Forest Service guidelines on applying adaptive management to site-specific environmental analysis for weed management projects (USDA FS 2001b).

The CEQ Task Force noted that "[t]o successfully implement adaptive management, monitoring must occur for long enough to determine if the predicted effects were achieved." Therefore, as part of the proposed action, inventory and monitoring are proposed as methods to adapt components or parameters of this decision to future weed treatment areas. This strategy is described in detail in Chapter 2.

The proposed weed control program involves the following steps:

- Inventory by searching places with a high likelihood for finding new weed populations, and enter new weed locations in the Geographic Information System database.
- Prioritize and select appropriate treatment methods based on criteria in this DEIS (Chapter 2), including applicable mitigation measures based on site conditions.
- Develop an implementation plan that is reviewed and updated annually, including coordination with other agencies regarding weed control activities.
- Notify the public about the annual weed treatment schedule and site-specific locations.
- Implement weed control treatments.
- Monitor for: treatment effectiveness in meeting weed control objectives; effects on other resources relative to those predicted in this DEIS; and implementation and effectiveness of mitigation measure used to minimize adverse impacts.
- Evaluate and document monitoring results for use in future weed treatment prescriptions.

Forest Plan Amendment

The proposed action and all action alternatives include an amendment to the Santa Fe National Forest Plan that would allow the use of herbicides in places currently prohibited by Forest Plan standards and guidelines. These areas include municipal watersheds and soils with low revegetation potential. Chapter 2 describes the proposed amendment in detail. The Carson National Forest Plan does not prohibit the use of herbicides in any specific areas.

Decisionmaking Framework

The forest supervisors for each forest are the responsible officials for decisionmaking on this project. They will decide which weed control alternative, if any, to approve for implementation, including approval of the proposed adaptive management strategy. Their decision includes consideration of the mitigation measures and monitoring requirements specific to this project. The forest supervisor for the Santa Fe NF will decide whether to approve the Forest Plan amendment as proposed or with modifications.

If a weed control alternative is selected, it will allow for treatment of the known weed populations as mapped and described in the EIS, as well as newly discovered weed populations. Treatment of new populations would adhere to the adaptive strategy criteria in the EIS, and would be reviewed per Forest Service Handbook 1909.15 (Section 18) to determine whether such actions are within the scope of the treatments and effects disclosed in the EIS, or whether additional environmental analysis under NEPA is needed.

The scope of this project and NEPA decision does not extend to weed prevention and education activities. While the Forests recognize that prevention and education are essential components of an overall integrated weed management strategy, proactive weed prevention and educational activities are already being implemented and do not require additional environmental analysis and decisionmaking subject to the NEPA process. Weed prevention is considered and often included as a mitigation measure in many site-specific project EAs and EISs, such as for logging, facility construction, special uses and other activities that can contribute to the spread of weeds (USDA FS 2001a). Contractors are typically required to wash their vehicles and equipment to eliminate weed seeds prior to bringing them onto national forest lands. Outfitter/guides and others using wilderness areas are prohibited from bringing in hay or unprocessed feed for horses or other domestic animals.

Public Involvement

One of the first steps in the public involvement stage of project planning is to use public comment to determine the appropriate scope of the analysis. In the scoping process, the need, context, and issues related to a proposed action are considered by the public, sponsoring agency, and other agencies potentially affected by the proposed action.

In 1996 and 1997, the Forest Service met with other Federal, State and county agencies to discuss the threat of weeds and coordinate treatments. Newspaper articles were also published to inform the public about the threat of weeds and the full range of treatment options, such as those being considered by the Forests. In 1998, the Forests began scoping with the public for this project, starting with public meetings held in Taos and Espanola. In March 2000, a scoping letter was sent to approximately 450 individuals, agencies, tribes and organized groups to inform them about the Forest's weed control treatment proposals. At that time, each forest was independently working on separate environmental assessments for forest-wide weed control projects. As a result of the March 2000 scoping, a decision was made to combine the efforts of the two forests and document the analysis in an EIS.

In December 2000, the Forests sent another scoping letter to the public about the proposed actions and published a Federal Register Notice of Intent to Prepare an EIS. At the request of local citizens, a field trip was conducted to discuss weed infestations and show interested people the weed conditions on the Tres Piedras Ranger District.

In December 2003, an additional letter was sent to all potentially affected tribal governments, to initiate consultation and solicit their comments about the proposed project. In May 2004, a 4-page update document was mailed to known interested or affected parties. It described the final issues and alternatives, as well as the status of the draft EIS and estimated release date.

A total of 34 individuals and 30 organizations commented on the initial scoping letters. The largest number of comments questioned the need for treatment when other solutions were available, such as eliminating grazing and closing roads, which they suggested led to the weed problems. Education was also suggested as a means of dealing with the weed problem. For some respondents, education was suggested as a substitute for treatment, and for others education was suggested as a complementary activity.

A large number of comments expressed opposition to any herbicide use. Most opposition was based on concerns that herbicides could adversely impact human health, nontarget plants, and wildlife. Concerns with impact to water quality and fish were also mentioned. Some respondents voiced concerns that herbicides were too nonselective and would have too broad of impacts. Potential impacts to people with multiple chemical sensitivities were mentioned as reason to avoid using herbicides and any associated chemicals (e.g. inert ingredients in the formulations). Suggestions were made to use a wide variety of non-chemical methods, such as hand digging (possibly enlisting volunteers to do this work) and using goats to graze the weeds where possible. In addition to the letters responding to the scoping letters, a petition with approximately 1,000 signatures was submitted from CAPE (Citizens Against Poisoning the Environment) stating opposition to the use of herbicides in managing weeds on the Carson National Forest.

One comment also raised concerns with using biological agents because of the possibility of introducing an insect that would have unforeseen effects (such as getting out of control itself).

Others with concerns about herbicides allowed that chemicals might be used under controlled conditions so that people who use the Forests to collect and use certain products would not be adversely impacted from herbicides (or that other methods would not destroy these culturally and economically important plants).

Another set of comments supported the need to treat weeds and supported use of the integrated approach (including herbicides), as long as appropriate oversight is given to the efforts so they are coordinated within the Forests and with other agencies conducting similar efforts. Some comments in this set also noted that strong monitoring should be a priority to be successful.

Issues

The Interdisciplinary Team (IDT) used public comment to clarify issues relating to the effects of the proposed action. Significant issues versus insignificant issues were identified in accordance with Council for Environmental Quality (CEQ) NEPA regulations (40 CFR §1501.7 and §1506.3). Significant issues relate to those impacts related to the proposed action that cannot be avoided without substantially compromising project objectives. These issues drove the formulation of alternatives to the proposed action so that the decision maker and the public could see the tradeoffs among alternative ways of achieving the purpose and need.

Some issues or concerns raised in comments were not considered significant for one of the following reasons:

- The concerns related to effects of the continued spread of weeds under the “no action” alternative. Those concerns were not identified as issues but rather as part of the project objectives or purpose and need.
- The action suggested or impact of concern is not relevant to (“outside the scope of”) the proposed action. For example, many comments suggested the use of prevention measures (e.g. eliminating livestock grazing or closing roads). However, the purpose and scope of this analysis is to control weeds that exist or become established in order to minimize their associated impacts to forest resources. Prevention and education are important and

separate actions that will continue to be carried out by the Forests and do not need to be part of this NEPA project decision. The Forests will continue to participate with other land management agencies to coordinate weed control activities and provide public information on weed identification and treatment.

- The impact of concern can be avoided or adequately minimized to a negligible level by incorporating appropriate mitigation measures into the proposed action.
- The impact of concern is already regulated by existing laws, regulations and policies.

A list of other issues and reasons for their categorization may be found in the project record.

The following issues provided the focus for developing a reasonable range of alternatives for meeting the purpose and need for this project. They reflect public concerns about effects that may result from proposed weed treatment actions, even though the magnitude of effects would be minimized by the proposed mitigation measures. Chapter 2 presents a detailed description of the proposed action, alternatives and associated mitigation measures and monitoring requirements.

Issue 1: Human Health and Safety

Weed treatment activities have the potential to affect human health and safety in a number of ways, including exposure to machinery, equipment and/or chemicals.

Although exposure to the machinery and equipment poses a safety risk, the larger public concern relates to the health risk posed by using herbicides. This risk is defined in three ways:

- By direct exposure during applications, such as exposure to herbicide applicators from the backpack spray drift, or people walking through a recently sprayed area.
- By contact with vegetation that has been sprayed and then collected for use. Some tribes and northern New Mexico residents use many plants found on the Forests for food and medicine. Plants are also used for ceremonial, home decoration and artistic purposes. A number of these users expressed concern that their health will be affected because they will be exposed to herbicide residues when they collect and process their plants.
- By direct or indirect herbicide exposure for people with heightened chemical sensitivities. Although the Forests would only use herbicides determined by the Environmental Protection Agency (EPA) and other research studies to be safe (low risk) for use in areas where people live, work and recreate, a health risk would remain for individuals who are exceptionally sensitive to any exposure to chemicals in the environment. Some northern New Mexico residents moved to this part of the United States to reduce exposure to chemicals under the general assumption that this area has lower amounts of chemicals than other places. Within this group are individuals who report varying levels of sensitivity to an herbicide or herbicides. Some individuals may not report sensitivity to an herbicide but to the additives that enhance an herbicide's effectiveness (surfactant). Even when herbicide label instructions are followed, risk assessments note that some risk remains from herbicide use, even if the amount of risk is very low. The only way to completely eliminate these risk factors attributed to herbicides is to eliminate the use of herbicides altogether.

Issue 2: Wildlife and Fish

Weed treatments have the potential to affect various wildlife species in the following ways:

- Habitat disturbance: Weed treatment activities such as vehicle use, equipment operation and other human activities would cause disturbance in or near habitat.
- Fish/wildlife health impacts from herbicides: Mammals, birds, amphibians, reptiles and fish would be exposed to herbicides by ingesting herbicides residing on plants, in the soil, and soil organisms, in streams or other water bodies. Concerns have been expressed about the potential for adverse impacts to fish or wildlife from single dose exposure or long-term accumulation of herbicides.
- Habitat reductions: Wildlife could be affected by temporary reductions in vegetation brought about by weed treatments.

Issue 3: Native Vegetation

Weed treatments have the potential to affect native vegetation in a number of ways. All treatments (manual, mechanical, grazing, fire, herbicide) could remove some nontarget native vegetation at least temporarily and within a relatively small geographic area, reducing the abundance and vigor of native plant populations. Of particular concern are potential impacts to plant species of limited abundance (threatened, endangered, or sensitive species), although mitigation measures minimize this risk.

Issue 4: Cost and Treatment Effectiveness

On weed infestation sites where nonchemical methods are proposed for use without supplemental herbicides, weed control effectiveness would be lower and treatment costs higher. More frequent and repeated treatments are typically needed to control weeds where herbicides are not used, and weeds may spread at a faster rate than they could be controlled where herbicides are not used.

Chapter 2 • Alternatives, Including the Proposed Action

Introduction

This chapter contains the following key sections:

- Description of alternatives considered but later eliminated from detailed study.
- Alternatives considered in detail, which were developed to address one or more significant issues while meeting the purpose and need at least partially.
- Adaptive strategy for addressing new weed infestations or situations found on the Forests.
- Mitigation and monitoring requirements to avoid or minimize adverse effects.
- Forest Plan amendment for the Santa Fe National Forest Plan.
- Permits and authorizations required prior to implementing this project.
- Comparison of alternatives that provides a basis for choice among alternatives.

The Forest Service interdisciplinary team evaluated four alternatives for this project:

Alternative A - No Action. This alternative is the baseline for comparing the other alternatives. Under this alternative, proposed weed control actions would not occur on the Forests, except those approved under previous environmental analysis documents.

Alternative B - Integrated Strategy (Proposed Action). This alternative was developed to fully meet the purpose and need for the weed control project while minimizing the risk of adverse impacts through mitigation measures and monitoring. It includes the full range of appropriate weed treatment methods, and often uses a combination of methods on the same site.

Alternative C - No Herbicides. This alternative was developed in response to issues related to effects of herbicides on human health, wildlife/fish, and nontarget native vegetation. It employes a variety of methods but does not allow herbicides to be used.

Alternative D - Herbicides Only. This alternative was developed in response to the cost and treatment effectiveness issue, as it would provide for a high level of effectiveness at a lower cost per treated acre compared to the proposed action. It would use herbicides exclusively.

Alternatives Eliminated From Detailed Study

The following briefly describes three alternatives that were considered but eliminated from detailed study, along with the reasons for eliminating them (in accordance with NEPA regulations at 40 CFR §1502.14).

Aerial Herbicide Application

This alternative was considered but eliminated from detailed study because the extent of the current weed infestations on the Forests is relatively small, which indicates that such a broad approach would not be necessary to achieve the purpose and need of the project. Aerial application can be an effective means of controlling or eradicating very large infestations of weeds, particularly in areas that have steep slopes, rocky soils, and are too difficult to access to effectively treat from the ground. Aerial application provides a means to effectively treat infestations in isolated areas, allowing rapid and efficient reduction of a threat of further establishment or expansion. However, given the public concern regarding this method and the expectation that ground-based applications can meet the purpose of the project, aerial application was not studied in detail.

Weed Prevention

An alternative to use weed prevention rather than herbicides or other treatments was suggested by the public during project scoping. The intent of the alternative would be to take action on human activities that promote the spread of weeds, such as by closing roads, restricting or modifying livestock grazing permits, and altering existing timber, mining, and recreational off-road vehicle activities. However, this alternative would not meet the purpose and need because it would not effectively reduce existing weed infestations or address the detrimental impacts of those infestations. It would not reduce the threat from undiscovered weeds that exist now or are expected to invade despite preventative measures. Impacts from weeds would continue to spread at a rate of 5 to 30 percent annually and degrade resources on the Forests despite the best prevention measures being implemented. Weed prevention is already being used on both forests and is often integrated as a mitigation measure during planning for ground-disturbing projects, such as the requirement to wash vehicles prior to use on the forest. Prevention actions typically do not require NEPA documentation for implementation. Weed prevention and education are also part of interagency agreements being implemented, New Mexico Department of Agriculture calendars, national publications, and news media releases.

Organic Treatment Methods

A third alternative was eliminated that would use methods common in organic gardens and nurseries. These methods include covering weeds with newspaper and dirt, rubber mats, and other means without disturbing the ground. There is limited experience and little study to show that using these methods would be effective to meet the purpose and need on a landscape scale across portions of the 3 million acres comprising the two forests. In addition, these methods are not practical to use on Federal lands where weeds are scattered and isolated. Finally, the use of newspaper and dirt may create more suitable sites for weed infestations and items such as rubber mats would likely be stolen.

Alternatives Considered in Detail

Alternative A: No Action

Under the No Action Alternative, previously approved and ongoing management activities and land uses would continue on the Forests. This includes weed treatment activities previously approved such as those along the lower Jemez River and those being implemented by other jurisdictions within the Forest boundaries such as along Federal, State and county roads. Chapter 3 and Appendix 1 describe past, present and foreseeable future activities including other weed treatment activities within and adjacent to the Forests. Weed inventories and prevention activities would also continue to occur.

Alternative B: Integrated Weed Control Strategy (Proposed Action)

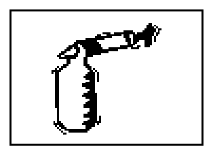
This alternative involves applying one or more methods to eradicate, control, or contain weeds where they occur on the Forests. A common element in all treatments is to destroy the plant, disrupt growth, or interfere with the reproduction cycle. Treatments are scheduled to begin in the spring of 2005, and would occur during the weed's growing season—spring, summer or fall—depending on the weed species and treatment method. Based on expected funding, each forest anticipates treating 300 to 800 acres annually, with an annual maximum of approximately 1,500 acres per forest, during the next 10 years. An adaptive strategy would be used to apply treatments to newly discovered weed populations or to modify treatment prescriptions based on results of monitoring. Treatment methods would need to be within the scope of the treatments and effects described in this document to be implemented under the adaptive strategy, and the same mitigation measure would apply to avoid or minimize adverse impacts. The adaptive strategy, including criteria and parameters that must be met in order to treat new weed sites or alter treatment prescriptions, are described later in this chapter.

This proposal applies a variety of methods including manual, mechanical, biological, cultural, prescribed fire, grazing, and chemical, based on the most feasible and appropriate methods for meeting treatment objectives, primarily based on the particular weed species and population size, along with considerations about specific locations and public concerns. Selection of the most feasible and appropriate treatment also depends on the specific objective (eradication, control or containment), risk of weed expansion, weed species biology, time of year, and environmental setting. By proposing several methods for weed control, this approach recognizes that using only one management method is unlikely to be effective in all situations (also see Strobel 1991).

Figure 3 provides general locations for treatments of known weed populations, although the size of each weed population is significantly smaller than it appears on the map, due to the map size and scale. Appendix 7 lists each mapped weed population and the treatment method(s) proposed.

The following describes proposed treatment methods and their map symbols:

Herbicides



Chemicals used to control plants are known as herbicides. Herbicides kill the existing plant but often allow remaining seeds to germinate. Herbicides are known to be the most effective treatment method for eradicating or controlling the weed species that currently exist on the two forests. Chemical treatments are often used in conjunction with and to improve the effectiveness of nonchemical treatments, either concurrently or as followup treatments. Herbicides are being proposed for weed sites where nonherbicide methods do not seem feasible or appropriate, due to ineffectiveness of other treatments, species characteristics, population size, treatment priority and objective, or access or terrain limitations of other methods.

The primary herbicides proposed for use on the Forests have picloram, metsulfuron methyl, clopyralid, dicamba, triclopyr, or glyphosate as their active ingredients. See Table 60 in Appendix 3 for general discussion of these chemicals and their properties. Mixtures of chemical ingredients could be used where they provide more effective control (Callihan et al. 1989), particularly for weeds that may have developed resistance to a particular chemical. Repeated use of the same herbicide can result in weed resistance. This problem would be minimized by using herbicides in rotation and with different modes of action (Whitson 1992). Herbicide mixtures may only be used when there are no known synergistic effects such that the toxicity of the mixture is not greater than either herbicide used alone.

Only herbicides that have been registered with the Environmental Protection Agency for rangeland, forestland, or aquatic use would be used. They would be those determined to be safe in areas where people live, work or recreate. The Forest Service has also completed risk assessments that determine the risk of herbicide use on human health and safety, wildlife, fish, etc. Only herbicides with a completed risk assessment would be used.

No aerial application of herbicides would be used for this project. Herbicides would be applied using ground-based methods such as: hand application using a glove, rag or wick to wipe the chemical onto the weed while preventing it from getting on nontarget vegetation or other resources; spray using a backpack containing the herbicide attached to a flexible sprayer, wand or other hand application device that directs the chemical onto the target weed; vehicles with a mounted herbicide tank and boom or wand spray device to direct the spray.

Booms or wands may be articulated or fixed. All these methods have turnoff capabilities in or near the operator’s hand. Herbicides may also be applied in granular or pellet form.

Where the objective is eradication and the target weed species has developed a large seed bed, herbicide applications usually require a followup treatment, either as a second herbicide application or another method. Because the herbicides proposed for use do not persist in the soil for more than a few months (at the maximum), the followup treatments are needed to eliminate new sprouts that were in seed during the initial treatment.

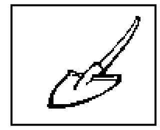
Biological Methods

Biological control methods include release of insects or plant pathogens that are proven natural control agents of specific weed species. The insect or plant pathogen would attack, weaken, and kill a targeted weed species and reduce its competitive or reproductive capacity. Biological controls would be used for reducing population densities and rates of spread (when the objective is containment), as they are not effective for eradicating or substantially controlling weeds. This treatment is most effective on dense infestations of a weed species covering large areas. It could take 10 to 20 years for some biological treatments to be effective (USDA FS 1999a). Other limitations in the use of biological controls include: weeds continue to spread while the biological controls are becoming established; some weed species do not have biological controls; populations of biological controls can fail (leave an area or die); and a mix of different species of biological controls is often necessary to effectively treat a given weed site.

Most experts regard the introduction of biological controls as the best long-term solution where there are large, widespread populations of a specific noxious weed species that cannot be feasibly eradicated. The U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS) rigorously screens and tests new biological agents for impacts on agricultural plants and on threatened, endangered, and sensitive plant species. It then prepares environmental assessments on the possible impacts of releasing those agents. Only APHIS-approved and State-approved biological controls would be used on the Forests, and would be released according to APHIS requirements.

Host-specific insects are proposed for use on some of the larger populations of riparian weeds like salt cedar, along with spotted knapweed (insects such as seed gall fly, root or seed head moth, flower or root boring weevil), and leafy spurge (e.g. flea beetles). In general, biological agents require an infestation large enough (more than 20 acres) to allow for the establishment of the controls to occur. For the Carson NF, weed infestations on adjacent lands could be added to the populations on National Forest System lands in order to make this treatment effective.

Manual Methods



Manual control methods involve hand pulling or digging with hand tools like shovels or hoes, or hand-operated power tools. It may also involve clipping or cutting off the tops of plants. If enough root mass is removed, the plant may be destroyed. Cutting plants reduces reproduction of plants by seeds. Cutting also depletes the carbohydrate reserves in roots, thereby weakening a plant's competitive advantage on a site. This method would be most often applied to small populations (less than an acre) of herbaceous weeds that spread primarily by seeds rather than through root sprouts.

Controlled Grazing

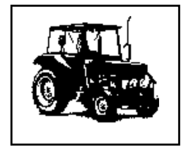
Grazing with goats or sheep has been shown to suppress weeds in some prolonged applications (Crabtree and Lake 2001). Goats have a digestive system that can handle most vegetation including weeds. Goats have been used on a limited basis in efforts to control weeds, using hay, water, or minerals to attract them to the weed patch. Other methods include herding and fencing to confine the goats/sheep within a specific area. For example, sheep can be induced to eat leafy spurge, which is toxic to cattle but not to sheep or goats. Sheep are known to suppress leafy spurge populations, but usually do not eradicate this weed. Most available information is anecdotal, but there are research projects currently in progress that will add to the scientific base. Herds of goats also trample and fertilize the treated areas, which in certain instances assists in revegetation efforts. The popularity of this method of weed control has been growing in the Western States in recent years, and the knowledge base of its effectiveness is also growing.

Management considerations should include the fact that sheep and goats will not typically graze the target weed species to the exclusion of native plants. Another consideration is that weed seeds may adhere to the coats of long-haired breeds of goats, or the fleece of sheep, which could contribute to the spread of weed seeds if not addressed in the application of the method (i.e. require animals to be sheared prior to entering an infestation). Animals should be confined to a restricted area for an appropriate length of time after moving from an infested area when there is a concern that viable weed seeds may be spread through the animals' feces. Goats appear to effectively reduce the viability of seed moving through their digestive tract, due to the very small opening between the rumen and the small intestine.

This method may be used to reduce the vigor of some weeds where numerous, repeat treatments can be applied at the appropriate times. The availability of herds managed for this type of control may be limiting. This method is primarily proposed as a minor, incidental treatment method, and would be evaluated for effectiveness. Where appropriate, grazing would be integrated with other treatment methods to achieve more effective weed control.

This weed control method would be conducted in accordance with Forest Service grazing regulations and regional policy. A site-specific project operation plan would be developed for the treatment area that would consider factors such as target weed species, type of livestock to be used, forage preference, planned grazing intensity, herding characteristics, topography, water availability, season of use, and a monitoring program. Forest Service regulations, policies, and the appropriate mitigation measures would be followed.

Mechanical



Mechanical control methods include actions such as mowing or root tilling. Mowing cuts plants off above ground while root tilling digs into the soil to unearth the roots. These methods employ large mechanized equipment such as tractors with specially designed attachments. These methods have not been demonstrated to be effective in eradicating or substantially reducing weed infestations, and typically require frequent repeat treatments. They do reduce plant and root vigor. Feasibility is also quite limited on the Forests due to the steep slopes and other common terrain features such as trees, boulders or logs. Thus, this method is only proposed for minor, incidental use, mainly along highways in conjunction with ongoing road maintenance actions. Most mechanical treatment is proposed in combination with another method.

Prescribed Burning

Burning is similar to plowing or cutting the tops of weeds. It removes the seed heads and for some plants can reduce the seeds bank in soil. Broadcast burning weeds on the soil surface may be employed if there are sufficient fuels to carry a fire, or use of propone torches may be used on weeds where a surface fire would not carry through the weed population. Generally burning is not highly effective when used alone to eradicate or control most weed populations. Thus, it would typically be used in combination with other methods.

Cultural Methods

Cultural methods are actions such as planting or seeding with desirable native plants immediately following a weed control treatment or other methods that allow desirable plants to out-compete the weed species. These methods are not proposed to be used alone to eradicate or control weed populations, but would be used where needed on treated sites as a followup method to favor native species and minimize subsequent weed infestation. This method would also be used where necessary to minimize soil erosion or stream sedimentation where needed following removal of weed species and exposure of bare soil.

Table 6 summarizes treatment methods and acres for Alternative B. Acres shown are for the weed populations treated. The table shows some underestimation of treatment acres for weed sites where more than one method would be used to treat the same site. However, for some sites treated with multiple methods, the different methods would be applied on different portions of the site. On the other hand, the table shows some overestimation of treatment acres where the weeds are scattered among nontarget native plants or bare ground that would not be treated. Overall for the Forests, the table provides a rough estimation of weed treatment acres by method.

Table 6. Alternative B Treatment Summary

Treatment	Population Acres	Percent Total
Biological-grazing	35	0.46%
Biological	135	1.83%
Biological in Jemez RD[1]	1,770	22.81%
Prescribed fire	82	1.13%
Grazing-herbicides	37	0.54%
Herbicide	3,508	48.27%
Manual	43	1.60%
Manual-grazing	90	1.21%
Manual-herbicide	1,485	19.33%
Mechanical	24	0.31%
Mechanical-biological-grazing	14	0.19%
Mechanical-herbicide	122	1.78%
Total	**7,345**	

[1] Area along the Jemez River, Santa Fe National Forest would add biological agents to already approved methods.

Alternative C: No Herbicides

This alternative involves conducting weed treatments over the same acres as Alternative B, except no herbicides would be used. Based on expected funding, each forest anticipates treating 150 to 400 acres annually, with an annual maximum of approximately 1,000 acres per forest, during the next 10 years. This alternative treats fewer acres per year due to the need for more repeat treatments on the same sites in order to achieve some level of weed control or eradication. Otherwise, this alternative includes the same adaptive strategy as Alternative B.

Figure 4 shows the general locations where treatments would occur on known populations. Appendix 7 lists more details regarding Alternative C treatments, including the known weed species, treatment method(s), locations and acreages.

Table 7 summarizes treatment acres by method for Alternative C. It includes the same over- and underestimations of treatment acres as described for Alternative B.

Table 7. Alternative C Treatment Summary

Treatment	Population Acres	Percent Total
Biological-grazing	34	0.46%
Biological	255	3.46%
Biological in Jemez RD[1]	1,770	22.81%
Prescribed fire	2,048	27.62%
Prescribed fire-mechanical	82	1.13%
Grazing-mechanical	40	0.54%

Treatment	Population Acres	Percent Total
Manual	1,541	20.93%
Manual-grazing	127	1.21%
Manual-mechanical	190	2.59%
Mechanical	1,283	18.99%
Mechanical-biological-grazing	16	0.19%
Total	**7,345**	

[1] Area along the Jemez River, Santa Fe NF would add biological agents to already approved methods.

Alternative D: Herbicides Only

This alternative would conduct weed treatments with herbicides only, over the same acres as Alternatives B and C except it eliminates the 1,690 acres of biological control treatments for the Jemez River/Rio Guadalupe riparian areas as they are currently undergoing authorized weed control with herbicides and other methods. Like Alternative B, each forest anticipates treating 300 to 800 acres annually, with an annual maximum of approximately 1,500 acres per forest. This alternative involves use of the same herbicide application methods, same type of EPA-approved herbicides, etc. as was described for Alternative B. It also includes the same proposed Forest Plan amendment as Alternative B.

Table 8 summarizes treatment acres by method for Alternative D. Figure 5 shows general treatment locations for Alternative D.

Table 8. Alternative D Treatment Summary

Treatment	Population Acres	Percent Total
Herbicide	5,435	100%
Total	**5,435**	

Adaptive Strategy

All alternatives would employ an adaptive strategy that has been determined to be necessary for the success of weed control projects and consistent with Forest Service policy (USDA-FS 2001b). As part of this adaptive strategy, weed treatments must be monitored, evaluated and modified as necessary to improve effectiveness of future treatments while reducing the potential for adverse effects to people and natural resources. This strategy allows for adopting findings from research studies on different practices or impacts, or changes in land or resource conditions.

Alternative C would employ this strategy, but would not include herbicides as a method in the array of tools. Alternative D also employs this strategy, but would still only use herbicides. Under Alternative D, adaptive management would be used to determine the effectiveness of herbicide applications (type of herbicide, application methods, timing, etc.). In all alternatives, the adaptive strategy would be key to finding and treating infestations that are not currently identified.

The adaptive strategy provides for flexibility to use the appropriate treatment method, based on the results of monitoring and evaluation. For Alternative B, the adaptive strategy would allow for any of the integrated weed control methods to be used on a given site. For example, if a few new weed plants are found on the roadside, this strategy would allow for the use of manual methods to dig them out. If monitoring indicates that weed control with herbicides would be just as effective with less impact on nontarget species with lower application rates, the lower application rates could be used. Another example would be that if monitoring reveals undesirable nontarget impacts on forbs from spring herbicide applications, herbicides might instead be applied during summer or fall if they are also effective on the target species.

The adaptive strategy would cover weeds found in additional locations as well as new species found on the Forests. The Forests propose an adaptive strategy with the following actions:

- Annually inventory portions of the Forests that are likely to have new infestations (e.g. areas burned by wildfires) and map any new weed infestations. Budgets will govern the extent of these inventories.
- Identify the weed treatment objective, priority and methods to use for newly mapped infestations based on the specific criteria described later in this section.
- Monitor the effectiveness and effects of weed treatment activities and associated mitigation measures.
- Evaluate and disclose monitoring results, and use those results to determine appropriate modifications in treatment prescriptions, mitigation measures, or implementation practices.
- New information (as described in Table 7) would supplement the EIS.
- Implement modifications or other feasible and appropriate treatment methods based on monitoring results, as long as the new or modified action and its effects are considered by an interdisciplinary team and determined by the responsible official to be within the scope of actions and effects evaluated in this DEIS (and in accordance with Forest Service Handbook FSH 1909.15 §18).

Treatment Objectives, Priorities and Decision Criteria

Treatment objectives for a given weed species fall into one of the following three categories:

- Eradication (elimination)
- Control (reducing the population over time)
- Containment (preventing the population from spreading)

Eradicating or controlling every weed infestation at the same time is beyond the budget and personnel resources of the two forests. Eradication would be the objective applied to first priority species or situations, followed by control for second priority situations, and containment for third priority. Therefore, a system for setting priorities is proposed so that treatment concentrates on species that have the greatest impact on the resource base, and those that become more difficult to control if action is delayed. Most weeds become much more difficult to control once they have spread.

Thus, the highest priority is to eradicate new species occurrences on the Forests, and then to keep existing populations from spreading or increasing in size.

Weed species of limited extent are eradicated or controlled. Because the size threshold varies by weed species, this determination would need to be made based on site-specific conditions.

Extremely widespread and common weeds are much more difficult to control, and so they are generally scheduled to "contain" as a Priority 3 species.

Treatment objectives and priorities are interconnected, and would be based on the following criteria, which is consistent with New Mexico's weed control laws and procedures.

Priority 1—Eradicate New Populations of High-Threat Species.

This priority immediately eradicates new populations of species that pose a high threat to resources. Eliminating these populations while they are small creates the best opportunity to avoid impacts from these species. Eradication includes all viable seeds and vegetative propagules. High-threat species are those that can rapidly expand into native habitats and displace native vegetation throughout the Forests in a relatively short period of time. Eradicate all infestations of Class A weeds, which are those species exotic to New Mexico, but threatening to invade the State. Examples include black henbane, leafy spurge, and toadflax. They have limited distribution on the Forests (e.g. yellow toadflax), but if they become widespread, they pose a threat to agriculture crops, rangelands, plants listed as endangered, threatened or sensitive and other resources in the State.

Priority 2—Control Existing Populations of High-Threat Species.

This priority gradually reduces existing populations of high-threat species. Control is accomplished by preventing seed production throughout the target area, decreasing the area coverage of the weed over time, and preventing the weed from dominating the area's vegetation. This priority strives to achieve low levels of the weed populations if eradication is not feasible. For Class B weeds, this priority would decrease the population size and eventually eliminate this class of weeds, which are exotic (NMDA 1999) and of limited distribution in the Forests but are common in other parts of the State and so likely to appear. As a general rule, the objective would be to substantially reduce Class B weed infestations. For populations of 5 to 25 acres in size this means reducing the size by about 75 to 100 percent. For Class B weed infestations greater than 25 acres in size, this means reducing the size by 50 percent. Examples of Class B weeds include bull thistle and musk thistle.

Priority 3—Contain Existing Populations of High-Threat Species.

This priority holds existing populations of aggressive weeds in check, so that they do not increase from their current size. Containing populations is accomplished by preventing weeds from expanding beyond the perimeter of the infestation, perhaps providing only limited treatment within the infestation, and treating to eradicate or control the weed outside the perimeter of the infestation. This priority would contain the spread of Class B weeds that are of limited distribution on the Forest (e.g. poison hemlock). For Class C weeds, which are widespread throughout the State and Forests, contain them to their present population size, or for populations greater than 5 acres in size, strive to reduce by 50 percent. Examples include salt cedar, Russian olive, and Siberian elm.

Priority 4—Eradicate New Populations of Moderate-Threat Species.

This priory eradicates new populations of less aggressive weeds. This priority immediately treats these new populations to eradicate them early, although they are not as high a priority as Priority 1 weeds. These populations expand into native habitats more slowly and/or are less successful than Priority 1 weeds in displacing native plants.

Priority 5—Control Existing Populations of Moderate-Threat Species.

This priority gradually reduces existing populations of less aggressive weeds.

Priority 6—Contain Existing Populations of Moderate-Threat Species.

This priority holds in place existing populations of less aggressive weeds.

Additional Criteria for Prioritizing and Determining Objectives and Methods

In addition, weed infestations found in the following locations would likely be given an elevated priority ranking:

- Areas that are now relatively weed free and have little or no road access, such as areas designated as wilderness, roadless recreation or semi-primitive non-motorized, including the road corridors and trails that lead to those areas;
- Areas that are now relatively weed free that provide unique and desirable wildlife habitat, such as recovery habitat for threatened or endangered species, deer and elk winter range; and riparian habitat;
- Areas on the Forests with weed populations adjacent to other land ownerships where land managers have active weed control programs; and
- Areas of high human use, including but not limited to administrative sites, developed recreation sites such as campgrounds, scenic viewpoints, interpretive sites, and trailheads.

Schedules for implementing weed treatments would be based first on the priorities just described, and spread out over time based on levels of funding and staffing on the Forests.

Selection of treatment method is based to a large extent on the priority of the weed species and associated objective, along with site-specific factors such as proximity to water or roads (which increases chance of spread), and the size of the weed infestation (small sizes are easier to eradicate).

For example, a Priority 1 weed species (Canada thistle) is found in a site that suggests eradication is the objective (it lies along a major highway). The size of the infestation is more than can be hand pulled (more than 2 acres). Therefore, an herbicide would be selected because that is the only method known to be highly effective and economically feasible for this weed population.

In addition to using treatment objectives, priority rankings, and infestation size, additional criteria that would be used in selecting the most appropriate treatment method under the adaptive strategy is shown in Table 9.

Table 9. Additional Treatment Criteria and Limitations

Weed Site Conditions	Treatment Method Limitations
Area of high human use such as a recreation site, administrative site or area where people often collect plants.	Method(s) must have been documented to be safe in areas of human occupation and use. Examples include nonherbicide methods or herbicides having very low risk of harmful effects to humans. Also adhere to other mitigation measures that apply to protection of human health and safety.

Weed Site Conditions	Treatment Method Limitations
Area where there is a shallow water table (≤ 6 feet deep) and soil with a high permeability rate, where there may be a risk of an herbicide leaching through the soil to the ground water.	Nonherbicide method(s) appropriate for the site conditions, or a short-lived, nonleachable herbicide that has been registered by the EPA for use on permeable soils with shallow water tables. Herbicides that use picloram as their active ingredient (e.g. Tordon 22K) would not be used. Also adhere to mitigation measures that apply to protection of soil and ground water resources.
In riparian areas or next to live water bodies containing aquatic species.	Method(s) determined and documented to have low risk to fish or other aquatic species. Examples include a nonherbicide method that avoids erosion/sediment production or herbicides registered by the EPA for aquatic habitats (e.g. Some 2, 4-D formulations, glyphosate). Also adhere to mitigation measures that apply to protection of riparian, water and aquatic resources.
Threatened, endangered or sensitive plant species are present.	Method(s) determined and documented to have low risk to native plant species, such as nonherbicide methods with appropriate disturbance controls or weed-specific herbicide spot treatment. Also adhere to mitigation measures that apply to protection of threatened, endangered or sensitive plant species, including limitations on herbicide spraying from vehicles.
Occupied threatened, endangered or sensitive wildlife species habitat.	Method(s) used must have been documented to have low risk to wildlife species. Also adhere to other mitigation measures that apply to protection of threatened, endangered or sensitive wildlife species.
Wilderness and designated nonmotorized areas	Motorized vehicles and mechanized equipment are prohibited in all wilderness areas. In the Pecos Wilderness, sheep or goat grazing for weed control would be prohibited. Controlled grazing for weed control would be prohibited in Rocky Mountain bighorn sheep habitat. See mitigation measures.

Mitigation Measures and Monitoring Requirements

Table 10 lists mitigation measures and monitoring requirements for all action alternatives, including best management practices (BMPs) for minimizing the risk of water pollution in accordance with Clean Water Act regulations. The mitigations were developed specifically for this project in order to avoid or minimize the risk of adverse project-related impacts to people or natural resources on the Forests, including potential impacts to human health and safety, native plants, special status plants or wildlife, soil, water, riparian and aquatic resources, and heritage resources. The table shows which alternatives each requirement applies to.

Table 10. Mitigation Measures and Monitoring Requirements for All Alternatives

Description of Mitigation Measure/Monitoring	Alternatives
HUMAN HEALTH/SAFETY and GENERAL MITIGATIONS	
Herbicides will not be used unless they have been registered for use by the EPA and all EPA label requirements (including limitations) are strictly followed.	B, D
In areas of human habitation or high use such as a recreation site, administrative site or area where people often collect plants, the treatment method must have been documented to be safe in areas of human occupation and use. Examples include nonherbicide methods or herbicides rated as having a very low risk of harmful effects to humans.	B, D
Herbicide application will strictly adhere to EPA label limitations regarding temperature, humidity, wind speed and other weather variables, to avoid spray drift to nontarget plants or other resources while increasing treatment effectiveness.	B, D
Herbicide use will be restricted to EPA approved application rates (amounts) and conditions listed on the label. In addition, the total acres treated by herbicides within the same Fifth level (HUC) watershed will not exceed the annual thresholds established in this DEIS (based on a worse case analysis).	B, D
Herbicides may only be applied by a trained applicator under supervision of a licensed applicator, in accordance with Forest Service directives.	B, D
Herbicide use will comply with the stipulations contained in Chapter 2150 of FSM 2100 - Environmental Management (USDA FS 1998a), including the requirement that a Pesticide Use Proposal (form FS-2100-2) be completed for all proposed pesticide (i.e. herbicide) uses on national forest lands.	B, D
Herbicide applicators will have the chemical spill plan and emergency cleanup kit onsite during treatments. The spill plan identifies methods to avoid accidental spills as well as how to report and clean up spills. The kit will contain appropriate spill cleanup supplies. (See Appendix 6)	B, D
Workers handling herbicides will be required to wear protective clothing, including long-sleeved shirt and long pants to reduce worker doses. Clothes should be cleaned daily. Workers will also wear waterproofed boots, gloves, and other safety clothing and equipment listed on the herbicide label. Workers mixing or loading herbicides will be required to wear eye protection (goggles or eye shields) and Tyvek suits or herbicide resistant aprons.	B, D
A Pesticide Application Record (PAR) will be completed on a daily basis for each project area detailing the herbicide application, treatment area, target species distribution and density, weather conditions, and recommendations for followup treatments or rehabilitation.	B, D
The Forests will provide public information about weed treatments using herbicides, including herbicide to be used, locations, application schedules, etc. This information will be posted on the Forest's internet Web sites and mailed to those who request it.	B, D
To further notify forest visitors and users, signs regarding herbicide use will be placed at access points to treatment areas prior to herbicide application. Signs will include the herbicide to be used, effective dates, and phone number for acquiring more information.	B, D

Description of Mitigation Measure/Monitoring	Alternatives
Traffic control and signing during weed treatment operations will be used as necessary to ensure safety of workers and the public. Recreation sites, roads, trails or other areas scheduled for treatment may be temporarily closed during weed treatment activities to ensure public safety.	B, C, D
Weed treatments will be coordinated with potentially affected adjacent landowners and range allotment permittees. Cooperative efforts on adjacent lands and range allotments would increase treatment effectiveness and the ability to meet weed control objectives.	B, C, D
NATIVE VEGETATION and TREATMENT EFFECTIVENESS	
Weed treatments will only be applied where weeds actually exist, not on areas with a potential for weed infestations.	B, C, D
Vehicles used for weed treatments will be properly cleaned prior to entering national forest lands and again before leaving the treated area to avoid further spread of weeds.	B, C, D
Where treatments result in exposing bare mineral soil, those sites will be evaluated to determine the need for revegetation (seeding, planting), mulching, or other erosion or sediment control measures. The evaluation would consider the potential for subsequent re-invasion by weed species, potential for erosion, water runoff, and/or stream sedimentation. Where seeding is used, certified “weed-free” seed will be required. Seed mixes will be based on site-specific conditions and objectives.	B, C, D
Herbicides will not be applied if snow or ice covers the target weed plants, to avoid runoff into soil and onto nontarget vegetation.	B, D
After treatment, livestock grazing will be deferred where needed to achieve weed treatment objectives, based on site-specific conditions. This will be accomplished by working with permittees and adjusting their annual operating instructions as necessary.	B, C, D
Biological agents will not be released until screened for host plant specificity and approved by the USDA Animal Plant Health Inspection Service and New Mexico Department of Agriculture.	B, C
All weeds that are mechanically or hand excavated after flower bud stage will be double bagged and properly disposed of at an approved facility (e.g. covered landfill).	B, C
Use of prescribed fire must adhere to restrictions contained in the Forest Plan and agency directives, such as those for using fire within wilderness (FS Manuals 2324.2 and 2324.04(b)0, requirements for detailed burn prescriptions, and other requirements intended to avoid unexpected consequences.	B, C

Description of Mitigation Measure/Monitoring	Alternatives
THREATENED, ENDANGERED (T&E) and SENSITIVE PLANTS	
If herbicides are to be sprayed within potential habitat for any T, E or S plant species, a survey of that habitat will be conducted if possible. If no survey is conducted, the potential habitat will be treated as if occupied by the T, E or S plant, and the mitigation that follows (for occupied habitats) applies.	B, D
Within 25 feet of any occupied T, E or S plant species habitat, there will be no spraying of herbicides from vehicles, and herbicides must be applied by hand to individual weeds (e.g. wand from backpack sprayer, or on gloves, wicks, rags).	B, D
Controlled grazing, mowing and prescribed burning will not occur within 25 feet of Holy Ghost ipomopsis or other Federally listed plant species.	B, C
Design ground-disturbing activities (tilling, pulling, digging, etc.) to avoid trampling or other direct impacts to individual Holy Ghost ipomopsis or other T, E or S plant species.	B, C
WILDLIFE, including T & E and SENSITIVE SPECIES	
In treatment areas exceeding 1 acre in size within T & E species wildlife habitat, conduct surveys for the species prior to implementation, if feasible. If surveys are not feasible prior to implementation, that area will be treated as if occupied. Within “occupied” T & E species habitats, avoid loud, persistent noise disturbance or modifications of breeding habitat features. If a potentially adverse effect cannot be avoided, develop a supplemental biological assessment and consult with USFWS to determine the appropriate mitigation measures.	B, C, D
For “occupied” Mexican spotted owl and Southwestern willow flycatcher habitat, implement applicable breeding season restrictions as specified in Forest Plans and recovery plans for those species.	B, C, D
For “occupied” sensitive wildlife species habitat where individuals in the population may be negatively impacted, consult with the forest biologist and apply mitigation measures that minimize those negative impacts to individuals while continuing to maintain population viability and avoid a trend toward Federal listing.	B, C, D
Herbicide applications will be limited to those herbicides and application rates documented to have a low risk to wildlife species.	B, D
In areas with bighorn sheep populations (high country/wilderness), controlled grazing with sheep or goats will be prohibited.	B, C
AIR, SOIL, WATER, RIPARIAN and AQUATIC RESOURCES	
All prescribed burning must comply with the New Mexico smoke management requirements (permitting, monitoring, etc.) to maintain levels of these emissions within State and Federal air quality standards.	B, C
Heavy mechanized equipment such as tractors with tillers or mowers will not be used on slopes over 40 percent, to minimize erosion potential.	B, C
Heavy equipment will not be used to mechanically dig up weeds within riparian zones unless a Forest Service soil, water or fisheries specialist examines the site-specific conditions and determines that there would be no adverse impacts to water quality, stream morphology or aquatic resources.	B, C

Description of Mitigation Measure/Monitoring	Alternatives
Herbicide treatment areas that may be near water or have a high water table will be field checked to verify GIS data. If applying herbicides within 25 feet of a water body, or within a riparian area or other areas with a shallow water table, a short-lived, nonleachable herbicide that has been registered by the EPA for use on permeable soils, near water, or in areas having shallow water tables must be used (e.g. 2,4-D, glyphosate, triclopyr). Herbicides that use picloram as their active ingredient (e.g. Tordon 22K) will not be used in this situation.	B, D
Herbicide application within a riparian area or 50 feet of a water body is limited to hand application onto individual weed plants (using backpack spray wand, or glove, wick, or rag).	B, D
Mixing and loading of herbicides will not occur within 200 feet of live water, and will adhere to the other mitigations measures listed in the Chemical Spill Plan (see Appendix 6)	B, D
The acres treated with herbicides within the same Fifth Level watershed will not exceed the annual application thresholds established in the EIS.	B, D
In riparian areas or next to live water bodies containing fish, methods used must have been documented to have low risk to aquatic species.	B, C, D
HERITAGE RESOURCES	
Adhere to the programmatic agreement developed for this project[5], including requirements for conducting preimplementation heritage resource inventories and evaluations, consulting with State Historic Preservation Office and tribes, applying appropriate mitigation measures to avoid adverse impacts, and monitoring treatment activities for effects to heritage resources. (Programmatic agreement is available in the project record.)	B, C, D
Herbicides applied from vehicles (e.g. trucks, off-road vehicles) will not occur within 25 feet of archaeological remains consisting of perishable materials with analytic or information value, including wood, organic ceramic paints, datable materials, and residues on artifacts. Within 25 feet of such archaeological remains, herbicides must be applied by hand to individual weeds (e.g. on gloves, wicks or rags) to avoid getting herbicides or carrier fluids onto those remains.	B, D
Adhere to the mitigations previously listed that minimize adverse impacts to nontarget native plants in order to reduce the risk to plants of ethnographic concern.	B, C, D
Notification of tribes and other traditional use groups will occur before herbicides are used to inform them of pending chemical treatment activities and schedules. This measure will reduce the risk to native plants used for traditional cultural purposes and the risk to the health of individuals who gather these plants.	B, C, D
Sheep or goat grazing will not be used on heritage resource sites easily damaged by trampling as identified through heritage resource inventories prior to implementation.	B, C

[5] Programmatic agreement between the USDA Forest Service, Carson and Santa Fe National Forests, USDA Forest Service Regional Office, and New Mexico State Historic Preservation Office, and other consulting parties, to comply with applicable portions of the National Historic Preservation Act, including Section 106 and its implementing regulations.

Description of Mitigation Measure/Monitoring	Alternatives
Avoid direct impacts to archaeological sites by designing ground-disturbing activities to avoid archaeological sites, and conduct archaeological surveys for all ground-disturbing activities. Root tilling, mowing, hand pulling, digging or other weed treatments that disturb the soil, will be conducted in a manner that avoids heritage resource sites whenever possible. If avoidance is not possible, data recovery or another similar mitigation measure may be required.	B, C
During prescribed burning, avoid perishable materials, conduct fuel assessments, and reduce fuels onsite without perishable materials, and develop prescriptions to ensure low temperature, low duration, low residence time and low intensity on sites to be burned.	B, C
MONITORING and ADAPTIVE MANAGEMENT	
Weed inventories and mapping will be conducted annually, and treatment of newly found populations will be identified and prioritized based on criteria in the EIS.	B, C, D
Treated sites will be monitored and results evaluated (documented) to determine: - Effectiveness of the method(s) used in meeting the objective; - Whether impacts to resources or people were within the scope of EIS predictions; and - Implementation and effectiveness of mitigation measures, and whether mitigations should be modified or added to enhance effectiveness.	B, C, D
Changes in treatment prescriptions made as a result of monitoring and evaluation, and treatments prescribed for newly found weed populations must adhere to all mitigation and monitoring requirements in the EIS, and the actions and effects must be within the scope of those considered in the EIS. New information will be considered in accordance with FSH 1909.15, Sec. 18, to determine the need for additional environmental analysis under NEPA. The evaluation and decision by the responsible official regarding consistency with the EIS will be documented in the project record.	B, C, D

Forest Plan Amendment

Alternatives B and D would require an amendment to the Santa Fe National Forest Plan in order to be approved as written. The current standards of the Forest Plan prohibit herbicide use within municipal watersheds, in areas of human habitation, on soils with low regeneration potential or less than moderate cation exchange capacity (USDA FS 1987). The amendment would relax these standards in order to allow herbicides to be used where necessary in those situations with specific limitations. The current Forest Plan also prohibits herbicide use if an environmental analysis shows that it is not “environmentally, economically or socially acceptable,” which is an ambiguous and nonquantifiable standard, subject to variable interpretations. The amendment would slightly modify that standard while continuing to focus on using the environmental analysis of environmental, economic and social impacts to determine the appropriateness of herbicide application. The specific language changes proposed for the amendment are ***italicized*** in Table 11.

The need for the amendment is to help meet the purpose and need for this project. In order to achieve the desired ecological conditions described in the Forest Plan, including maintaining native vegetation and wildlife habitat quality, along with sustainable soil, water and riparian conditions that would otherwise be threatened by ineffective treatments and the continued spread of weeds, it may be necessary to have the flexibility to apply herbicides to weed populations that cannot be effectively treated with other methods. This could in some instances include herbicide applications within municipal watersheds, on national forest lands adjacent to human residences, and on some soils with a low revegetation potential or less than moderate cation exchange capacity. The amendment includes appropriate limitations on herbicide use and requires sufficient ground cover to ensure that soil erosion does not exceed the tolerance level for that soil type based on the Terrestrial Ecosystem Survey for the Santa Fe National Forest (USDA FS 1993). This would ensure that long-term soil productivity would be maintained. In addition, the Forest Plan standard and guideline regarding cation exchange capacity is proposed for deletion because it is outdated. That particular soil measurement is not used by the Forest Service in the Southwestern Region.

Table 11. Proposed Santa Fe National Forest Plan Amendment

Existing Forest Plan Direction (p.76)	Proposed Forest Plan Direction
Chemical treatments may be applied: - When determined through an environmental analysis to be environmentally, economically, and socially acceptable. - On areas outside municipal watersheds and areas of human habitation. - On soils with moderate or high revegetation potential.	Chemical treatments may be applied: - When determined through an environmental analysis to ***have no long-term adverse environmental, economic, or social impacts.*** ***- Within municipal watersheds only when the municipality concurs with the proposed treatment prescription and mitigation measures to be implemented***. -On ***any soils provided that effective ground cover is quickly restored and soil erosion on that site is not reduced to below the tolerance level identified in the Terrestrial Ecosystem Survey for the affected soil unit***.

Permits and Authorizations Required

- Consult and obtain concurrence from the U.S. Fish and Wildlife Service on the Forest’s biological assessment and determinations of effects to threatened or endangered species. This will occur prior to signing a record of decision authorizing project implementation.
- Consult and obtain concurrence from the New Mexico State Historic Preservation Officer regarding identification, evaluation, and determination of effects of the project on heritage resources. Final consultation and concurrence from the State SHPO will occur prior to implementation, based on the Programmatic Agreement for this project that was approved by the New Mexico State Historic Preservation Officer.
- Obtain concurrence from APHIS and the State of New Mexico for any biological control method to be used.

- Agency employees or contractors applying herbicides must first be certified, and adhere to all other pre- and post-implementation requirements in FS Manuals 2080 and 2150 regarding weed management and coordination with other agencies.
- Comply with the New Mexico Pesticide Control Act governing public applicators, record keeping, etc.
- Prior to burning, a burn plan must be prepared and burn permit obtained from New Mexico Environmental Department Air Quality Bureau.

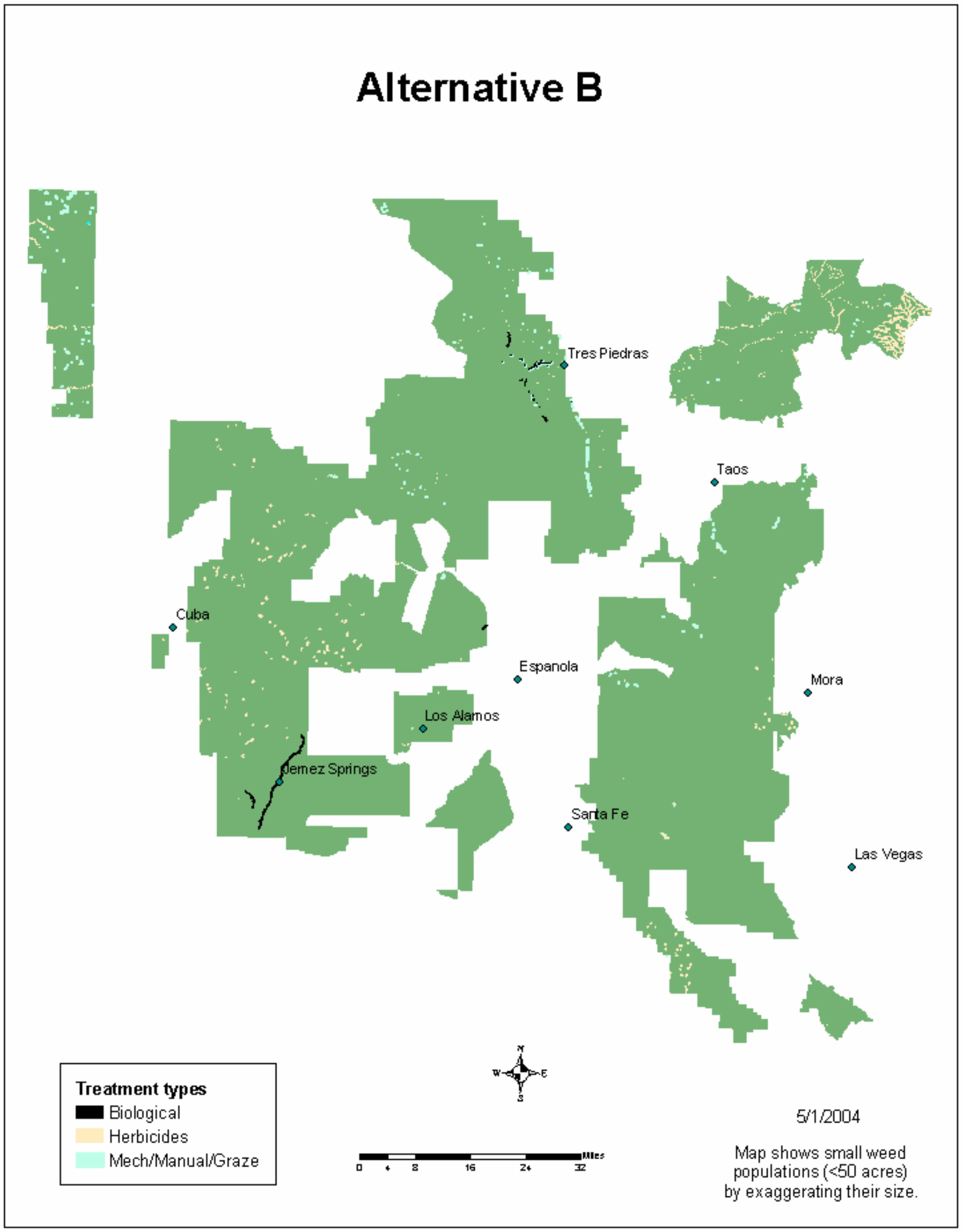


Figure 3. Alternative B

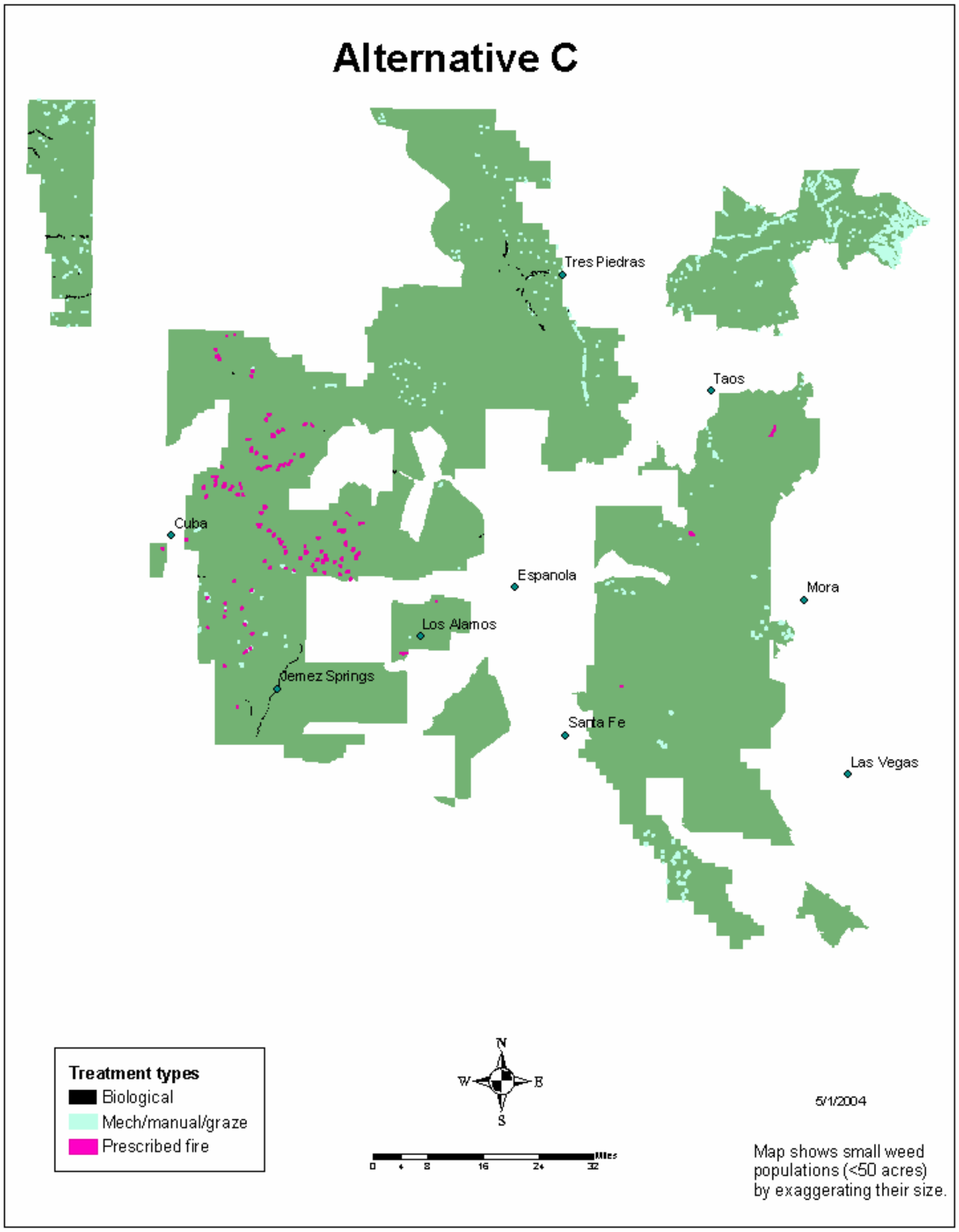


Figure 4. Alternative C

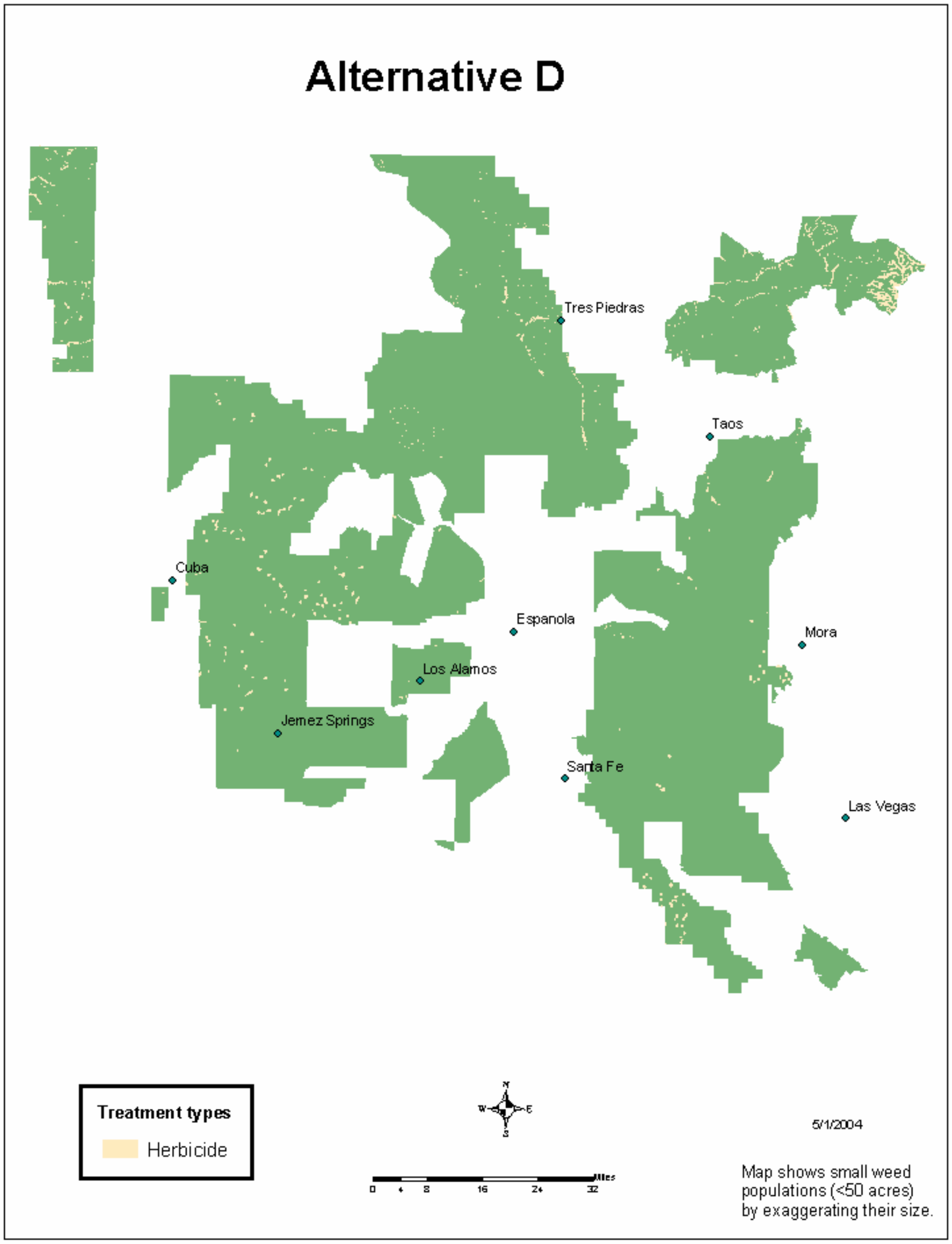


Figure 5. Alternative D

Comparison of Alternatives

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

Table 12 provides the comparison of alternatives based on the significant issues or effects as well as how well the alternatives meet the purpose and need (objectives) for the project. The comparison table is intended to provide the public and decision makers with a clear basis for choice between alternatives.

Table 12. Comparison of Alternatives by Issues and Objectives (Purpose and Need)

Significant Issues and Objectives	Alternative A	Alternative B	Alternative C	Alternative D
Issue 1: Herbicides and Human Health	No risk of health impacts from herbicide exposure (0 acres treated with herbicides).	Low risk of health impacts from using herbicides, to workers or general public, based on EPA ratings, risk assessments and other mitigation measures. Higher risk to people with multiple chemical sensitivities, although public notification requirement allows for avoidance of treated areas. Approx. 70 percent of treatments include herbicides (5,150 acres).	No risk of health impacts from herbicide exposure (0 acres treated with herbicides). Slightly increased risk of exposure to smoke from prescribed burning.	Same as Alt. B but slightly higher risk of exposure for people with chemical sensitivities as 100 percent of treatments include herbicides (5,435 acres).
Issue 2: Herbicides and Wildlife	No risk of herbicide impacts to wildlife. Weeds would degrade native plant habitats, especially riparian areas important to numerous species.	Low risk of herbicide impacts to wildlife based on EPA ratings, risk assessment, and mitigation measures. Native wildlife habitat quality (especially riparian habitat) would improve as weeds are eradicated and controlled.	No risk of herbicide impacts to wildlife. Less improvement in wildlife habitat.	Same as Alt. B

Significant Issues and Objectives	Alternative A	Alternative B	Alternative C	Alternative D
Issue 3: Herbicides and Native Plant Communities	No short-term impacts from herbicides. In long-term, weed-caused decline in abundance and diversity of native plant communities, especially native riparian plants.	Short-term reduction in some nontarget plant species. Long-term improvement in abundance and diversity of native plant communities, especially riparian plants.	Similar short-term reduction in nontarget plants. Low to moderate long-term improvement in native plant communities. Weed spread rate may equal or exceed control rate without herbicide use.	Same as Alt. B
Issue 3: Continued- Rare or Sensitive Native Plant Species	No risk of treatment-related impacts. In long-term, weeds may cause a decline in Federally listed or sensitive plant species	No impact to threatened or endangered plants due to mitigation measure. For sensitive plants, treatments "may impact individuals but are not likely to result in a trend toward Federal listing or loss of population viability," due to mitigation measures and species locations.	Same as Alt. B	Same as Alt. B
Issue 4: Cost and Treatment Effectiveness (based on level of effort to meet objectives)	No cost effectiveness; would incur much higher costs in future.	Moderately cost effective; $1,313,000 relative cost.	Least cost effective; $1,585,000 relative cost.	Most cost effective; $550,000 relative cost.
Objectives: Protect native plant communities, soil and water quality, wildlife habitat, and long-term ecosystem health	No protection; no effectiveness. Weed-related impacts to vegetation, soil, water, riparian habitat, etc. would continue.	Highest level of treatment effectiveness and resource protection from weed impacts due to combination of treatments including herbicides.	Lowest level of effectiveness and resource protection from weed impacts. Fewer acres treated annually for a given budget due to need for repeat treatments on the same acreage.	High level of effectiveness and resource protection from weed impacts. Not quite as effective as herbicides combined with other methods.

In addition to the summarized comparison of alternatives related to significant issues and project objectives, there are a few other key differences between the effects of each alternative, based on the detailed effects analysis described in Chapter 3. The most noticeable consequences from weed treatment under Alternatives B, C, and D would be the long-term, beneficial improvements to native ground vegetation such as grasses, forbs and shrubs. Riparian vegetation such as rushes, sedges, willows and cottonwoods would particularly benefit from this project. Protecting and improving native plant communities would have positive effects on soil and water conditions, as well as wildlife and aquatic habitats (particularly due to enhancing riparian vegetation).

Negative effects to native vegetation, soil, water and aquatic organisms would be very minor and of short duration. The increases in sediment (more with Alternative C) and herbicide delivery to streams (for Alternatives B and D) would have no measurable long-term consequences. There would be a low risk of adverse impacts to fisheries, including Rio Grande cutthroat trout (a sensitive fish species) or other aquatic organisms based on application of mitigation measures, risk assessment and EPA guidelines, and maintaining herbicide levels well below impact thresholds for each watershed as established in the analysis. Alternative C would cause more ground disturbance and associated impacts to soils, especially on soils with a severe erosion hazard rating. However, all alternatives would remain with soil erosion tolerance levels needed to protect long-term soil productivity. Soils with low revegetation potential would receive herbicide treatments in Alternatives B and D, while reestablishing native vegetation would take longer under Alternative C. Mitigation requirements for all alternatives would ensure that vegetative ground cover is adequately reestablished. With the required mitigation measures, all soil and water quality standards would be met.

Differences between alternatives in their effects to air quality, heritage resources, livestock grazing, recreation, wilderness and visual resources were expected to be negligible, such that they would not be given weight in the decisionmaking process. There would be minor increases in noise and traffic associated with the action alternatives, although generally within background levels.

By controlling the spread of weeds and protecting native plant communities, habitats and watershed conditions on the Forests, Alternatives B and D would maintain or enhance social or economic conditions, particularly for local rural communities in northern New Mexico who typically rely on the Forests' natural resources for their livelihood, traditional culture and quality of life.

Chapter 3 • Affected Environment and Environmental Consequences

This chapter contains affected environment sections that summarize the physical, biological, social, and economic environments of the project area, as well as environmental consequences sections that describe the effects of implementing the proposed action and other alternatives. The environmental consequences focus on the project's purpose and need as well as issues identified in Chapter 1, providing the scientific and analytical basis for the comparison of alternatives presented at the end of Chapter 2.

Specialists' reports contained in the project record may contain more detailed information for the affected environment sections than what is contained in this document. The affected environment sections in this chapter provide succinct descriptions of affected resources commensurate with the relevance to and importance of the issues or impacts, in accordance with direction provided in NEPA implementing regulations at 40 CFR §1502.15.

An agency approved adaptive weed management strategy was incorporated into this proposed project to address uncertainties about new or undiscovered weed infestations as well as post-implementation monitoring results that may indicate a need to modify treatment methods in order to meet project objectives. In the context of this uncertainty, the effects described in this chapter include consideration of the adaptive strategy, including use of treatment method selection criteria, prioritization ratings, thresholds, limitations, mitigation measures, and monitoring requirements described in Chapter 2.

Cumulative Actions for Cumulative Effects Analysis

This section briefly discusses other activities and land uses occurring within and surrounding the project area that could contribute to cumulative effects when added to the effects of weed control treatments included in this project. Cumulative effects are those impacts on the environment that result from incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions. While this section outlines these potentially cumulative actions used by the interdisciplinary team in their cumulative effects analysis, the actual analysis and estimations of cumulative effects for each affected resource is described in each separate resource section in this chapter.

The geographic extent for most resources for which cumulative effects have been evaluated consists of land administered by and immediately adjacent to the two forests, based on the area directly or indirectly affected by project activities. Project activities are anticipated to occur over approximately 10 years (or more), and would be well distributed spatially in localized weed infestation sites across the 3 million acres comprising the two forests.

The actions that would be expected to contribute most to potential cumulative effects are weed control actions being undertaken by other jurisdictions or on private lands in and around the Forests. However, other activities expected to occur on the Forests that affect similar resources are also included.

Past and present (ongoing) weed treatments on the Forests are:

- Manual control (hand digging rosettes and clipping seed heads) of thistles (musk, Scotch, and bull) on the Jicarilla, Questa, and Camino Real Ranger Districts, Carson National

Forest, and on the Espanola, Jemez, and Cuba Ranger Districts, Santa Fe National Forest. In fiscal year 2003, the Forests treated 238 acres.

- Herbicide, mechanical, and manual treatment of salt cedar, Siberian elm and Russian olive in riparian areas on the Jemez Ranger District, Santa Fe National Forest.
- Goat grazing of yellow toadflax, Russian knapweed, and hoary cress within highway rights-of-way was used in 2002, just south of Tres Piedras, Carson National Forest.
- Mowing plants along U.S. Highways 64 and 285 by New Mexico State Highway/Transportation Department to maintain visibility for highway safety. When the mowing occurs prior to seed heads maturing, it limits the spread of weeds. When this is done after seed heads have matured, it tends to spread weed seeds to noninfested sites.

Foreseeable future weed control activities using biological, manual, mechanical and herbicides within the cumulative effects area would be conducted by private landowners, county, State and other Federal agencies. Appendix 1 describes these activities in detail. Acreage treated varies widely from year to year and tends to be small. These other agencies and landowners expect that weed control activities would increase over the next 10 years as the weed problem becomes more prominent. Based on conversations with other agencies and landowners in northern New Mexico, it is estimated that they would cumulatively treat approximately 5,000 to 8,000 acres per year over the next 10 years, although the acreage estimates vary widely by treatment method. Acreage estimates for nonaerial herbicide applications are generally quite small relative to the acreages estimated for biological control methods.

In addition to the weed control programs, other activities likely to be implemented by the two forests in the next 10 years include thinning/removing trees for hazardous fuels reduction, prescribed burning, trail reconstruction and restoration, wildfire burned area rehabilitation, fish habitat improvement, road and bridge maintenance and construction, recreation site and facilities reconstruction, and special use permits for various forest uses.

Table 13 displays the main resources that would likely be affected by this proposed weed control project and the associated issues (effects) that were identified for those resources. The second column displays other actions considered by the interdisciplinary team in their cumulative effects analysis, which includes past, present or foreseeable future activities that are not part of the proposed project but could affect forest resources or visitors in a similar manner. In completing the cumulative effects analysis, the team not only considered other actions that could affect the resource in a similar manner as the project, but the effects associated with those actions.

Table 13. Summary of Cumulative Activities by Key Resource Issues

Resources and Issues	Other Actions Contributing to Similar Effects
Human Health/Safety: herbicide exposure and risk of health impacts	Other actions that introduce chemicals into the environment include, but are not limited to: herbicides recently applied or expected to be applied on thousands of acres in northern New Mexico by San Juan and Sandoval County Weed Management Areas, Soil and Water Conservation Districts, Bureau of Indian Affairs, Valle Caldera National Preserve, Bureau of Land Management, National Park Service, Santa Fe Watershed Association, The Nature Conservancy, and Audubon Society. Other limited chemical introductions would come from: driving vehicles on or off roads, constructing facilities and roads, reconstructing and

Resources and Issues	Other Actions Contributing to Similar Effects
	maintaining roads, extracting oil-gas or mineral resources, etc. Weed control activities on public and private lands also contribute to beneficial cumulative effects by reducing allergic reactions and skin irritations associated with specific weeds.
Vegetation: loss of native plants	Activities include: thinning/removing trees and prescribed burning for fuel hazard reduction; grazing livestock; camping outside developed sites; driving off existing roads or trails; constructing new facilities (e.g. Cow Creek Campground, Buckman water diversion facilities, powerlines, portions of roads to be rebuilt); and clearing vegetation from highway/road rights-of-way, etc. Weed control activities on public and private lands add to the beneficial cumulative effects of the project by restoring native vegetation being displaced by weeds. Wildfire burn area rehabilitation (seeding, planting, etc.), fuel reduction activities, meadow and riparian restoration projects, etc., on public and private lands also contribute to restoration of native vegetation.
Wildlife/Fish: habitat disturbance	All projects and public land uses create noise and visual disturbance including, but not limited to: constructing new facilities or roads, reconstructing or maintaining roads, thinning projects, prescribed burning, creating habitat for reintroduction of Rio Grande cutthroat trout (killing domestic fish, creating barriers…), reintroductions of wildlife species or animal control actions conducted by State Department of Game and Fish, driving vehicles on or off roads and trails, group camping and partying, etc.
Wildlife/Fish: herbicide-related health risk	Same actions as described for Human Health/Safety
Wildlife/Fish: native vegetation/ habitat reduction	Native vegetation cover that may provide nesting, foraging or hiding cover habitat for some species is temporarily removed (while maintaining long-term site productivity) during many forest activities such as thinning and burning projects and livestock grazing. Counties and other agencies clear vegetation along road and highways, and manual/mechanical weed control treatments listed in Appendix 7 remove some native vegetation. Weed control activities on public and private lands add to the beneficial cumulative effects of the project by restoring diverse vegetation/habitat that is being displaced by weeds. Wildfire burn area rehabilitation (seeding, planting, etc.), fuel reduction activities, meadow and riparian restoration projects, fish habitat improvement projects, etc., on public and private lands also contribute to restoration of high quality wildlife and fish habitat.
Soil and Water: risk of excessive erosion, sedimentation, or chemical load	Thinning, burning, grazing, constructing/reconstructing facilities or roads, driving off roads or trails, camping, etc., increase soil erosion and potentially cause sediment to move into streams. Actions previously described that include use of herbicides or other chemicals could add to chemical loading in soil, water or aquatic environments. Weed control activities on public and private lands add to the beneficial cumulative effects of the project by reducing erosion caused by monocultures of weed replacing native plants. Wildfire burn area rehabilitation (erosion control), fuel reduction activities, meadow and riparian restoration projects, restoration of dispersed recreation sites that have been denuded,

Resources and Issues	Other Actions Contributing to Similar Effects
	closure/decommissioning of unneeded roads and trails, etc., on public and private lands contribute to soil stabilization, soil productivity and water quality.
Air: smoke or dust particulates	Other prescribed burning, wildfires, and residential firewood burning add to regional haze, along with other sources of air pollution. Use of unsurfaced roads throughout the forest for all activities creates dust.
Heritage Resources: risk of damage or loss	Same activities as “Soil and Water” above that increase soil erosion pose a risk of inadvertent damage to heritage resource sites.

Vegetation Resource

Affected Environment - Vegetation

The first part of this vegetation resource section discusses the weeds known to occur as well as other potentially affected vegetation, then the second part focuses on special status plant species (threatened, endangered or sensitive plants).

The Forests lie within the Colorado Plateau Semi-Desert Province and Arizona-New Mexico-Mountains Semi-Desert-Open Woodland-Coniferous Forest-Alpine Meadow Province (Mountains Regime) of the Tropical/Subtropical Steppe Division; and the Great Plains-Palouse Dry Steppe Province and the Southern Rocky Mountains Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province (Mountains Regime) of the Temperate Steppe Division within the Dry Domain. Fire, insects, and disease are the primary natural sources of disturbance to vegetation (McNab and Avers 1994).

Vegetation cover follows altitudinal gradients similar to those in the southern Rocky Mountains. Dominant vegetative cover types occurring on the Forests include grasslands, sagebrush, shrublands, pinyon-juniper, oak, ponderosa pine, mixed conifer, spruce-fir and subalpine. Riparian vegetation is also found in valley bottom lands, and along streams and lakes within each of these cover types.

Weeds pose threats to biological diversity of native plant communities, altering of ecosystem processes, and loss of rare or special status plants. The weed species known to occur on the Forests were listed in Chapter 1 and are described in detail in Appendix 2. Weed populations are known to exist on approximately 7,350 acres within the Forests. The anticipated expansion rates vary between 5 and 30 percent annually, depending on weed species and ecologic conditions at each infestation site (Tu et al. 2001). At a conservative estimate of 8 percent of growth per year, the expected weed population is expected to exceed 15,000 acres in 10 years. Our key concern is that weeds contribute to the decline in frequency of native plant species that depend on similar habitat as the weeds. Weeds also cause a decline in species richness overall. Weeds are highly adept at capturing available moisture and nutrients, and quickly spreading, choking out other vegetation. Displacement of native vegetation, decreased species diversity, and changing habitat structure and composition result from invasions by these species.

Infestations of Russian knapweed, hoary cress and yellow toadflax have been identified in highway rights-of-way within the Forests' boundaries. Major wildfires have occurred on both forests in recent years. Monitoring of recent high severity burns has identified these areas as locations for new infestations.

The Jemez Ranger District (Santa Fe National Forest) completed NEPA analysis and began implementation of the Jemez Riparian Enhancement Project in 1999. The Jemez Ranger District has been successfully using herbicides to selectively control salt cedar, Russian olive and Siberian elm and restore native riparian plant species such as willows and cottonwoods. The lower 2 feet of small weed species are sprayed with a mixture of Garlon 4 (triclopyr) and vegetable oil. Larger weed trees are cut near the ground and their stumps are treated with Garlon 3A and water. Previously approved, small acreage weed control treatments have also occurred on the Carson National Forest, and on both forests where other agencies have jurisdiction such as along highway rights-of-way.

Thirteen additional species of weeds have not been detected on the Forests, but are of concern in New Mexico and have potential for introduction and spread on the Forests (USDA NRCS 2002) as described in Chapter 1. The priority for management of these species is early detection and eradication.

Table 14 displays the total acres of known weed infestations by vegetation cover type.

Table 14. Weed Infestations by Vegetation Type

Vegetation Type	Total Acres	Acres Infested	Percent of Total Acres Infested
Grasslands	241,030	420	0.17
Sagebrush/Shrubs	95,713	20	0.02
Pinyon-Juniper	823,324	1,160	0.14
Oak Woodlands	29,600	50	0.17
Ponderosa Pine	640,500	1,920	0.30
Mixed Conifer	511,219	610	0.12
Spruce-Fir	348,815	230	0.07
Riparian/Valley Bottom Lands	343,431	2,850	0.83

The following paragraphs briefly describe each vegetation cover type and inventoried weed infestations within each type.

Grasslands

Grasslands are widespread at all elevations within both forests, typically as openings within shrublands and forest cover types. Weed species include black henbane, bull thistle, Canada thistle, leafy spurge, musk thistle, scotch thistle, yellow starthistle and yellow toadflax. Weeds found to date cover 420 acres of grasslands (0.17 percent).

Sagebrush/Shrub Cover Types

Sagebrush and shrub cover types are widespread at lower and middle elevations (6,200-7,900 feet) within both forests, typically as openings within forest cover types. Weed species known to be present include black henbane, bull thistle, Canada thistle, Dalmation toadflax, musk thistle, perennial pepperweed, Russian knapweed, Scotch thistle, and spotted knapweed. Weeds found to date cover 20 acres of shrublands (0.02 percent).

Pinyon-Juniper Cover Types

Pinyon-juniper cover types are widespread at lower and middle elevations (5,700-8,400 feet) within both forests. Weed species known to be present include bull thistle, Canada thistle, Dalmation toadflax, diffuse knapweed, leafy spurge, musk thistle, Russian knapweed, Scotch thistle, Siberian elm and spotted knapweed. Weeds found to date cover 1,160 acres of pinyon-juniper woodlands (1.21 percent).

Oak Woodlands Cover Type

Oak woodlands are widespread at middle elevations (7,700-9,000 feet) within the Santa Fe National Forest and Carson National Forest. The most common oak species present in weed

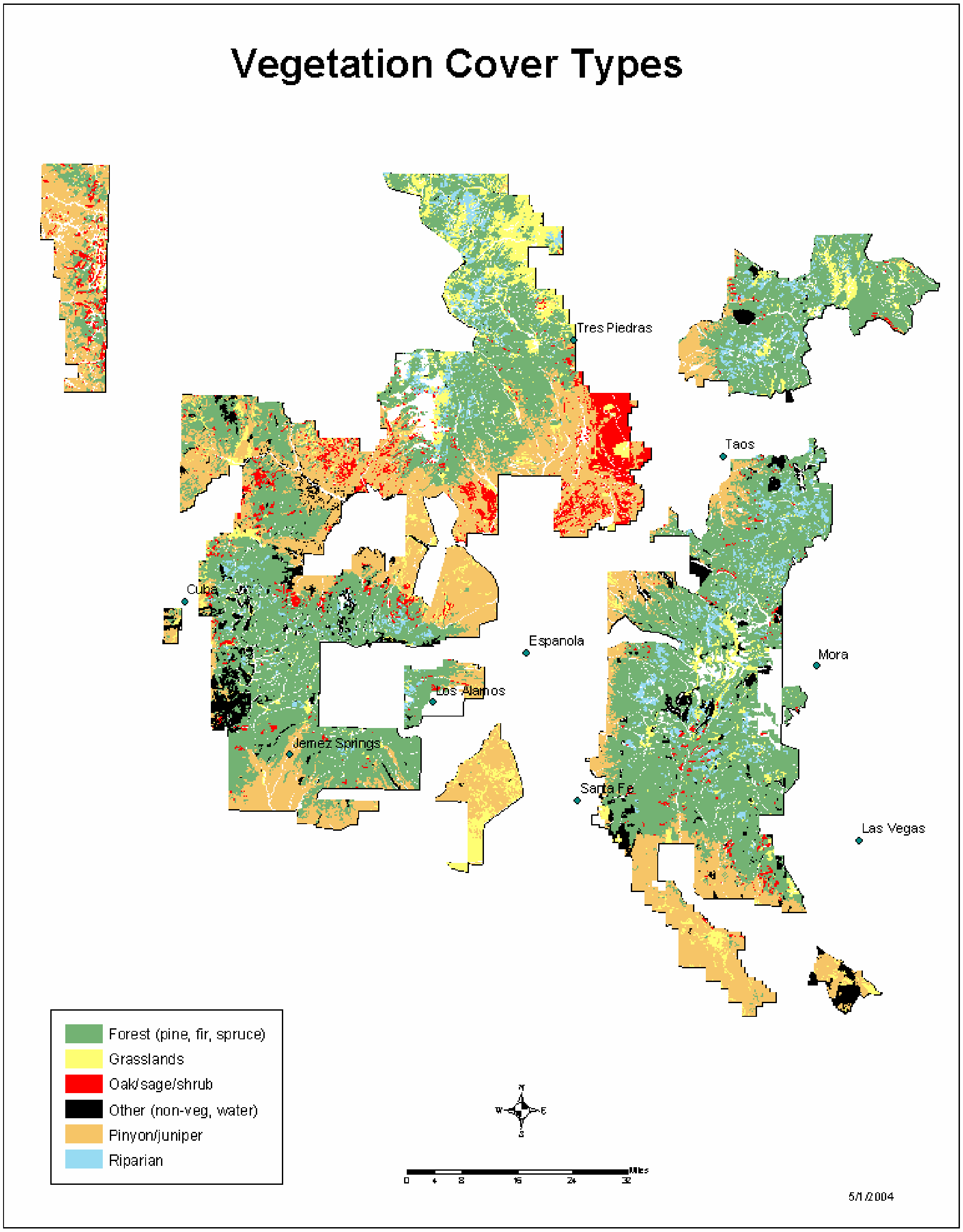


Figure 6. Vegetation Types in the Project Area

infested areas is Gambel oak. Weed species known to be present include bull thistle, Canada thistle, diffuse knapweed and musk thistle. Weeds found to date cover 50 acres of oak woodlands (0.17 percent).

Ponderosa Pine Cover Types

Ponderosa pine cover types are widespread at middle elevations (7,200-9,000 feet) within both forests. Weed species known to be present include bull thistle, Canada thistle, Dalmation toadflax, diffuse knapweed, leafy spurge, musk thistle, Russian knapweed, Russian olive, Scotch thistle and yellow toadflax. Weeds found to date cover 1,920 acres of the ponderosa pine forest (0.30 percent).

Mixed Conifer Cover Types

Mixed conifer cover types are widespread at middle and upper elevations (6,900-11,200 feet) within both forests. Weed species known to be present include black henbane, bull thistle, Canada thistle, diffuse knapweed, leafy spurge, musk thistle, Russian knapweed, Scotch thistle, spotted knapweed and yellow toadflax. Weeds found to date cover 610 acres of mixed conifer forest (0.12 percent).

Spruce-fir Cover Types

Spruce-fir cover types are widespread at upper elevations (8,700-11,500 feet) within both forests. Weed species known to be present include bull thistle, Canada thistle, musk thistle, Russian knapweed and yellow toadflax. Weeds found to date cover 230 acres of spruce-fir forest (0.17 percent).

Riparian Areas/Valley Bottom Lands

Riparian areas and valley bottoms with wet soils are widespread throughout all elevations within both forests. Riparian areas often overlap other cover types at the mapping scale used for this analysis. Where information indicated riparian areas present, these acres were subtracted from other cover types so they were not counted twice. Weed species known to be present include bull thistle, Canada thistle, Dalmation toadflax, field bindweed, hoary cress, musk thistle, poison hemlock, Russian knapweed, Russian olive, salt cedar, Scotch thistle, Siberian elm, spotted knapweed and yellow toadflax. Weeds found to date cover 2,850 acres of riparian and valley bottom areas (0.17 percent), with salt cedar covering the most acres.

Environmental Consequences - Vegetation

Alternative A (No Action)

The No Action Alternative would not meet the purpose and need. It would not help to restore diverse, sustainable native plant communities in weed infested areas. It would result in continued invasion and spread of weeds throughout the Forests and particularly on and near the 7,350 acres proposed for treatment. The anticipated expansion rates vary between 5 and 30 percent annually, depending on weed species and ecologic conditions at each infestation site. Given a conservative estimate of 8 percent per year, the number of acres impacted by weeds would double over the next 10 years. The 7,350 acres of inventoried and mapped weed infestations underestimates existing weed infestation acres when the uninventoried areas are considered. There could easily be 10 to 20 percent more weed infested acres than those inventoried, which would spread exponentially to a minimum of 20,000 acres within 10 years, at an 8 percent spread rate.

As weed populations grow, weeds would contribute to the continuing decline in frequency of some native species and a decline in species richness overall. Weeds are highly adept at capturing available moisture and nutrients, and quickly spreading, choking out other vegetation. Once weeds begin to dominate native plant communities, a loss of species diversity, composition and ecosystem function could occur (USDA FS 2003c).

Overall, not treating weeds on the Forests would likely cause continued displacement of native vegetation and decreased species diversity. Thus, the historic trends and natural ecosystem functions and processes in native plant communities would incur negative, long-term impacts.

For example, dense infestations of yellow starthistle would not only displace native plants and animals, but would threaten natural ecosystems and nature reserves by fragmenting sensitive plant and animal habitat. Bull thistle, Canada thistle, musk thistle, and Scotch thistle would threaten natural communities by directly competing with and displacing native vegetation, decreasing species diversity, and changing the structure and composition of some habitats. Riparian area communities would continue to be threatened by direct competition from Canada thistle, field bindweed, hoary cress, perennial pepperweed, poison hemlock, Russian olive, salt cedar and Siberian elm. These species displace native riparian vegetation and change the vegetation structure of these areas away from native species, which consequently changes the ecological processes (waterflow for instance) which makes natural recovery more difficult if not impossible.

Ecosystem processes that involve water retention and nutrient cycling would also be impacted by weeds. A type of ground cover called cryptogrammic ground crust would be reduced by spotted knapweed. This ground crust is composed of small lichens and mosses and commonly covers undisturbed soil surfaces. This ground crust is important for soil stabilization, moisture retention, and nitrogen fixation. Knapweed also increases erosion rates because of its taproot growth characteristics. Runoff was 56 percent higher and sediment yield was 192 percent higher on spotted knapweed plots compared to bunchgrass plots during a simulated rainfall period. (Lacey 1989). Knapweed infestations would have long-term detrimental effects on soil and water resources (USDA FS 2003a).

Introduction and spread of weeds threatens biological diversity of native plant communities, and can alter ecosystem processes such as intensity and frequency of fire, hydrologic cycles, and soil erosion rates.

The following notes key differences in effects of Alternative A, based on vegetation type:

Grasslands: These habitats are highly vulnerable to weed invasion, especially when considering the additive effects of drought and grazing. Many weed species would continue to out-compete grasses or excrete chemicals that eliminate grass from a weed infestation altogether.

Sagebrush/Shrub: In many areas in the intermountain west and the Great Basin, encroachment by cheatgrass (*Bromus tectorum*) and other weeds is rapidly displacing sagebrush/scrub communities (Sheley 1999). This reduction in native shrub communities would continue on the Forests, and would reduce wildlife forage, nesting and hiding cover. In addition, fire regimes would become more frequent and occur earlier in the season in these altered communities, which promotes further weed establishment and spread.

Pinyon-Juniper: These habitats would continue to become more vulnerable to weed invasion due to large scale die off of pinyon pine. The reduction of live vegetative cover and increased potential of wildfire leaves this community type at higher risk for further weed establishment and spread.

Oak Woodlands: This community would continue to be inherently at low risk for weed invasion because of the closed canopy nature of Gambel oak thickets and woodlands.

Ponderosa Pine: Weeds would invade ponderosa pine community types, especially those recently thinned out and opened up by fuel reduction activities. The effects of weeds typically affect the lower structure of this community type and would not impact the trees. Ponderosa pine grasslands are the most vulnerable to the effects from weeds. While the structure of the pine forests may remain intact for some time after weed invasion to this community type, changes in fire regimes (increased intensity) and future reestablishment of ponderosa pines may be retarded or prevented as openings necessary for the pine to regenerate do not develop.

Mixed Conifer and Spruce-fir: Many of the acres in this forest community are infested with thistles, although generally these are older forests with higher percentages of canopy cover that are not highly vulnerable to weed invasion. Ecological factors like a short growing season reduce the risk of weed spread and invasion. However, without weed control, weeds would continue to infiltrate this community, particularly in the younger stands, which could retard the development of mature mixed conifer communities.

Riparian and Valley Bottoms: Riparian communities would continue to be particularly vulnerable to weed infestations. Weeds like salt cedar (*Salt cedar* spp.), Russian olive, Siberian elm, and bull thistle would expand their influence in riparian areas and valley bottoms on the Forests. They would eventually replace native riparian vegetation such as willows, cottonwoods, rushes, and sedges.

Alternative B (Proposed Action)

Tables 15 through 23 display the treatments proposed for these vegetation cover types. It should be noted that the acreages do not match precisely with weed occurrence or treatment tables in this DEIS due to rounding off to the nearest acre.

Table 15. Treatment Acres in Grassland

Treatment	Alt. B	Alt. C	Alt. D
Biological	3	65	
Biological: Jemez RD	63	63	
Herbicides	251	0	354
Manual	6	72	0
Manual-Herbicide	68	0	0
Manual-Mechanical	0	8	0
Mechanical	2	175	0
Mechanical-Biological-Grazing	6	6	0
Mechanical-Herbicide	20	0	0
Prescribed Fire	0	28	0
Total	**419**	**417**	**354**

Table 16. Treatment Acres in Sagebrush/Shrub

Treatment	Alt. B	Alt. C	Alt. D
Herbicides			18
Manual	1	2	
Manual-Grazing			
Manual-Herbicide	6	0	0
Manual-Mechanical		4	
Mechanical	12	12	
Total	**19**	**18**	**18**

Table 17. Treatment Acres in Ponderosa Pine

Treatment	Alt. B	Alt. C	Alt. D
Biological-Grazing	13	13	
Biological	6	38	0
Bilogical: Jemez RD	92	92	
Grazing-Herbicides	20		
Herbicides	1,179		1,823
Manual	3	608	0
Manual-Grazing	10	30	
Manual-Herbicide	576	0	0
Manual-Mechanical		7	
Mechanical		241	
Mechanical-Biological-Grazing	6	6	
Mechanical-Herbicide	10		
Prescribed Burning		880	
Total	**1,915**	**1,915**	**1,823**

Table 18. Treatment Acres in Oak Woodlands

Treatment	Alt. B	Alt. C	Alt. D
Biological	0	1	
Herbicides	48		49
Manual	1	8	0
Manual-Grazing		1	
Prescribed Burning		39	
Total	**49**	**49**	**49**

Table 19. Treatment Acres in Pinyon-Juniper

Treatment	Alt. B	Alt. C	Alt. D
Biological	20	36	0
Biological: Jemez RD	523	523	0
Herbicides	512	0	629
Manual	16	65	0
Manual-Grazing	41	41	0
Manual-Herbicide	15	0	0
Manual-Mechanical		11	0
Mechanical	9	392	0
Mechanical-Biological-Grazing	1	1	
Mechanical-Herbicide	15		
Prescribed Burning		85	
Total	**1,152**	**1,154**	**629**

Table 20. Treatment Acres in Riparian/Valley Bottoms

Treatment	Alt. B	Alt. C	Alt. D
Biological-Grazing	22	21	0
Biological	94	102	0
Biological: Jemez RD	1,050	1,050	0
Grazing-Herbicides	11	0	0
Grazing-Manual	38	49	0
Herbicides	554	0	1,630
Manual	7	704	0
Manual-Herbicide	774	0	0
Manual-Mechanical		141	
Mechanical	1	192	0
Mechanical-Biological-Grazing	2	3	0
Mechanical-Herbicide	44	0	0
Prescribed Burning		335	
Prescribed Burning-Mechanical	81	81	
Total	**2,678**	**2,678**	**1,630**

Table 21. Treatment Acres in Mixed Conifer

Treatment	Alt. B	Alt. C	Alt. D
Biological-Grazing			
Biological: Jemez RD	41	41	0
Herbicides	524		564
Manual	5	35	
Manual-Grazing	2	2	
Manual-Herbicide	17	0	0

Treatment	Alt. B	Alt. C	Alt. D
Manual-Mechanical		12	
Mechanical		127	
Mechanical-Biological-Grazing	1	1	
Mechanical-Herbicide	15		
Prescribed Burning		388	
Total	**605**	**606**	**564**

Table 22. Treatment Acres in Spruce-Fir

Treatment	Alt. B	Alt. C	Alt. D
Herbicides	205	0	228
Manual	3	19	0
Manual-Grazing	1	1	0
Manual-Herbicide	2		
Manual-Mechanical		4	
Mechanical		19	
Mechanical-Biological-Grazing			
Mechanical-Herbicide	18		
Prescribed Burning		186	
Total	**229**	**229**	**228**

Table 23. Treatment Acres in Other (e.g. urban)

Treatment	Alt. B	Alt. C	Alt. D
Biological: Jemez RD	1	1	0
Herbicide	127	0	134
Manual	2	8	0
Manual-Herbicide	4	0	0
Manual-Mechanical		1	
Mechanical		17	
Mechanical-herbicide	1		
Prescribed Burning		107	
Total	**135**	**134**	**134**

This alternative would improve native vegetation by suppressing, containing or eradicating weeds on treatment areas. Alternative B would assist the reestablishment of native plant communities by removing the dominant and aggressive weeds. Regardless of the methods used at each site, there would be a noticeable decline in weeds overall, and an increase in native plant abundance and vigor. As weeds are removed and the bare soil fills in with native plants, the plant community would become more resistant to re-establishment of weeds.

Alternative B would result in a reduction in individual, nontarget ground cover plants or small patches of these native plants if they are interspersed with weeds. However, the loss of native plants would be temporary and very small, estimated at less than an acre on the larger weed treatment sites. Temporary reductions in native plants would vary primarily by the weed treatment method used.

Biological methods avoid loss of nontarget plants altogether, as the insects cannot be released without APHIS approval, based on assurance that they would only consume the target weed species. The effectiveness of using biological control to control weeds and restore native species would be more gradual and would not be detectable in the short term. Manual methods would be able to usually avoid cutting or digging up nontarget plants. Herbicides applied manually or with backpack sprayers would utilize directional spray devices that minimize herbicide spray on nontarget vegetation. Adherence to wind and weather condition requirements would minimize the amount of spray that would drift through the air onto nontarget plants. Vehicle-mounted herbicide spraying is less precise but includes a directionally controlled wand and on/off switch to minimize hits to nontarget vegetation. Mechanical, grazing and burning methods would impact entire roadsides or areas treated, unless a torch is used to burn just weed species. However, those three methods would be used on less than 5 percent of the treatment acreage so would have very little effect on native vegetation across the Forests. In addition, because methods like burning, grazing and mowing only remove the tops of plants, they would have a less intense short-term effect on the ground cover. On a landscape level, the temporary reduction in native species would be negligible.

Herbicides would cause the more noticeable change in the composition of native plants that are sprayed with herbicides, since some herbicides would kill those plants entirely, depending on the selective nature of the herbicide used. However, applications at prescribed rates should not eliminate any native (or nonnative) populations from the plant community. Herbicides constitute a short-term disturbance to plant communities that have evolved to withstand and recover from long-term changes and disturbances (USDA FS 2003a). If infestations remain untreated, they would expand and reduce native vegetation through competition. Native plant communities are more at risk from competition by nonnative species than from changes resulting from herbicides.

Plants of special concern in Native American or traditional Hispanic cultures were also considered as special plants that may be impacted by weed control treatments. However, individuals who collect plants from the Forests for use in medicines, handicrafts or other purposes can obtain advance notification of treatments, including the method, location and timing. This may allow them to gather plants prior to weed control treatments and/or notify the Forest Service of any specific areas of concern or traditional use areas. Traditional cultural properties would be protected through the procedures outlined in the programmatic agreement developed for protection of heritage resources, including consultation with affected parties, as described in Chapter 2, and in the “Heritage Resources” section of this chapter.

Once the dominant weeds are removed or killed, community diversity is expected to be reestablished from the existing seeds in the soil and seeds from adjacent areas. It is expected that at least the grasses or other early seral plants would recover within treated areas within the first growing season, and abundance and diversity of native plants would increase over the following few years. Mitigation measures require revegetating areas where necessary following treatments, which would avoid creating or leaving bare soil conditions. Measures such as deferring grazing after treatment, monitoring, and the adaptive management approach would further enhance the effectiveness of treatments. For all treatments proposed, reestablishment of vegetative cover is key in prevention of weed reinvasion in all treatment types and plant communities (Sheley 1999).

Treating weeds now while the infestations are relatively small would greatly increase the chance of effectiveness and reduce any negative effects to native plants, compared to delaying treatment for several more years. Overall, there would be no noticeable, long-term, or irreversible loss of native nontarget vegetation or native species diversity.

There are only a few minor differences in effects to native plants based on vegetation cover types. The current weed infestation is highest in riparian/valley bottoms dominated by salt cedar and other weeds, and much of those areas would be treated with biological controls (alone or in combination with other methods). Proposed treatments would help restore riparian areas, which are particularly important elements in the ecosystem and account for much of the biological diversity of any given area. Riparian areas and valley bottoms would be expected to revegetate faster than adjacent uplands. Removal of salt cedar in particular would improve water availability and enhance the native riparian vegetation growth.

The ponderosa pine and pinyon-juniper communities, which are the most prevalent forest vegetation cover types on the Forests, would experience the next highest acres of weed treatment. Conifer tree seedlings and saplings are the most vulnerable to the effects of weed eradication, but they can reestablish quickly on exposed mineral soils. Larger conifer trees would not likely succumb to any of the weed control methods. Removal of weeds in the pinyon-juniper cover type is of increasing importance due to the current loss of pinyons resulting from the bark beetle epidemic. Weed treatments in this cover type would help prevent the spread of weeds in areas where pinyons have died and been removed. Grasslands, shrublands and higher elevation conifer forest communities would continue to be the least affected by weed infestations or weed treatment activities.

Alternative C (No Herbicides)

The most noticeable effects to native vegetation would be the beneficial increase in native species abundance and diversity on the treated acres, similar to effects described for Alternative B. The main difference with this alternative is that for a given budget, the expectation is that fewer acres would be treated each year with initial entry treatments. Many more repeat treatments on the same sites would likely be needed to control weeds without the use of herbicides as an adjunct method. In the short term, many of the nonherbicide methods would contain or control some weed species with repeat applications. Biological controls would likely be effective in the long term, after biocontrol insect populations have grown enough to have a significant effect on weed populations, which could take years. The other nonherbicide treatment methods are generally not as effective against weed species as herbicide treatment in combination with these other methods.

Therefore, there would be a high risk that the rate of weed spread would exceed the rate of weed control, and the Forests would not be able to get ahead of the weed problem. Thus, effects in the long term would be most similar to Alternative A (No Action).

Alternative D (Herbicides Only)

Beneficial effects to native vegetation abundance and diversity on the treated acres would be very similar to effects described for Alternative B. The key difference is the slightly reduced effectiveness of some herbicide treatments without the supplemental use of other methods. It is well known from past studies that the most effective weed control treatments are those that utilize a combination of herbicides with other nonherbicide methods. This reduced effectiveness means that repeated treatments may be required above what would be necessary if a combination of treatments were used.

Unlike Alternative C, this reduced effectiveness would not likely result in a reduction in the number of acres treated because the cost-effectiveness of treating with herbicides is high.

Cumulative Effects - Vegetation

The analysis area for cumulative effects on vegetation is the area in and immediately adjacent to the Forests. This boundary represents the areas where the actions proposed in this project are most likely to interact with other activities, in particular the weed treatments and ground disturbance on both Forests and other lands (private, State, BLM, etc).

In all action alternatives, cumulative impacts to nontarget plant species would stem from forest management activities, public land uses, and activities on other public and private lands, as described in the beginning of this chapter. For example, cumulative effects include potential short-term reduction in nontarget vegetation from herbicides applied in ongoing weed treatment projects on the forest, on private inholdings, and on other public lands in and around the Forests. There would also be continued spread of weeds through activities that disturb the soil, such as dispersed recreational activities.

However, forest projects to be conducted over the next 10 years would primarily be aimed at restoring native vegetation and ecosystem functionality, based on agency priorities and budgets. Long-term ecosystem restoration projects would compensate for activities that remove or damage native vegetation, including short-term removal of nontarget plants from this proposed project. Overall, the most noticeable cumulative effect on vegetation would be beneficial, especially over the long term. Forest management activities would result in increased abundance and diversity of riparian, grasslands and other ground vegetation, which would be enhanced by the effects of this weed control project.

Affected Environment - Special Status Plants

There is one Federally listed (endangered) plant within the project area—Holy Ghost ipomopsis—which occurs in one known location on the Santa Fe National Forest. No “threatened” plants occur on the Forests. There are seven plant species listed as sensitive in the Southwestern Region of the Forest Service that could exist on the Forests. Four of these plants—Arizona willow, Chiricahua dock, egg-leaf coral and hairless (pecos) fleabane—are located in high elevation alpine and subalpine communities where weed infestations are unlikely to occur. The vegetation specialist report in the project files has detailed habitat information for each species.

Table 24 identifies the special status plants likely to occur on the Forests, along with their associated vegetation cover types.

Table 24. Special Status Plant Species Habitat by Vegetation Cover Type

	Nontarget Cover Types	Sagebrush/ Shrubs	Pinyon Juniper	Oak Woodland	Ponderosa Pine	Mixed Conifer	Riparian
Arizona willow	Subalpine						
Chiricahua dock	Subalpine						
Egg-leaf coral	Alpine Meadows						
Hairless fleabane	Subalpine meadows						
Parish’s alkali grass							X (b)
Ripley’s milkvetch		X	X	X	X		
Holy Ghost ipomopsis					X(a)		
Small-headed goldenweed					X (c)		

Key: (a) Holy Ghost Canyon; (b)Alkaline springs and seeps; (c) Granitic rock crevices

Environmental Consequences - Special Status Plants

To summarize effects to special status plants, all alternatives would have “no effect” on the endangered Holy Ghost ipomopsis, and “no impact” on the four sensitive plants that occur in remote alpine and subalpine forest communities. For the other three sensitive plants, actions involved in Alternatives B, C, and D “may impact individuals or habitat but will not likely result in a trend toward Federal listing or reduced viability of the population or species,” primarily due to the mitigation measures required for protection of these plant species.

Alternative A (No Action)

The effects under this No Action Alternative would be the same as previously described for other native plant species. Without treatment, weeds would continue to spread throughout the Forests, displacing native understory vegetation. An increase in weeds would reduce the endangered and sensitive plants on the Forests. For certain sensitive species, especially those likely to occur in or near existing weed infestations, this would eventually lead to a downward trend in population viability and a trend toward Federal listing. The Holy Ghost ipomopsis, the very rare and endangered plant species on the Santa Fe National Forest, is located along a road and near a number of thistle populations along the same road system. It is likely that in the next 10 years these weeds would migrate to this native plant population and, once established, have an adverse impact because they use similar habitats and compete for resources.

On the other hand, this No Action Alternative eliminates the risk of inadvertent damage to special status plants from weed control treatment activities such as mowing, grazing, burning, digging, or herbicides.

Alternative B (Proposed Action)

Any potential adverse impacts to individual special status plants as a result of weed control treatment actions would likely be avoided by following the pretreatment survey and avoidance procedures outlined in Chapter 2. Thus, there is a very low risk of accidental damage or mortality to individual plants during weed control treatments if the survey and avoidance procedures are not appropriately carried out. For example, special status plant species may be negatively impacted by herbicide spray drift, but it is unlikely to occur because mitigation measures prohibit vehicle mounted herbicide spraying within 25 feet of occupied habitat and require herbicides to be applied by hand (gloves, wicks, rags, etc.) to individual weed plants. If herbicides are to be sprayed within potential habitat for any special status plant species, a survey of that habitat will be conducted if feasible. If no survey is possible, the potential habitat will be treated as if occupied by the species and avoided until surveys can be completed.

Biological control agents are extensively tested to ensure that they have a very narrow host range and would not pose a serious threat to nontarget plants. Although extensive screening and testing reduces the potential for injury to native plants, biological control is not risk free. Agents may attack plants closely related to the host weed. The State of New Mexico does not allow use of biological controls on thistle because of this possibility. Therefore, only agents approved for use in the State would be used in order to avoid this possibility.

Hand pulling and digging can be selective in terms of plants removed. Hand pulling may inadvertently destroy native or sensitive species growing in close proximity to weeds because of trampling by pulling crews. Damage may occur to the root systems of nontarget plants that are intermingled with the root systems of target species. Implementation of the listed mitigation measures will minimize the potential for negative effects to the Holy Ghost ipomopsis.

Controlled grazing, mowing, and prescribed burning will not occur within 25 feet of Holy Ghost ipomopsis plants. There will be no direct or indirect effects to this species from these treatments. These treatments may impact individuals or habitat of sensitive species, but they are not likely to result in a trend toward Federal listing or reduced viability for the population or species.

Implementation of Alternative B with appropriate mitigation would not contribute to a loss of population viability nor a trend toward Federal listing of any sensitive plant species. No negative impacts would be expected to the sensitive species that occur in the remote, high elevation forests, and may impact individuals or their habitat to a minor degree in areas where weed treatments are more likely to occur. This alternative would also be expected to have “no effect” on the endangered Holy Ghost ipomopsis based on mitigation measures and the high probability that they would be effective in protecting this plant population.

The most noticeable consequence of implementing this alternative would be the reduction in weed infestations that would otherwise take over sites currently occupied by some of the special status plants.

Alternative C (No Herbicide)

Implementation of Alternative C would result in no potential impact to endangered or sensitive plants relative to herbicide application. Individual sensitive plants such as the small headed goldenweed, Parish’ alkali grass and Ripley milk-vetch would have a moderate risk of negative impacts from mechanical, burning, grazing and manual treatment methods, and little if any risk of impact from biological controls. However, implementation of Alternative C with identified mitigation measures would not likely contribute to a loss of population viability nor contribute to a need for Federal listing of any sensitive plants.

Like Alternative B, implementing weed control treatments would reduce the magnitude of weed infestations that can out-compete and eventually extirpate special status plants. However, without use of herbicides, Alternative C would not be as effective in controlling or containing weeds, and could result in degradation of sensitive plant habitat by weed infestations similar to those described in Alternative A. For this reason, it would be especially important under this alternative to concentrate treatments on weed infestations that are threatening species such as Holy Ghost ipomopsis, small headed goldenweed, Parish' alkali grass and Ripley milk-vetch, since these are the most vulnerable to competition.

Alternative D (All Herbicide)

Implementation of Alternative D would have very similar effects to those described for Alternative B. The difference is there would be no risk of negative impacts to special status plants from mechanical, burning, grazing or manual methods. No negative impacts to special status plants would be expected from herbicides either, due to the mitigation measures that include a 25-foot, no-spray buffer around occupied special status plant habitats.

Like Alternative B, the most noticeable consequence of implementing this alternative would be the beneficial reduction in weed infestations that would otherwise take over sites currently occupied by some of the special status plants. Alternatives B and D in particular would contribute to maintaining or improving habitat for special status plants.

Cumulative Effects - Special Status Plants

The analysis area for cumulative effects on vegetation is the area in and immediately adjacent to the two forests. This boundary represents the areas where actions proposed in this project are most likely to interact with other activities, in particular the weed treatments and ground disturbance on both Forests and other lands (private, State, BLM, etc).

In all action alternatives, cumulative impacts to nontarget plant species would stem from forest management activities and activities on other public and private lands as described in the beginning of this chapter.

Cumulative effects on vegetation were previously described in this "Vegetation Resource" section and apply equally to special status plants. The main difference is that special status plants would be protected more than other native vegetation during all forest management activities and special use authorizations. Thus, the likelihood of negative cumulative effects is even lower for the special status plants.

Based on the prediction that there would be little to no risk of negative consequences to special status plants from this proposed project, and minimal impacts to special status plants from other ongoing or future activities on the Forests, negative cumulative effects to special status plants would be insignificant.

Cumulative beneficial effects would be slightly more pronounced because management activities aimed at restoring ecosystem functionality, including interagency weed control programs, would result in increasing the abundance and diversity of native vegetation, including special status plants. Beneficial, long-term cumulative effects would greatly outweigh any minor or short-term reductions in native vegetation caused by ground-disturbing activities.

Wildlife Resources

The affected environment for wildlife resources is divided into three sections: management indicator species, special status species, and migratory bird species. The environmental consequences section begins with a discussion on wildlife in general followed by the same three sections on specific categories of wildlife species.

Affected Environment - Management Indicator Species

Management Indicator Species (MIS) were identified during development of Forest Plans, and are used to monitor effects of management activities on populations of wildlife and fish, including those that are socially or economically important. Species which are both an MIS and a TES Species will be discussed in the TES section, and aquatic MIS species will be discussed in the “Fish and Aquatics Resources” section.

Table 25 displays the MIS identified on the Forests, estimated acres of existing habitat on the Forest where it is a MIS, and the acres of weed infestations within those habitats, along with the probability that the species would be found within a proposed weed treatment area. There are additional descriptions of each MIS habitat and estimated population trend, based on MIS assessments conducted on each forest.

Table 25. Wildlife Management Indicator Species (MIS), Habitat and Weed Infestation

Species	National Forest	Habitat	Estimated Acres of Habitat	Estimated Acres of Weed Infestation	Probability of MIS Occurrence in a Treatment Area
Brewer’s Sparrow	Carson	Sagebrush	81,752	120	High
Juniper Titmouse	Carson	Pinyon-Juniper	348,729	117	High
Abert’s Squirrel	Carson	Ponderosa Pine	63,190	709	High
Hairy Woodpecker	Carson and Santa Fe	All forest types (Snags and down logs)	1,088,700	6,980	High
Red Squirrel	Carson	Mixed Conifer	217,606	187	High
Rocky Mountain Elk	Carson and Santa Fe	All Types	3,048,100	7,250	High
Merriam’s turkey	Carson and Santa Fe	Most habitat types	1,615,410	6,060	High
Rocky Mountain Bighorn sheep	Carson and Santa Fe	Alpine	78,900	5	Low
Pinyon jay	Santa Fe	Pinyon-Juniper	465,725	4,413	High
Mourning dove	Santa Fe	Most habitat types	990,000	5,347	High

Species	National Forest	Habitat	Estimated Acres of Habitat	Estimated Acres of Weed Infestation	Probability of MIS Occurrence in a Treatment Area
Mexican Spotted Owl	Santa Fe	Mixed Conifer	See TES	Section	
White-tailed Ptarmigan	Carson	Alpine	See TES	Section	

[1] Information from Santa Fe and Carson forest-wide MIS reports (Carson NF 2003, Santa Fe NF 2003). Acres of weed infestations are based on currently known populations. Forest-wide surveys have not been completed and weed populations are expanding.

Brewer's Sparrow

Brewer's Sparrow is an indicator for sagebrush habitat on the Carson National Forest (USDA FS 1986a). In northern New Mexico the habitat for Brewer's sparrow is sagebrush, brushy plains and the interface of pinyon-juniper woodlands and sagebrush. Brewer's sparrow is strongly associated with high sagebrush vigor throughout its range, preferring areas dominated by high shrub cover, large patch size and bare ground. The Carson National Forest has an estimated 81,752 acres of habitat for Brewer's sparrow as of 2002 (USDA FS 2003a). The trend for habitat on the forest is increasing based on the gradual conversion of grasslands to sagebrush. The population trend for the Carson National Forest is considered stable.

Juniper (Plain) Titmouse

The plain titmouse is an indicator species for pinyon-juniper (PJ) canopies (USDA FS 1986a). Also known as "juniper" titmouse, the plain titmouse is a resident of deciduous or mixed woodlands, favoring oak and PJ. The titmouse usually nests in natural cavities or old woodpecker holes primarily in oak trees, but it is capable of excavating its own cavity in rotted wood. The species feeds mainly on insects, seeds and occasional fruits, and also is a bark gleaner. As a cavity nester, large, older trees are an important feature. The Carson National Forest shows a decrease in acres of habitat from 364,900 to 348,729 between 1986 and 2002. There is a downward trend in habitat with a loss of about 2 percent in the available habitat since 1986. Population trend for the Carson National Forest is also downward, although this is a common species on the Forest (USDA FS 2003a).

Abert's Squirrel

Abert's squirrel principally utilizes the ponderosa pine forest type. The species is an indicator for the presence of interlocking canopies in ponderosa pine (USDA FS 1986a). Abert's squirrel depends on ponderosa pine for basically all its life necessities and requires diversity of age classes and tree densities. Pine twigs, pine cones, pine seeds, pine bark, as well as truffles are used by Abert's squirrel. In addition to pure ponderosa pine stands, Abert's squirrels are also associated with gambel oak, true pinyon, junipers, quaking aspen and Douglas-fir. The Carson has an estimated 63,190 acres of ponderosa pine with interlocking habitat crowns. This is an increase of almost 20 percent from 1986. The habitat condition for the species is considered poor to fair, but in a slight upward trend. The Abert's squirrel population on the Carson is considered to be stable but likely lower than potential. (USDA FS 2003a)

Hairy Woodpecker

The hairy woodpecker is a forest generalist, keying in on available snags and live aspen. On both forests this species is found in areas with abundant snags and downed logs. Nests are primarily in trees averaging 17 inches in diameter and approximately 60 feet high. It forages primarily on tree trunks averaging 17 inches in diameter and greater than 30 feet high. Down logs are important for foraging by providing insects. Scott and Church (1988) found that hairy woodpecker densities were negatively correlated with aspen basal area in west-central Colorado. Removal of snags, large snags, future snags and down logs increases the probability of decreased population numbers of hairy woodpeckers.

The Santa Fe National Forest Plan modeling predicted that hairy woodpecker habitat quality would improve over time as young stands mature into diameter classes acceptable as cover. Nesting habitat was more limiting than feeding habitat. The Santa Fe National Forest contains an estimated 976,231 acres of hairy woodpecker habitat. The trend for habitat on the forest is considered stable (USDA FS 2003b). The Carson National Forest estimates 112,444 acres of habitat. This is up from 106,880 acres in 1986. The habitat trend on the Carson is considered upward (USDA FS 2003a). Population trends on both forests are considered stable.

Red Squirrel

Red squirrels are an indicator species for the mixed conifer habitat type on the Carson National Forest. The squirrels require mature coniferous trees as a source of cones and seed. The best cone production occurs in 200- to 300-year-old Douglas-fir, 40- to 300-year-old white fir, and 150- to 200-year-old Engelmann spruce. The more diverse the tree species are, the more likely that the cone crop production will exist to sustain red squirrel populations. They are predominantly found in areas with greater than 60 percent canopy closure. Red squirrels utilize large diameter trees for nests that are located on big branches near the trunks of the tree. They may also use mistletoe formations in Douglas-fir. There are an estimated 217,606 acres of red squirrel habitat on the Carson National Forest. This is an increase of approximately 20 percent from 1986. The habitat condition is rated as relatively good, with an upward trend. The population trend for the Carson is considered stable. (USDA FS 2003a)

Rocky Mountain Elk

Rocky Mountain elk inhabit most forest types with good forage and cover. These ungulates utilize a variety of habitat types during the course of their life. They appear to be extremely adaptable to a variety of successional stages and vegetation types. Certain vegetation types are of limited value to elk due to aspect, elevation, snow depth, lack of water availability, and/or vegetation components. The Santa Fe National Forest Plan modeling predicted that elk were limited primarily by low forage availability. Creating a greater proportion of early seral stage habitat and associated forage improved elk habitat. The Carson National Forest Plan identifies elk as an indicator of general forest habitat type. There are an estimated 1,624,026 acres of elk habitat on the Santa Fe, and 1,424,074 acres of elk habitat on the Carson. The habitat trend on the Santa Fe is rated as stable and increasing on the Carson. The population trend for elk is rated as increasing for both forests. (USDA FS 2003a, 2003b)

Merriam’s Turkey

Merriam’s turkey is a management indicator species for both forests. Merriam’s turkey has the widest distribution and is the most common subspecies of turkey. It is found in many mountainous areas of northern New Mexico. The bird utilizes ponderosa pine, a source of mast (nuts and seed) and its favorite roosting tree. The ponderosa pine is an essential component of its permanent habitat, while surface water is a range requirement. Turkeys prefer to roost in tall mature or overmature ponderosa pines with relatively open crowns and large horizontal branches starting at 20 to 30 feet from the ground. Trees with a diameter of over 14 inches are used as roosts. These trees must have excellent protection from the wind, and must be located in sites with an open ridge or rocky ledge nearby to provide ease in entering and exiting the roost site. Hens normally nest within one-half mile radius of water. A good healthy ponderosa pine understory provides the turkey cover as well as forage. Turkeys forage in grasslands, brush communities, deciduous tree-brush and in ponderosa pine. They eat grasses and grasshoppers in the summer, oak nuts and pine seeds in fall, and tall grasses in the winter. The Santa Fe National Forest Plan modeling determined that feeding habitat was the primary limiting factor for turkey and harvest patterns that promoted early seral stages or provided an open canopy allowing grass, forbs and mast providing vegetation were the most beneficial for turkey. The turkey was used as an indicator for the presence of old growth pine in the Carson National Forest Plan. The Santa Fe has an estimated 1,314,113 acres of turkey habitat, and the Carson an estimated 301,297 acres. The Santa Fe rates the habitat trend for turkey as stable; and the Carson rates the trend as slightly upward. The Santa Fe MIS report (USDA FS 2003b) rates the turkey population as stable to slightly increasing. The Carson MIS report (USDA FS 2003a) indicates an upward trend for turkeys on that forest due to transplants into previously unoccupied habitat.

Bighorn Sheep

Rocky Mountain bighorn sheep are indicator species for both forests. These bighorn sheep inhabit the cliffs and crags or other extremely rocky areas in tundra and alpine areas from the summit peaks to around 200 meters below the treeline of the mountains of northern New Mexico. Bighorn prefer precipitous terrain adjacent to suitable feeding sites of high mountain meadows with grasses, forbs and browse species. Since bighorn are highly susceptible to the diseases carried by domestic sheep, the viability of the species is dependent on whether or not domestic sheep are present within their occupied habitat. Currently bighorn sheep occur in the Pecos, Latir Peak, and Wheeler Peak Wilderness areas and the Gold Hill area. The Santa Fe National Forest Plan estimated habitat capability for bighorn sheep based on the health of alpine and meadow areas and effects of encroaching canopy closure. The Carson uses bighorn as an indicator for the presence of alpine, subalpine tundra and mountain meadow grassland. There are an estimated 58,505 acres of habitat on the Santa Fe; and 10,100 to 20,430 acres of habitat on the Carson. Habitat trend is considered stable on both forests. The population trend for the Santa Fe is stable to increasing. Population trend for the Carson is increasing. (USDA FS 2003a, 2003b)

White-tailed Ptarmigan

See TES section for habitat description.

Pinyon jay

Pinyon jays are an indicator species for the Santa Fe National Forest. Pinyon jays nest mainly in stands of pinyon-juniper. It needs open woodlands for nesting and an adequate supply of seeds, especially nuts. They are gregarious and breed in colonies up to 150. They spend the winters in large flocks of tens or thousands moving in search of pinyon stands with a successful crop of pinyon nuts that are a primary food source along with other seeds, fruits and insects. The Forest Plan modeling predicted that pinyon jay habitat would improve by increasing foraging areas. Alternatives which favored a variety of mast (nut) producing plants found in early seral stage forests were best for pinyon jays. The habitat trend for pinyon jay is ranked as stable on the forest. However, this trend is likely to change to declining in the next MIS assessment due to the recent die off of pinyon on the forest due to bark beetles. The population trend for the Santa Fe National Forest is ranked as stable to downward, based on the State trend and the breeding bird survey routes located near the Forest. (USDA FS 2003b)

Mourning Dove

Throughout the Santa Fe National Forest, mourning dove habitat is abundant. They are found in ponderosa pine, spruce-fir, aspen, and pinyon-juniper forest types. Coniferous trees and ground sites are preferred in the year before deciduous trees have developed leaves. In all situations, however, abundant food and water must be available within 20-30 km. These habitats and grassland habitats found on the forest meet the feeding requirements for mourning dove. Water developments and underburning in ponderosa pine create favorable feeding areas. Most nesting occurs in lower elevation habitats. The abundance of nesting and cover opportunities on the Santa Fe contribute to maintaining viable populations of mourning dove. In general, habitat affected by disturbance will have the canopy opened up allowing for the growth of more understory vegetation, improving mourning dove habitat. The habitat trend for mourning dove is considered stable to increasing across the forest. The population trend for mourning dove on the Santa Fe is ranked as stable based on the statewide trend and breeding bird surveys in and adjacent to the forest. (USDA FS 2003b)

Mexican Spotted Owl

See TES section for a description of habitat for this species.

Affected Environment - Threatened, Endangered, and Sensitive Species

In this section, the Threatened, Endangered, and Sensitive (TES) animal species on the Forests are described. TES plant species were addressed in the vegetation section. TES species that are strictly aquatic, such as fish and aquatic insects, are addressed in the aquatic section. For purposes of this analysis, the affected environment includes the TES species present on the two forests, the habitats they occupy, and habitats suitable for occupation. The list of species was developed from the USDA Forest Service Region 3 list of sensitive species and letters/information from the U.S. Fish and Wildlife Service (USFWS 2000, 2003).

Table 26 lists TES wildlife species that are either known to occupy the Forests or could potentially occur based on the habitat on the Forests. It also summarizes their habitat, estimated acres of habitat, acres of weed infestations, and probability of occurring in areas planned for treatment.

Table 26. Threatened, Endangered and Sensitive Species

Species	Status	Habitat	Estimated Acres of Habitat [1]	Acres of Known Weed Infestations [2]	Probability of TES Species Occurrence in Treatment Areas
Jemez Mountain Salamander	Sensitive	Forested areas surrounding Valles Caldera	100,000	500	High
Northern Leopard Frog	Sensitive	Associated with water	147,300	2,520	High
Western Boreal Toad	Sensitive (Candidate)	High elevation lakes and forest	0 (possibly extirpated from New Mexico)	0	Low
Southwestern Willow Flycatcher	Endangered	Low gradient riparian with open water and well developed willow patches	<10,000	<500	Moderate
Bald Eagle	Threatened	Primarily riparian areas along major river corridors	<100,000	<1,500	High
Mexican Spotted Owl	Threatened	Old growth and mature mixed conifer habitat	<30,000 in PACs <500,000 in potential habitat	<1 Acre in PACs <2,000 acres in potential habitat.	Low
Least tern	Endangered	Wetlands (Does not nest on forest)	0	0	Low
American Peregrine Falcon	Sensitive	Associated with cliffs	<100,000	<1,000	Low
Northern Goshawk	Sensitive	Most forested habitats except pinyon-juniper	<50,000 in PFAs 2,441,000 in potential habitat	1,250 in PFAs 3,480 in potential habitat	High
Boreal owl	Sensitive	High elevation spruce-fir forests	422,800	100	Low
White-tailed ptarmigan	Sensitive	Alpine areas	78,900	5	Low

Species	Status	Habitat	Estimated Acres of Habitat [1]	Acres of Known Weed Infestations [2]	Probability of TES Species Occurrence in Treatment Areas
Western Yellow-billed Cuckoo	Sensitive (Candidate)	Riparian areas along river systems	<100,000	<1,500	Low
Blue-black silverspot butterfly	Sensitive	Wet alpine meadows	<5,000	Unknown but low probability due to limited weed infestations at high elevations	Low
Goat peak pika	Sensitive	Talus slopes in the Jemez Mountains	<10,000	Unknown but low probability of weed infestations due to habitat type	Moderate
New Mexico jumping mouse	Sensitive	Wet meadows in the Jemez and Sangre de Cristo Mountains	<10,000	<100	Moderate
Southwestern river otter	Sensitive	Large Rivers (Currently not present in New Mexico)	0 (Extirpated from New Mexico)	0	Low
Swift fox	Sensitive	Short and mid grass prairie	381,700	1,290	Moderate
Linnaeus Ramshorn snail	Sensitive	Seasonal ponds (Coyote Creek Near Carson)	0 (Only known location is not on the Forests)	0	Low

[1] Acres of habitat are based on a combination of habitat type, known areas of occupancy, and/or proximity to habitat features.

[2] Acres of weed infestations are based on currently known populations. Forest-wide surveys have not been completed and weed populations are expanding.

The following section provides some additional information about TES species habitats on the two forests.

Jemez Mountains Salamander (*Plethodon neomexicanus***)**

The Jemez Mountain salamander is endemic to the Jemez Mountains in portions of Los Alamos, Sandoval, and Rio Arriba Counties. They occur in and under rotting coniferous logs or under rocks in coniferous forests where they feed upon invertebrates including ants and beetles (BISON-M 2001).

Northern Leopard Frog (*Rana pipiens*)

Northern leopard frogs occur between 1,120 and 3,050 meters elevation in New Mexico. They can be found on both the Santa Fe and Carson National Forests. They are found associated with ponds, streams and other permanent water. Threats to local populations include changes in wetlands, especially the alteration of marshy ponds to reservoirs; stocking of predatory fish; natural local extinctions as ponds dry up during years of low precipitation; and predation and competition by introduced bullfrogs (BISON-M 2001).

Western Boreal Toad (*Bufo boreas boreas*)

The Western boreal toad is found in coniferous forest of Engelmann spruce, subalpine fir, Douglas-fir and lodgepole pine. It lives near springs, streams, ponds and lakes in foothill woodlands, mountain meadows, and moist, subalpine forest. In New Mexico, the species appears to be exclusively a high mountain form (i.e., above 2,600 m), and it is usually associated with beaver ponds. It is totally dependent on standing or running water for breeding. The western Boreal toad is not abundant over much of its extensive range. However, in New Mexico the species was quite peripheral and probably of low population density. It was first discovered in the State at Lagunitas Lakes in 1968. A second population was documented at Canjilon Lakes in 1974, with a third found at Trout Lakes in 1978. Recent surveys indicate that it is possible that the species has declined in New Mexico in recent years and is possibly extirpated. Any resource management activities that negatively affect alpine wetlands will negatively affect breeding habitat for boreal toads (BISON-M 2001). The Carson National Forest is working with the New Mexico Department of Game and Fish on potential reintroductions of boreal toad in the Lagunitas, Canjilon and Trout Lakes areas.

Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

This Federally endangered bird nests in dense riparian vegetation including box elders, salt cedar, and willows. Nest sites have been found in pure stands of salt cedar in New Mexico. However, the species prefers more diverse native riparian vegetation that includes willow and cottonwood. Suitable nesting habitat is in patches of vegetation that are more than 10 feet in diameter. Nest sites are located in close proximity to water. The southwestern willow flycatcher is an insectivore. It is known to occur in Rio Arriba and Sandoval Counties (BISON-M 2001).

Bald Eagle *(Haliaeetus leucocephalus)*

Bald eagles nest in large trees in close proximity to rivers, lakes, or reservoirs. Night roost trees may be found in protected sites such as canyons in areas that include the Pecos Valley. Bald eagles winter in many areas of New Mexico including Taos, San Miguel, Sandoval, and Rio Arriba Counties (BISON-M 2001).

Mexican Spotted Owl (*Strix occidentalis*)

The Mexican spotted owl's nesting and roosting habitat is characterized by steep topography, cool shady canyons, and mature mixed conifer forest having high canopy closure. Protected activity centers (PACs) are established to protect territories of individual Mexican spotted owl (MSO). Owls also use ponderosa pine and other vegetation types for foraging. On the Santa Fe National Forest there are 303,063 acres of MSO mixed conifer habitat (USDA FS 2003b). The Carson has very limited areas that are suitable for MSO (USDA FS 2003a). Currently there is less than 1 acre of weeds known to exist in PACs. Approximately 5,153 acres of weeds are located in mixed conifer habitat.

Least Tern *(Sterna antillarum)*

The interior least tern occurs in small remnant colonies along major river systems in the midwestern United States and winters in South America. In New Mexico, the least tern is a rare summer resident at wetland areas, and nests only at or near Bitter Lake National Wildlife Refuge. (BISON-M 2001**)**.

American Peregrine Falcon (*Falco peregrinus*)

The peregrine falcon lives at 6,500 to 9,000 feet in mixed conifer, ponderosa pine, and spruce-fir. They nest on high cliffs near water, and forage over a very large area. Nesting cliff sites exist on both forests. Under the interagency agreement (USDA FS 1991) for peregrine falcon, a site plan is developed for each nesting area. Protective zones of sensitivity (A-D) are established in roughly concentric circles around these areas, and protective requirements are identified for each zone. (BISON-M 2001).

Northern Goshawk (*Accipiter gentiles*)

The northern goshawk in the Southwest occurs mainly in ponderosa pine forests, but also in mixed-conifer and spruce-fir. Foraging habitat consists of a mosaic of forest clearings, densely forested areas, and relatively open areas with grasses, forbs and shrubs. Nest areas are stands with large trees and relatively high canopy cover of 50 to 60 percent or higher (Reynolds, et al. 1987).

Inventories have been conducted on portions of northern goshawk habitat on both forests. The Forests establish post-fledgling areas (PFA) and foraging areas (GFA) around each goshawk nesting site. There are numerous PFAs and GFAs scattered throughout both forests. Approximately 1,243 acres of weeds are found in PFAs for Northern Goshawks. An estimated 1,243 acres of weeds are found in habitat types preferred by the goshawk.

Boreal Owl *(Aegolius funereus)*

The Boreal owl has been found in small numbers on both the Santa Fe and Carson National Forests. Throughout its range, the Boreal owl occurs mainly above 2,900 m in climax spruce-fir forests. The boreal owl is associated with relatively inaccessible tracts of high elevation coniferous forest, especially mature to old growth spruce and fir. The Boreal owl is a secondary cavity nester, and is dependent upon large cavities created by woodpeckers. Surveys in New Mexico indicate that present quantities of spruce-fir habitat in the isolated mountain ranges of New Mexico and Arizona are inadequate to host viable populations of Boreal owls. It seems the largely mixed conifer habitat of the mountain ranges peripheral to the Rockies (in these states) are more favorable for Northern saw-whet owls than Boreal owls. Recent New Mexico Dept. of Game and Fish assisted surveys found this species to be resident in very small numbers in spruce-fir and similar habitats in the San Juan, Sangre de Cristo, and Jemez Mountains (BISON-M 2001).

White-tailed Ptarmigan (*Lagopus leucurus*)

The white-tailed ptarmigan serves as an indicator species on the Carson National Forest. It is used as an indicator species for the presence of alpine tundra and subalpine deciduous shrub (USDA FS 1986a). It is also on the Region 3 sensitive species list. Little is known about this avian species in New Mexico, for it lives on the windswept tundra above 11,000 feet. The presence of high elevation shrubby willows (*Salix* spp.) is likely the most important factor for successful over wintering of the species. Buds and twigs of various species of willow provide the bulk of the food eaten by white-tailed ptarmigan. The shrubs should reach a minimum height of 0.5 meters. In areas where willow is not readily available, alder catkins become the dominant dietary component along with some needles of spruces, pines and firs.

In New Mexico, white-tailed ptarmigan exist only on the peaks of the Sangre de Cristo Mountains from the vicinity of Santa Fe northward to the Colorado border. There are approximately 10,106 acres of suitable alpine tundra on the Carson. On the Santa Fe, ptarmigan habitat approximately coincides with the habitat for bighorn sheep, as ptarmigan were reintroduced into the Pecos Wilderness in 1981. Ptarmigans are also considered to be present on Costilla, Latir, Wheeler, Truchas and associated peaks. The actual population and trend for this species in New Mexico is unknown, due to limited information available at this time (BISON-M 2001).

Western Yellow-Billed Cuckoo (*Coccyzus americanus*)

Yellow-billed cuckoos breed in riparian woodlands and similar habitats at lower (2,800-5,500 feet) to middle (5,000-7,500 feet) elevations. It occurs at elevations where stream conditions provide sufficient permanent moisture for emergent plants or for a narrow band of deciduous trees and shrubs: at low elevation characterized by cottonwood and sycamore, at mid-elevation by white alder and bigleaf maple, and at high elevation by willow. Populations fluctuate substantially in response to fluctuations in caterpillar abundance. Declines resulting from loss or disturbance of riparian habitat have been consistently reported in the West: the greatest factors affecting the yellow-billed cuckoo have been the invasion of exotic woody plants into Southwest riparian systems, and clearing of riparian woodlands for agriculture, fuel, development, and attempts at water conservation (BISON-M 2001).

Blue-black Silverspot Butterfly (*Speyeria nokomis nokomis*)

This butterfly is an inhabitant of wet alpine meadows and seeps. It is unknown if this species occurs on the Forests, but there is suitable habitat present (BISON-M 2001).

Goat Peak Pika *(Ochotona princeps nigrescens)*

The goat peak pika inhabits volcanic talus slopes in the Jemez Mountains at elevations above approximately 8,800 feet. This species is an herbivore (BISON-M 2001).

New Mexican Jumping Meadow Mouse (*Zapus hudsonius luteus*)

The New Mexican jumping mouse occurs in streamside vegetation that is dense and diverse with grasses, sedges, and forbs. This species is known from the Jemez and Sangre de Cristo Mountains. They are active June-August (BISON-M 2001).

Southwestern River Otter (*Lutra canadensis sonorae*)

The southwestern river otter inhabits permanent water sources with high quality water and low sediment loads. This species feeds upon fish and crustaceans. Southwestern otters utilize den sites that include rock piles, vegetation, and natural cavities which may be located up to one-half mile from the water body. This species may have been extirpated from New Mexico, although there have been sightings reported without verification in Taos County (BISON-M 2001).

Swift Fox (*Vulpes velox*)

Swift fox has been recorded from San Miguel and Mora Counties. They could occupy small portions of the Santa Fe and Carson forests. Swift foxes have been found to inhabit Plains-Mesa Sand Scrub and grasslands habitat in New Mexico. It occupies shortgrass and midgrass prairies over most of the Great Plains. Swift and kit foxes are grassland and desert species, most common where soft soils support large populations of rodents, especially kangaroo rats, on which these foxes prey. Factors implicated in the decline of this fox have been intense trapping pressure, destruction of prairie habitat, rodent control programs, indiscriminant hunting, and capture by dogs (BISON-M 2001).

Linnaeus Ramshorn Snail (*Gyraulus crista*)

Linnaeus' ramshorn snail has a circumboreal distribution and, consequently, the species is found in a variety of habitat types (Taylor et al. 1985). In general, it is most common and characteristic of seasonal ponds—although also occurring rarely or sporadically in permanent water sites. In Michigan, this snail was found to be most active in spring in a temporary pond, spending the remainder of the time buried in the mud bottom (Kenk 1949). The known location in New Mexico, which represents the southernmost known station in North America, is along Coyote Creek, a montane stream at about 2,680 meters. There the species was found in a single, pond-like backwater of the creek, but it may be more widespread in the area (BISON-M 2001).

Affected Environment - Migratory Birds

To meet Presidential Executive Order 13186 (January 2001) that emphasizes conservation of neotropical migratory birds, the Forest Service analyzes impacts of proposed forest management activities by addressing the following: (1) effects to “Highest Priority” species as identified by New Mexico Partners in Flight, (2) effects to important bird areas and (3) effects to important over wintering areas.

New Mexico Partners in Flight considers eight risk factors in identifying conservation priority species: (1) Global Abundance, (2) New Mexico Breeding Abundance, (3) Global Breeding Distribution, (4) New Mexico Breeding Distribution, (5) Threats to Breeding in New Mexico, (6) Importance of New Mexico to Breeding, (7) Global Winter Distribution, and (8) Threats on the Wintering Grounds. Species with the highest risk factors are classified as “highest priority” for conservation action. This evaluation addresses general effects to migratory birds, and specific effects to highest priority species for the main habitat types found in the project area.

Currently there are no designated important bird areas on the Forests. There are two areas that have been proposed for inclusion into the Important Bird Area system. These areas are the Chama River Gorge from El Vado to the north end of Abiquiu Reservoir, and the Caja del Rio and the Santa Fe River Canyon below the Caja del Rio.

Important over wintering areas are often large wetlands. The areas that are considered important on Forests include the Rio Chama and Rio Grande corridors.

Table 27 lists high priority migratory bird species that are either known to occupy the Forests, or are likely to occur based on the habitat on the Forests, based on Partners in Flight (Web site) and potential habitat on the Forests. It also summarizes their habitat, estimated acres of habitat, acres of weed infestations, and probability of the bird species occurring in weed treatment areas.

Table 27. Migratory Bird Habitat and Probability of Occurrence in Treatment Areas

Highest Priority Species	Primary Habitat	Estimated Acres of Habitat	Acres of Known Weed Infestations[1]	Probability of Occurrence in Treatment Areas
Black Swift Red-naped sapsucker Hammond's Flycatcher American Dipper Veery MacGillivray's Warbler	High elevation riparian woodland	~100,000	~2,000	High
Brown-capped rosy finch White-tailed ptarmigan	Alpine Tundra	78,900	5	Low
Williamson's sapsucker Olive-sided flycatcher Dusky flycatcher	Mixed Conifer	553,900	1,910	High
Ferruginous hawk Gray vireo Black-throated gray warbler Gray flycatcher Bendires thrasher	Pinyon-juniper	823,900	350	High
Ferruginous Hawk Prairie Falcon Bendires Thrasher Long-billed curlew Lark bunting	Plains and Mesa Grassland	236,200	1,252	High
Lewis's woodpecker Red-headed woodpecker	Middle elevation riparian woodland	~50,000	~1,000	High
Blue grouse Boreal owl	Spruce-fir	422,800	100	Low
Flammulated owl Virginia's warbler Grace's warbler	Ponderosa pine	640,500	1,120	High

Highest Priority Species	Primary Habitat	Estimated Acres of Habitat	Acres of Known Weed Infestations[1]	Probability of Occurrence in Treatment Areas
Bendire's thrasher	Great Basin Desert Shrub	145,500	40	Moderate
Sage sparrow				
Loggerhead shrike				
Sage thrasher				
MacGillivray's warbler	Montane shrub	22,700	40	Moderate
Green-tailed towhee				
Black swift	Cave/Rock/Cliff	~10,000	0	Low
Prairie falcon				

[1] Acres of weed infestations are based on currently known populations. Forest-wide surveys have not been completed and weed populations are expanding

Environmental Consequences - Wildlife (General)

This section describes effects to all wildlife species, including mammals, birds, reptiles, and amphibians. The analysis focused on the key issues identified in Chapter 1, related to how the weed control project activities may cause: habitat disturbance (noise and visual disturbance), negative health impacts from herbicides used, or impacts to habitat quality from reductions in existing surface vegetation.

Alternative A (No Action)

As described in the vegetation section of this DEIS, without control treatments, weeds would continue to reduce the abundance and diversity of native vegetation that provides habitat for native wildlife species. For wildlife species that rely on that habitat, a decline in habitat quality would occur. For species that do not rely on the displaced habitat, no effect would occur.

The No Action Alternative would allow weed populations to expand on and near the 7,350 acres proposed for treatment. The anticipated expansion rates vary between 5 and 30 percent annually (see "Vegetation Resources" section), dependent on the weed species and ecologic conditions at each infestation site. The anticipated effects of weed infestations on wildlife are typically a result of the loss of suitable habitat and the displacement of native forage. Large areas of monocultures of weeds can develop and biological diversity can be lost. The effects can ripple through the system causing habitat structure changes that can alter ecosystem interactions. Natural habitat for wildlife would be reduced, such as nesting and ground cover, grass production, seed producing food sources, and prey base. These effects can negatively affect populations of many big game, predator, small mammal, bird, reptile, and amphibian species.

Weed infestations have had documented detrimental impacts to wildlife, especially big game species that occupy foothill and mountain slopes as important winter range. For example, in Colorado the invasion of Russian knapweed has resulted in a large reduction in the availability of winter range for wildlife. It was estimated that there would be a loss of 220 elk annually in Montana due to weed invasions of big game winter ranges (FICMNE 1998). In Arizona, stands of the weed Lehmann lovegrass have fewer quail, small mammals and seed-harvesting ants (FICMNE 1998).

Alternative B (Integrated Methods)

The key effect this alternative would have is an overall improvement in wildlife habitat conditions. Weeds would be eradicated or controlled on the acres treated, thus allowing for the restoration of native vegetation, and improvements in biological diversity. The improvement would be seen mostly for wildlife species that rely on the displaced habitat. As weeds are removed, these species would benefit from the native, more usable habitat.

The treatment methods themselves pose a low risk to individual animals and no effect to populations. A small percentage of the 3 million acres on the Forests would be treated in a given year (a maximum of about 1,500 acres), and those acres would be widely distributed across the Forests. Many weed treatments would occur along roadsides and recreation sites that are frequently disturbed and receive little use by wildlife. The following describe effects specific to the key wildlife issues identified, considering all wildlife species including management indicators, special status species and migratory birds. In addition, a species-specific effects analysis for those particular groups of species is contained in subsequent sections.

Habitat Disturbance Effects: Disturbance in each treatment area would occur during both treatment and monitoring activities. Disturbance from vehicles, including trucks, off-highway vehicles, and humans on horseback or foot would increase during the activity periods. Effects of noise on wild animals can be classified as those affecting auditory physiology and sensory perception, those affecting behavior, and those affecting populations (Bowles 1995). Noise levels are expected to marginally increase with activity around the subject treatment areas for a very short period of time. As a result of increased human activity and noise from operation of vehicles and activities, some animals would avoid the local area during the period of treatment activity. However, due to the brief duration of the exposure, they would likely quickly resume their normal behavior after treatments were completed.

Fluctuating noise levels may elevate heart rate, catecholamine levels, and corticosteroid levels in wild animals, but these elevated levels are generally of short duration, and animals often habituate to these disturbances over time. Short-term increases in these measures do not correlate well with actual stress experienced by animals (Bowles 1995). As most wildlife would avoid the areas during treatment activities, this behavior would indirectly reduce the risk of direct herbicide exposure to those animals.

The mechanical methods (mowing, tilling), broadcast burning treatments, and vehicle-mounted herbicide applications would cause the most noise disturbance while release of biological controls would cause little to no noise disturbance. Manual methods, controlled grazing, and manual application of herbicides would cause minimal noise and habitat disturbance. Typically, the duration of traffic would be limited to 1 or 2 days and once complete, wildlife would return to these areas. The level of affect also depends on the current level of background noise for an area. Since many areas with weed infestations are near roads, trails and high use recreation sites, wildlife that use these areas should be habituated to human use. Overall, habitat disturbance from treatments would not be expected to adversely impact wildlife species or populations.

Habitat Modification Effects: All treatment methods aim to have some impact on the vegetation in an area. In most cases, the changes in vegetation structure would be slight because the target weeds make up only a small part of that structure. In some cases, changes in the habitat structure could be significant if the target plant species (such as salt cedar) is dominant. These changes would benefit wildlife species, such as southwest willow flycatcher, that rely on a more diverse habitat structure.

Weed treatments would cause temporary and localized reduction in existing vegetation, including some native vegetation that could be killed or removed along with the weeds. This would not measurably impact wildlife habitat qualities, due to the relatively small acreages that would be treated in a given time and location, and the mitigation measure that requires prompt revegetation of treated sites. Ground cover vegetation would be expected to return by the first growing season after treatment, and the natural abundance and diversity of vegetation would gradually return over subsequent growing seasons.

Each method would have a slightly different and minimal effect on the structure and composition of wildlife habitat. None of the treatments would result in a loss of large trees, snags, or down log habitat components that are important for many species.

Controlled grazing with sheep or goats would change the structure of vegetation, but the magnitude of this change would be small. Risks to bighorn sheep would be avoided by restricting grazing in bighorn sheep areas.

Biological controls (introduction of insects) would not adversely affect habitat or wildlife since they have been studied to ensure that they are plant-host specific. Thus the insects would not impact native vegetation or other beneficial insects.

Manual methods of weed control such as hand pulling, cutting or digging would result in minimal changes in wildlife habitat quality, especially when conducted on such a small scale and spread widely across the Forests.

Mechanical methods would primarily involve mowing along existing road rights-of-way, in conjunction with roadside mowing done by other jurisdictions. Other mowing or mechanical weed treatments would not result in any major alteration in habitat quality. Burning of individual weeds with a propane torch would leave the remaining habitat structure and composition intact.

Broadcast burning weed infestations in grasslands or similar habitats conducive to burning would result in a minor and temporary change to the seral stage and vegetative community. A controlled surface burn would result in little if any loss of large snags or down logs, so would not impact the habitat trend or populations of snag dependent species such as hairy woodpecker.

Herbicide use impacts on vegetation structure depend on the specific application method, type of herbicide, rate of application, and season of application. Effects of herbicide application would be a change in composition of forbs, grasses, and shrubs in treatment areas. Nontarget plants could be damaged by unintentional application, drift, or residual soil activity of herbicides. These short-term impacts to plant composition and community diversity would likely be offset within as little as the first growing season. There would be no long-term loss of species diversity of native vegetation due to the proposed treatments, and species composition under most treatments is expected to resemble native plant assemblages within 1 to 3 years (Rice et al. 1997a). For additional discussion relative to vegetation, see the “Vegetation Resources” section.

Herbicide Toxicity Effects: A risk assessment of various herbicides considered toxicity, potential dosage through various routes (injection, inhalation, dermal), and length of exposure to a number of wildlife species (USDA FS 1992, SERA 1995, SERA 1996, SERA 1997, SERA 1998a, SERA 1998b, SERA 1999a, SERA 1999b, SERA 2000, SERA 2001, SERA 2002, SERA 2003a, SERA 2003b, SERA 2003c). The risk assessments concluded that potential risks for most wildlife species are low for most herbicides and surfactants using recommended application rates.

Risk was rated as moderate to high for only a few species and a few herbicides under extreme situations that would not occur under the proposed project. Concentrations of chemicals used in testing are typically at least 50 percent chemical. Concentrations that would be used in implementing this project would come nowhere near those levels. Formulations of the proposed herbicides would likely be anywhere from tens of thousands of times below those resulting in impacts on animals. Most of the herbicides are either nontoxic or of low toxicity to birds, mammals, and insects. None of those tested have been shown to cause cancer, birth defects, genetic defects, or problems with fertility or reproduction. There is no evidence of synergistic effects or hormone disruption from these chemicals (SERA 1995, SERA 1996, SERA 1997, SERA 1998a, SERA 1998b, SERA 1999a, SERA 1999b, SERA 2000, SERA 2001, SERA 2002, SERA 2003a, SERA 2003b, SERA 2003c). Thus, the herbicides proposed for use, when used at the application rates and concentrations listed on the labels, would have a very low toxicity to wildlife species.

There is a general lack of data and some uncertainty relative to herbicide effects on amphibians, so there is the potential for an unquantifiable negative impact on amphibians from herbicide application. Based on mitigation measures and the risk assessment information, it is anticipated that there would be a low risk that the proposed herbicide use would be toxic to amphibians. Mitigations are required that minimize herbicide delivery in or near water bodies, limit the amount of herbicide used within a given watershed, and limit the type of application permitted in riparian areas. Also, the extent of proposed herbicide treatments within potential amphibian habitat areas is small. If herbicides were to impact individual amphibians on a local basis, it would not affect the population as a whole. Appendix 3 describes the herbicides and wildlife risk assessment in more detail.

Population or habitat trends would not be impacted for any of the wildlife species that occur on the Forests. The following discussion describes impacts of specific treatment methods.

Alternative C (No Herbicides)

Implementation of this alternative would improve native vegetation and help maintain or improve biological diversity, by suppressing, containing or eradicating weeds on treatment areas. However, given the same level of funding as Alternative B, the effectiveness of each treatment application would be less than Alternative B. For a number of weed species that resprout from roots left after mechanical/manual treatments (e.g. Canada thistle or spotted knapweed), even a greater number of return treatments would probably not be highly effective at reducing populations. The site objectives for a given area would require concentrated effort over several years. In the places where weed treatments are not successful, or if the spread rate of weeds continues to exceed the rate of control, the long-term effects would be similar to Alternative A (No Action). Thus, the beneficial improvements to native vegetation and wildlife habitat would be lower for this alternative.

Short-term disturbance effects and habitat alteration effects to wildlife would be the same as described for Alternative B, except there would be more repeat treatments to achieve the objective so recovery of native vegetation would probably take longer. The difference with this alternative is the elimination of the (low) risk to individual animals posed by herbicide toxicity effects.

Alternative D (Herbicides Only)

As with Alternatives B and C, implementation of this alternative would improve native vegetation and help maintain biological diversity by suppressing, containing or eradicating weeds on treatment areas. Some species of weeds do not respond to treatments that apply herbicides alone so for these sites a number of return treatments could be necessary, and expected effectiveness in meeting objectives would fall between Alternatives B and C.

Effects of this alternative associated with the key issues raised would be very similar to those described for Alternative B. One difference would be eliminating the risk to individuals posed by mechanical treatments. The level of noise and habitat disturbance would be slightly less than either Alternative B or C as the use of herbicides would result in a reduced need for repeat treatments on many sites.

Cumulative Effects - All Wildlife

The cumulative effects area for wildlife includes the two forests and immediately adjacent lands. Weeds are spread over both forests, from low elevation to high elevation and in nearly all habitat types. Weeds are spreading on surrounding private, Federal, State and county lands. Thus the effects of this project have the potential to interact with the whole suite of actions occurring on the Forests and surrounding lands. Actions considered that would have similar effects are listed in the beginning of this chapter. Foreseeable future impacts on wildlife include increasing recreation on public land, increasing off-road vehicles such as snowmobiles and ATV use, increasing potential for catastrophic fire, and continued spread of weeds.

Current disturbance to wildlife would have a cumulative effect throughout the forest and on adjacent land caused by management activities, including disturbance from recreational uses, ranching, special uses, construction activities, and off-road motorized uses in summer and winter. As other agencies and private landowners continue to treat weeds in areas adjacent to the forest, wildlife would be exposed to short-term and localized habitat disturbance and to herbicides associated with those treatments. Those effects from other ongoing and foreseeable future activities would add to the effects predicted for each alternative.

The weed infestations occupy less than one-half of one percent of the Forests acreage and are well dispersed. Treatment projects will be spread out in both time and space. The actual direct and indirect effects of each alternative on MIS, TES and migratory bird species are predicted to be of such low magnitude that they cannot be measured. In all action alternatives, treatment in specific species habitat is limited to less than one-tenth of one percent of the habitat for any one species. The addition of this amount of disturbance to that caused by other activities will not be measurable.

Although some individual animals may be affected (primarily through short term disturbance effects), no impacts to population or habitat trends is predicted, even when considering this project's impacts in addition to other impacts occurring in the project area.

Environmental Consequences - Management Indicator Species

Effects previously described for all wildlife habitat and populations on the Forests apply to management indicator species. Table 28 provides additional disclosures of estimated effects of each alternative for each specific management indicator species on each forest.

Table 28. Effects to Management Indicator Species

Management Indicator Species	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Brewer's Sparrow	Weeds would continue to have little to no affect on sagebrush habitat used by this species.	Weed treatments would have little affect because the sagebrush component is not heavily threatened by weeds. No impacts to population or habitat trends are expected.
Juniper Titmouse	Weeds would continue to reduce seed and insect production in the understory, affecting food for this species.	Weed treatments would benefit seed and insect production in the understory over the long term. Some loss of vegetation in the short term could cause temporary displacement. No impacts to population or habitat trends are expected.
Abert's Squirrel	Weeds would not affect larger trees used by Abert's squirrel.	Weed treatments would not affect larger trees used by Abert's squirrel. Changes in understory structure would not affect population or habitat trends.
Hairy Woodpecker	Weeds would not affect snags and down logs important to hairy woodpecker.	Weed treatments have low potential to cause a loss of large snags or down log habitat components. Changes in understory structure would not affect population or habitat trends.
Red Squirrel	Weeds would not affect mature mixed conifer trees used as primary red squirrel habitat.	Weed treatments would not affect mature mixed conifer trees used as primary red squirrel habitat. Changes to understory structure would not affect population or habitat trends.
Rocky Mountain Elk	Weeds would continue to displace grasses used as elk forage so habitat would decline in quality and quantity.	Weed treatments would result in improving elk foraging habitat. No impacts to population or habitat trend are expected.
Merriam's turkey	Weeds would continue to displace native plants, grasses and insects used by turkeys, so habitat quality would decline.	Weed treatments would result in improving native grasses and other surface vegetation so would improve turkey habitat. No impacts to population or habitat trend are expected.

Management Indicator Species	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Rocky Mountain bighorn sheep	Weeds would continue to be very limited in high elevation bighorn sheep habitat so there would be little impact on their habitat.	Weed treatments would only improve bighorn sheep habitat to a small degree. Avoiding domestic sheep/goat grazing in bighorn habitat would avoid introducing disease to the bighorn sheep population. No impacts to population or habitat trend are expected.
Pinyon jay	Weeds would continue to be very limited in pinyon pine habitat, so there would be little to no effect.	Weed treatments would not affect pinyon pine trees used by pinyon jay. Changes to understory structure would not effect population or habitat trends.
Mourning dove	Weeds would continue to displace native habitat in a wide variety of habitats that this species depends upon.	Weed treatments would restore native vegetation that this species uses. Since the dove uses a wide variety of habitats, changes to understory structure would not affect population or habitat trends.

Environmental Consequences - Threatened, Endangered, Sensitive (TES) Species

Effects previously described for all wildlife habitat and populations on the Forests apply to TES species. Table 29 provides additional disclosures of estimated effects of each alternative for each specific TES species on each forest. Effects are generally the same for all action alternatives other than the minor differences noted in the general wildlife effects, such as the slower rate of native vegetation recovery under Alternative C. Also under Alternative C, the low risk of impacts to individual animals from herbicides would be eliminated, and under Alternative D, the low risk of impacts to individual animals from mechanical treatments would be eliminated.

Table 29. Effects to TES Species and Habitats

TES Species	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Jemez Mountain Salamander (S)	Weeds would have no impact to rotting logs and undersides of rocks that salamanders depend on.	Treatments would have no impact to the logs and rocks that salamanders depend on; logs and rocks would not be removed. There is a low risk that some individual salamanders could be impacted by herbicides or mechanical treatments. No impacts to population or habitat trends are expected.

TES Species	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Northern Leopard Frog (S)	Weeds would continue to expand and displace native vegetation in riparian areas and around ponds, which would reduce habitat quality and tend to dry out these wet areas.	Treatments would improve and increase native vegetation in riparian areas, wetlands and pond areas. Replacing salt cedar with native willows would benefit the leopard frog and help retain more water in these wet areas. No impacts to population or habitat trends are expected.
Western Boreal Toad (S/C)	Weeds would not preclude boreal toad reintroduction in potential sites.	Treatments would not preclude boreal toad reintroduction into suitable habitat.
Southwestern willow flycatcher (E)	Weeds would continue to displace native riparian vegetation. While the flycatcher will nest in stands dominated by salt cedar, it is considered suboptimal habitat because it lacks the diversity and thermal cover found in native willow/cottonwwod habitats.	Treatments would improve native willow/cottonwood riparian habitats preferred by willow flycatchers. During treatments, some loss of existing vegetation would occur and could reduce their suitability for use by flycatchers until native vegetation is reestablished. There would be a very low risk that some individual birds could be impacted by treatments, especially with mitigation measures requiring surveys prior to treatments in potential habitat. If surveys show habitat is occupied, measures would mitigate effects. No adverse effects to population or habitat trends are expected.
Bald Eagle (T)	Weeds would not affect large trees and snags that bald eagles depend on in their winter range habitats.	Treatments would not affect large trees and snags that bald eagles depend on in their winter range habitats. No impacts to population or habitat trends are expected.
Mexican Spotted Owl (T)	Weeds would continue to reduce understory vegetation used by owl’s prey, thereby reducing the owl’s prey base.	Treatments would improve owl’s prey base habitat. No effect to population or habitat trends are expected.
Least tern (E)	Weeds would not affect this species because of its life history and limited occurrence in New Mexico.	Treatments would provide little benefit to the tern. No effect to population or habitat trends are expected.
American peregrine falcon (S)	Weeds would not alter habitat for this species.	Treatments would not alter habitat for this species. No impacts to population or habitat trends are expected.

TES Species	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Northern goshawk (S)	Weeds would reduce prey base habitat.	Treatment would improve prey base habitat. No impacts to population or habitat trends are expected.
Boreal owl (S)	Weeds would not likely be a problem in the mature, high elevation coniferous forests needed by this species.	Treatments would not likely affect the mature, high elevation coniferous forests needed by this species. No impacts to population or habitat trends are expected.
White-tailed ptarmigan (S)	Weeds would not affect this alpine habitat to any large degree. Weeds could reduce willows that could reduce over-wintering success.	Treatments would not affect this alpine habitat to any large degree, but could potentially improve over-wintering success in willow habitat. No impacts to population or habitat trends are expected.
Western Yellow-billed Cuckoo (S)	Weeds would continue to displace native riparian habitat for this species.	Treatments would improve native riparian habitats for this species. Short-term loss of vegetation for 1-2 years could reduce habitat suitability until willows/cottonwoods are reestablished. No impacts to population or habitat trends are expected.
Blue-black silverspot butterfly (C)	Weeds would continue to reduce native riparian vegetation, increasing the potential for impacts to this species habitat.	Treatments would continue to improve native riparian vegetation, increasing the beneficial effects to this species habitat. No impacts to population or habitat trends are expected.
Goat peak pika (S)	Weeds would continue to reduce native vegetation used as forage by this species.	Treatments would increase forage availability for this species. No impacts to population or habitat trends are expected.
New Mexico jumping mouse (S)	Weeds would continue to reduce native vegetation used as forage by this species.	Treatments would increase forage availability for this species. No impacts to population or habitat trends are expected.
Southwestern river otter (S)	Weeds would not impact this species.	Treatments would not impact this species.
Swift fox (S)	Weeds would continue to reduce native vegetation used by prey species for this fox, thereby reducing prey base.	Treatments would increase prey base habitat for this fox. No impacts to population or habitat trends are expected.

TES Species	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Linnaeus Ramshorn snail (S)	Weeds would not impact this species.	Treatments would not impact this species.

Environmental Consequences - Migratory Birds

Effects previously described for all wildlife habitat and populations on the Forests apply to migratory birds. Table 30 provides additional disclosures of estimated effects of each alternative for migratory birds associated with specific habitats on the Forests.

Table 30. Effects to Migratory Birds and Habitats

High Priority Species	Migratory Bird Habitat	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Black Swift	High elevation riparian woodland	Weeds would continue to reduce riparian habitats and have a negative impact on these species. Weed species on the Forests are most prevalent in riparian areas (2 percent of riparian areas have known infestations).	Treatments would increase native riparian habitat vegetation and improve habitat for these species. No impacts to population or habitat trends are expected.
Red-naped sapsucker			
Hammond's Flycatcher			
American Dipper			
Veery			
MacGillivray's Warbler			
Wilson's Phalarope	Wet meadow	Weeds would continue to reduce riparian habitats and have a negative impact on these species. Weed species on the Forests are most prevalent in riparian areas (2 percent of riparian areas have known infestations).	Treatments would increase native riparian habitat vegetation and improve habitat for these species. No impacts to population or habitat trends are expected.
Bobolink			
Brown-capped Rosy Finch	Alpine tundra	Weeds would not occur to any large extent in this habitat, thus there would be no effects expected.	Treatments would not likely occur in this habitat, thus there would be no effects expected.
White-tailed ptarmigan			

High Priority Species	Migratory Bird Habitat	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Northern Goshawk Mexican spotted owl Williamson's sapsucker Olive-sided flycatcher Dusky flycatcher	Mixed conifer	Weeds would continue to spread; approximately 0.3 percent of this habitat type has inventoried weeds. Populations of these species would be negatively impacted by the loss of native vegetation and associated habitat.	Treatments would benefit these species as weeds are eliminated or controlled in these habitats. No impact to population or habitat trends.
Ferruginous Hawk Prairie Falcon Bendires Thrasher Long-billed curlew Lark bunting	Plains/mesas grassland	Weeds would continue to spread; approximately 0.04 percent of this habitat type has inventoried weeds. Populations of these species would be negatively impacted by the loss of native vegetation and associated habitat.	Treatments would benefit these species as weeds are eliminated or controlled in these habitats. No impact to population or habitat trends.
Ferruginous Hawk Gray Vireo Bendires Thrasher Black-throated gray warbler Gray flycatcher	Pinyon-juniper	Weeds would continue to spread; approximately 0.05 percent of this habitat type has inventoried weeds. Populations of these species would be negatively impacted by the loss of native vegetation and associated habitat.	Treatments would benefit these species as weeds are eliminated or controlled in these habitats. No impact to population or habitat trends.
Lewis's woodpecker Red-headed woodpecker	Mid-elevation riparian woodland	Weeds would continue to reduce riparian habitats and have a negative impact on these species. Weed species on the Forests are most prevalent in riparian areas (2 percent of riparian areas have known infestations).	Treatments would increase native riparian habitat vegetation and improve habitat for these species. No impacts to population or habitat trends are expected.

High Priority Species	Migratory Bird Habitat	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Blue grouse Boreal owl	spruce/subalpine fir	Weeds would continue to spread; approximately 0.02 percent of this habitat type has inventoried weeds. Populations of these species would be negatively impacted by the loss of native vegetation and associated habitat.	Treatments would benefit these species as weeds are eliminated or controlled in these habitats. No impact to population or habitat trends.
Flammulated owl Virginia's warbler Black-throated gray warbler	ponderosa pine	Weeds would continue to spread; approximately 0.2 percent of this habitat type has inventoried weeds. Populations of these species would be negatively impacted by the loss of native vegetation and associated habitat.	Treatments would benefit these species as weeds are eliminated or controlled in these habitats. No impact to population or habitat trends.
Bendire's thrasher Sage sparrow Loggerhead shrike Sage thrasher	Great Basin desert shrub	Weeds would continue to spread; approximately 0.03 percent of this habitat type has inventoried weeds. Populations of these species would be negatively impacted by the loss of native vegetation and associated habitat.	Treatments would benefit these species as weeds are eliminated or controlled in these habitats. No impact to population or habitat trends.
MacGillivray's warbler Green-tailed towhee	Montane shrub	Weeds would continue to spread; approximately 0.2 percent of this habitat type has inventoried weeds. Populations of these species would be negatively impacted by the loss of native vegetation and associated habitat.	Treatments would benefit these species as weeds are eliminated or controlled in these habitats. No impact to population or habitat trends.

High Priority Species	Migratory Bird Habitat	Alternative A (No Action)	All Weed Management Alternatives: B, C, D
Black swift	cave/rock/cliff	No weed infestations are known to occur on this habitat type.	No impacts
	Important Bird Areas	No Important Bird Areas are currently designated.	No impacts
	Over-wintering Areas	Over-wintering areas are associated with large river riparian areas. These areas are among the most heavily impacted by weeds such as salt cedar, which reduce habitat suitability for many species.	Treatments would maintain or enhance suitability of over-wintering areas as they would reduce weeds such as salt cedar.

Fish and Aquatic Resources

Affected Environment

Proposed weed treatment would occur in the San Juan, Arkansas, and Rio Grande River basins of northern New Mexico, which is the affected environment for this proposed project. Refer to the “Water Resources” section for a map and description of the fifth-level watersheds and details about water quality.

Figure 9 shows the watersheds in the forests. Of the 55 fifth-level watersheds that drain the project area, 31 watersheds currently have weed infestations. Weed infestations within each watershed are relatively small, although a high percentage of acres infested with salt cedar or similar riparian weed species occurs within 300 feet of flowing waters.

This analysis will focus on the potential impacts to aquatic organisms, particularly those listed as Management Indicator Species (MIS) for either of the two forests. Aquatic organisms listed as MIS are the Rio Grande cutthroat trout (USDA FS 2003a, 2003b), resident trout (USDA FS 2003a), and aquatic insects (macroinvertebrates) (USDA FS 2003a). The Rio Grande cutthroat trout is also listed as a sensitive species for the Southwestern Region of the Forest Service.

The Rio Grande cutthroat trout is one of 14 subspecies of cutthroat trout native to the Western United States (Behnke 1987). Rio Grande cutthroat trout are found primarily in clear, cold mountain lakes and streams in Colorado and New Mexico within the Rio Grande Basin (Sublette et al. 1990). In New Mexico, the Rio Grande cutthroat trout exist only in mountain streams in the Sangre de Cristo and Jemez Mountain ranges from the headwaters of the Rio Grande to tributaries in northern New Mexico, which include the Pecos, Chama, and Jemez Rivers. Currently, the Carson National Forest manages approximately 360 miles of perennial streams as either known or potential Rio Grande cutthroat trout habitat. The Santa Fe National Forest manages approximately 600 miles of known or potential Rio Grande cutthroat trout habitat (USDA FS 2003b).

The Rio Grande cutthroat trout spawn from the middle of May to the middle of June after the peak runoff from snowmelt occurs (New Mexico Game and Fish 2001). An average water temperature of about 10 °C (50 °F) appears to be a key factor initiating spawning of Rio Grande cutthroat trout (Stumpff 1998). Male cutthroat trout typically mature sexually at 2 years of age; whereas, females usually mature at 3 years (Irving 1954, Drummond and McKinney 1965). Depending on size, an individual female may deposit 2,000-4,500 eggs into a gravel nest, or redd. Sediment-free depositional gravel beds that have a continuous flow of well-oxygenated water are required for successful development of the embryos. Suitable gravels range from 6-40 mm in diameter (Magee et al. 1996, Harig and Fausch 1999). Hatching of Rio Grande cutthroat trout is temperature dependent, occurring in 21 days at about 11 °C (52 °F). Juveniles need shallow calm water that is protected from direct sun and other harsh weather elements. Side channels, undercut banks and overhanging vegetation or exposed roots along margins provide this type of habitat. Adult Rio Grande cutthroat trout need pools with residual depth greater than 1 foot in order to survive harsh winter conditions (Harig and Fausch 2000).

The decline in Rio Grande cutthroat trout numbers in New Mexico is attributed to many factors, which include but are not limited to: (1) introduction of nonnative trout species who either prey upon or hybridize with Rio Grande cutthroat trout; (2) dewatering of streams for irrigation; and (3) altered stream habitat.

Nonnative trout introductions are the major factor for decline of Rio Grande cutthroat trout. German brown trout were introduced in the early 1900s. They currently occupy most perennial streams on the Santa Fe National Forest, but are no longer stocked. They feed primarily on other fish, including Rio Grande cutthroat trout. This aggressive behavior limits productivity of Rio Grande cutthroat trout and eventually leads to extirpation of the native fish in a given stream segment. Rainbow trout have been stocked in New Mexico since 1896 and are distributed throughout the State (Sublette et al. 1990) in cold-water streams and lakes. New Mexico Game and Fish (NMG&F) continually supplement populations with stocking. Rainbow trout hybridize with cutthroat trout and compete for food. The key limitations to fully restoring Rio Grande cutthroat trout populations in New Mexico are the quality of the aquatic habitat or the presence of nonnative fish that compete with, prey on and hybridize with Rio Grande cutthroat trout.

Altered stream habitat is attributed to activities such as long-term fire suppression, timber harvest and firewood consumption, livestock grazing, road construction, dispersed and developed recreational activities including off-road-vehicle use in riparian areas. In addition, whirling disease was discovered in 1999 in New Mexico, including waters on the Santa Fe National Forest (Pecos River, Rio Cebolla, Cañones Creek, Jacks Creek) and Carson National Forest (Middle Ponil Creek). It is unclear at this time what effects this may have on the overall population of Rio Grande cutthroat trout over the long term.

Aquatic surveys on the Santa Fe National Forest show quality of habitat conditions primarily in the “less than moderate” category. In more remote, high elevation areas, stream habitat is moderate to excellent. Poor habitat conditions and water quality in the lower elevations are limiting factors to the size of Rio Grande cutthroat trout populations. Habitat and proper functioning condition surveys on the Carson National Forest indicate that streams are in “moderate to good condition.” The primary habitat concerns are the lack of large, woody debris and lack of pool development. These factors—along with competition and hybridization with nonnative trout—result in reduced numbers of populations of Rio Grande cutthroat trout and a lack of connectivity between populations.

Decreased water quality can be attributed but not limited to surface soil disturbance, soil compaction, road runoff, unstable banks, and delivery of pollutants from nonpoint sources. Poor habitat conditions can be attributed but not limited to a lack of instream structure (mostly missing large, woody debris), sediment-filled pools, loss of undercut banks, depletion of beaver populations, lack of side channel development, and poor riparian health.

Many contributing factors lead to each condition. For example, in the case of large woody debris, removal of riparian and instream wood from past timber and firewood practices is only one contributing factor. Fire suppression, grazing, and large wildfires also contributed. In addition, the agency removed large wood from streams up until the 1980s because of previous scientific thought that wood was a barrier to migration (AFS 1983).

Stream habitat inventories conducted to assess fish habitat condition and flood plain function, as well as establishing baseline for future monitoring, confirmed that there is a lack of large wood in many streams outside higher elevation, wilderness streams. Surveys in 2002 noted that in isolated locations in wilderness, streams host nearly 70 pieces of large wood per mile. In similar stream types outside of the wilderness, streams rarely reached 10 pieces per mile, in many cases going several miles without one piece of wood.

Resident Trout (rainbow, brown and brook) are Carson National Forest management indicator species for quality perennial streams and riparian vegetation. Rainbow trout were first introduced into New Mexico in 1896 and have subsequently been introduced into all major drainages of the State (USDA FS 2003b). Of particular importance relative to this species habitat needs and the proposed weed treatment, is the maintenance of riparian vegetative and structural cover, used as escape and resting cover and to maintain cool (generally <18 C) water temperatures (USDA FS 2003a). Brown trout were introduced into New Mexico during the early 1900s (USDA FS 2003a). This species typically inhabits coldwater streams and lakes, and tends to occupy deeper, lower velocity, and warmer waters than other trout. Brown trout prey on other trout species and compete for food and space. Riparian vegetation that provides canopy shade (between 50 and 70 percent) is desirable for this species (USDA FS 2003b). Brook trout were introduced into most major drainages of New Mexico during the early 1900s. They are found primarily in cold, clear headwater streams as well as lakes, and adapt well to a variety of freshwater environments (USDA FS 2003a).

Aquatic insects (macroinvertebrates) are found in aquatic environments and help to maintain ecosystem health by eating bacteria and dead or decaying plants and animals. In addition to their role in the food base for fish, populations of certain aquatic insects are indicators of high water quality, including overall aquatic condition, quality of fisheries and associated riparian habitat (USDA FS 2003b). In natural perennial streams, primary factors controlling distribution and composition of aquatic insects are temperature, flow, substrate, chemical condition, and aquatic/riparian vegetation. Of these factors, riparian vegetation, water chemistry, and temperature are of primary importance relative to potential impacts of the proposed weed treatment activities.

Environmental Consequences

The environmental consequences discussion focuses on the potential impact of herbicides and sediment on fish, since impacts on aquatic insects tend to be more short term. The analysis considered scientific research on the risks of herbicide use, along with watershed modeling to determine the risk of herbicide applications into aquatic systems at levels that could have an adverse impact. Appendix 3 contains more information regarding the risk assessment for fish and aquatic species.

The “Water Resources” section described the 11 representative watersheds selected for detailed analysis relative to estimate potential herbicide delivery into streams on the Forests. These 11 watersheds were evaluated with a model developed to calculate picloram delivery via surface water runoff/overland flows to the aquatic system after application. Details of the methodology and associated assumptions are found in Appendix 5. Refer to Chapter 2 for a detailed description of treatments proposed for known weed infestations on the Forests, as well as the adaptive management strategy that would be used.

A “worse case analysis” method was used in modeling in order to identify a very conservative threshold acreage limit for where herbicide levels could have an impact to aquatic resources. Picloram was selected because it is the only herbicide proposed for possible use that has a risk quotient categorized as “high.” The risk quotient for glyphosate is “moderate” while all others are "low." Risk of using picloram has been evaluated using literature review and conservative direct modeling. The model also used Alternative D (herbicide only) as if all 7,350 acres of inventoried weed infestations would be treated with herbicides only, and within the same year rather than being spread out over the next 10 years. Detailed results of the analysis are presented in Appendix 5 and contained in the project record.

Alternative A (No Action Alternative)

Weed treatment activities including herbicide use would continue to be implemented by other jurisdictions along Federal, State, and county roads and on public and private lands within the same watersheds that overlap the Forests' boundaries. These herbicide applications would not be expected to have any measurable adverse consequences to fish populations on the Forests, primarily due to the limited amounts and concentrations that would be used at one time within the same aquatic systems. The level would be well below thresholds shown by the watershed modeling to have a toxic impact to fish.

Without the proposed weed control treatments, weeds would continue to spread exponentially at a rate of approximately 5 to 30 percent annually. Minor but cumulative adverse impacts to aquatic habitat and fish populations would be expected to result over time from a combination of: (1) increased runoff, erosion, and sedimentation due to less overall vegetation density and diversity (See "Vegetation Resources" section); (2) reduced streambank stability where weeds eliminate native riparian vegetation along stream channels; (3) increased surface water temperature where salt cedar replaces native riparian shade species such as willows and cottonwoods; and (4) reduced organic matter entering surface waters.

A large portion of the weed infestation acreage on the Forests occurs along drainage bottoms. Weeds would be expected to reduce infiltration and increase runoff and sediment production in those areas because they reduce the vegetative ground cover and allow crusting of exposed soil (Lacey et al. 1989). Taprooted weeds reduce infiltration because they do not have the dense, fine root system of grasses. Water runoff was 56 percent higher and sediment yield was 192 percent higher on spotted knapweed plots compared to bunchgrass plots during a simulated rainfall period (Lacey et al. 1989). These conditions would have long-term, adverse effects on water resources on the Forests.

Increases in sediment would impact aquatic organisms in several ways. Resident trout, as well as many other aquatic species, require habitat with little sediment. Suspended sediment can impact the respiration of these species and an increase in embeddedness (sediment that fills the gaps in spawning gravels) can reduce the quality of spawning habitat for trout. Sediment increases can also negatively affect aquatic insects, either through reduction in the populations of these prey-base species, or a change in species composition, which can then be amplified through other species higher up the food chain.

Alternatives B and D (Proposed Action and Herbicides Only)

Weed treatment on both Forests, including use of herbicides, would occur on an estimated 600-1,600 acres per year (maximum of 3,000 acres per year for both forests) over the next 10 years. Under Alternative B, approximately 60-70 percent of the treatment acres would involve the use of herbicides alone or in combination with other methods. Alternative D would use herbicides on all weed treatment sites.

Aquatic insects are an important food source for fish, so contaminants that affect the insects can affect the health of the fish that eat them. Since aquatic insects are adapted to highly variable stream environments, they would be better able to tolerate change on the Forests compared to those in more stable lake and pond environments (Mackie 1998), although their response to pollutants can vary. The degree of impact to an aquatic system is dependent on the chemical and physical properties of the pollutant and the ability of a given species to tolerate an impact (Nimmo 1985). Impacts on species abundance and diversity resulting from catastrophic substrate loss or degradation are well documented. Aquatic insect community response studies (Resh et al. 1988) have shown that recolonization within a few years generally results, though responses can vary within an individual species (Minshall 1982).

Since the timing of chemical releases and water conditions relative to the distribution and life cycles of organisms determines the potential exposure and, correspondingly, the biological effects of exposure, the effect of herbicides is more difficult to track. The effect on benthic species (i.e. species that live on the bottom of a water body) is determined primarily by the amount in the water and substrate. The composition and toxicity change rapidly and continuously as individual compounds are transported through the aquatic system and dispersed and degraded at differing rates by physical, chemical, and biological processes (Nimmo 1985). The rates of these weathering processes and population recolonization vary depending on temperature, currents, wind, and concentrations of suspended and dissolved components of the receiving water, sediment sorption, and biological activity.

Several potential risks to fish and aquatic organisms were considered in this analysis, including the risk of herbicides leaching through the soil into ground water, accidentally spilling in or near aquatic systems, or entering aquatic systems via overland flow events (major water runoffs). Most herbicides are applied in liquid formulations and are sprayed on the foliage of the target vegetation. Soils are rarely a major receptor, although it is possible for herbicides on the soil to leach through to ground water and ultimately reach the aquatic environment. This method of introduction usually poses the least amount of risk to the aquatic environment because chemicals typically disappear from the soil surface by either plant uptake of the chemical, volatilization, natural decomposition of the active ingredients, or adsorption of the herbicide by soil particles. As Norris et al. (1991) indicates, leaching of chemicals through the soil profile is a public concern, but is least likely to occur in undisturbed forest environments. The half-lives of most of the herbicides are 24 to 48 hours, although picloram ranges from 20 to 277 days, which is more than any of the other herbicides proposed for use. Mitigation measures—such as limiting the use of picloram on highly permeable soils with shallow water tables, in riparian areas, or near water bodies—would minimize potential leaching effects.

Herbicide container leaks, spills, improper storage or handling, as well as rinsing of containers can potentially result in surface or ground water contamination. Mitigation measures in Chapter 2 and described in a detailed chemical handling and spill prevention plan, would reduce the risk of impacts from an accidental spill of herbicide in or near a water body. With mitigation measures and other standard herbicide use and handling procedures in place, the risk of adverse impacts is considered very low.

Another mode of herbicide entry to the aquatic system includes overland flow from either precipitation events or irrigation. Risks vary depending on soil composition and the timing and intensity of the precipitation events after herbicide application. Risks tend to be lower on well-vegetated forests and rangeland where soil infiltration is typically greater than precipitation.

Norris et al. (1991) indicated that overland flow occurs infrequently on most undisturbed forestlands because the infiltration capacity of the forest floor and soils is usually far greater than the rate of precipitation. However, denuded and compacted soil such as along roads, trails, or at camping sites, typically provides increased potential for surface runoff. When high-severity wildfires reduce soil infiltration rates and hydrologic function, the magnitude of accelerated erosion and runoff temporarily increases. This effect is greatly diminished by the second year after a fire because vegetative recovery begins and soil erosion ceases once the erosion rills break through the soil hydrophobic layer (DeBano et al. 1998).

Results of picloram modeling for the representative watersheds receiving treatment are discussed in the following “Water Resources” section and in Appendix 5. Modeling shows that for two watersheds (Ponil Creek Watershed on the Carson National Forest and Lower Jemez River Watershed on the Santa Fe National Forest), if all the known weed infestations were treated with herbicides in the same year, the level of herbicide that could potentially reach the water could exceed the no effect threshold. Because weed infestations in these watersheds would not be treated 100 percent with herbicides within a single year, and many mitigation measures would be applied to mitigate potential impacts, the likelihood of this occurring is very low and no measurable effects would be expected to aquatic organisms.

The concentration of herbicide that would likely reach aquatic resources would be below the threshold where an adverse impact could be detected. This is based on the treatment acreage and spatial distribution across the Forests as proposed, while allowing for adaptive management changes as long as the herbicide treated acreage is within the thresholds established by the model for a given watershed. This determination is also based on application of the mitigation measures designed to protect aquatic resources. These measures include prohibiting the use of picloram near water, avoiding the spaying of any herbicides near water bodies, remaining below the modeling thresholds described in Appendix 5, using herbicide spill control measures, and others. Additional protective measures in Chapter 2 would be applied to streams with sensitive Rio Grande cutthroat trout species. Measures limit herbicide use to a short-lived, nonleachable herbicide registered by EPA for use on permeable soils with shallow water tables for areas where there is a highly permeable soil and shallow water table. This would help avoid the risk of an herbicide leaching through to the ground water, and would eliminate the use of picloram in those situations. Furthermore, methods selected for use in riparian areas or next to aquatic species habitats would be restricted to either nonherbicide methods or herbicides registered by EPA for use in aquatic habitats and documented as having a low risk to fish and other aquatic species. The mitigation measures have been successfully implemented on other forests and should be highly effective. Monitoring the effects of treatments and effectiveness of mitigation measures would further reduce the risk of unexpected impacts over the life of this project.

As adaptive management is implemented over time, the Forests would ensure that herbicide treatments are within the thresholds established by the model results. These thresholds set yearly application limits for picloram (used as a conservative measure for all other herbicides), based on the watershed and whether the soils are runoff or infiltration dominated. Herbicide applications would also be limited based on whether they would be conducted in spring or fall. As long as the limits are not exceeded, future herbicide treatments under the adaptive strategy would have the same low risk of adverse effects.

Long-term, beneficial impacts to aquatic resources would likely result from effective weed treatment because of increased ground cover near streams (soil stabilization and maintenance of riparian vegetation) where treatments successfully return native vegetation to dominance.

In terms of other potential adverse effects from weed treatment methods, the minimal increases in soil erosion would be well within acceptable limits as described in the “Soil Resources” section of this DEIS, and heavy equipment would not be used on slopes over 40 percent. Based on the analysis presented in the soil, water and vegetation sections, along with mitigation measures to limit sediment impacts, there would be a minimal increase in sediment delivery to streams and no observable impact to aquatic habitat or species caused by increased sedimentation.

Alternative C (No Herbicide)

This alternative eliminates all risk of herbicide delivery to aquatic systems from implementing this project. The effects from the nonherbicide weed control methods would be similar to those described for Alternatives B and D in terms of the limited amount of soil erosion, runoff and sediment delivery to aquatic systems. However, because of the need to repeat treatments more often, and the larger number of acres where the soil surface would be disturbed, this alternative would result in a slightly higher rate of potential sediment delivery. Most of the treatments are in previously disturbed areas and mitigation measures would minimize long-term increases in erosion or sedimentation, so the increase in erosion and sediment movement over current conditions would still be quite small.

Beneficial, long-term effects on streams and aquatic organisms associated with controlling and eradicating weeds would be slightly less than the effects of implementing Alternatives B or D, since this alternative would not be as rapid or effective in reducing weed infestations.

Cumulative Impacts

The analysis area for cumulative effects on fisheries and aquatic resources is the area in and immediately adjacent to the two forests. This boundary represents the areas where the actions proposed in this project are most likely to interact with other activities, in particular the weed treatments and ground disturbance on both forests and other lands (private, State, BLM, etc.). The beginning of this chapter lists past, ongoing and foreseeable future activities considered in this cumulative effects analysis that could continue to impact water, soils and aquatic resources.

Herbicide applications ongoing by the Forest Service as well as by others on public and private lands in northern New Mexico can potentially have cumulative effects on aquatic resources. Information regarding the magnitude and extent of future herbicide application is quite limited, including how much picloram is or will be used. Based on efforts to obtain this information, as contained in Appendix 1, picloram use would be fairly limited, and herbicide applications would continue to be implemented on small acreages without the use of widespread aerial application methods.

In terms of cumulative, long-term effects from chronic exposure to herbicides, there is a limited amount of research on this topic. Data collected under laboratory conditions does not account for environmental variables such as temperature, wind, photodegradation, soil permeability, precipitation frequency and intensity, local geochemical influences, stream volume (dilution factor) or water quality (Munn and Gilliom 2001). Woodward (1976) documented chronic exposure effects in lake trout (*Salvelinus namaycush*) fry after 60 days. It is unlikely that there would be any chronic exposure effects on the aquatic environment from this project given exposures of 1 or 2 days as opposed to 60. With mitigation measures in place as previously described, concentrations of herbicides and the duration of those concentrations on the aquatic environment would be small, below levels at which chronic exposure effects are documented.

Most of the jurisdictions that apply herbicides follow similar mitigation measures and have chemical spill plans in place to reduce potential adverse impacts. Government agencies applying herbicides must all meet acceptable levels of water quality protection. Most of the treatment by other jurisdictions and landowners would continue to primarily occur along highways and roads, and in valley bottoms, where soil conditions are more conducive to infiltration than runoff. If runoff were to occur, much of the private treatments occur low in the watersheds, where stream flow would likely be greater, allowing for faster dilution than those locations being treated in the headwaters.

The lands adjacent to the Forests are not used for intensive farming or agriculture, with small herd livestock grazing and hay growing as the largest use. These agricultural uses do not typically apply large amounts of herbicides (although this could increase as thistles and other weeds invade pasture lands). However, cumulatively, there is a very slight risk that herbicide use by the Forests along with adjacent landowners may exceed those “no impact” thresholds proposed by the Forests. It should be noted, however, that these threshold values are very conservative and have incorporated safety factors that mean little impact is expected even in the event a level exceeds the threshold. In addition, the contribution to cumulative impacts from weed control alternatives would be negligible, since the direct and indirect effects from the alternatives would be at immeasurable levels.

Other activities around the Forests that increase soil erosion and sedimentation would add to the negligible amount of erosion and sediment increase expected from proposed weed control activities. Since the direct and indirect effects from the alternatives are quite small, their contribution to cumulative impacts would also be minimal, especially since activities displacing soil near streams would occur at different times and in widely distributed sites across the Forests. Increases in sediment would most likely occur during significant rainfall and runoff events.

The most likely cumulative effects from all weed control treatments in northern New Mexico, together with other ecosystem restoration projects being planned or conducted on the Forests, would be the beneficial restoration of native plants and soil stability that reduce sedimentation and improve aquatic conditions.

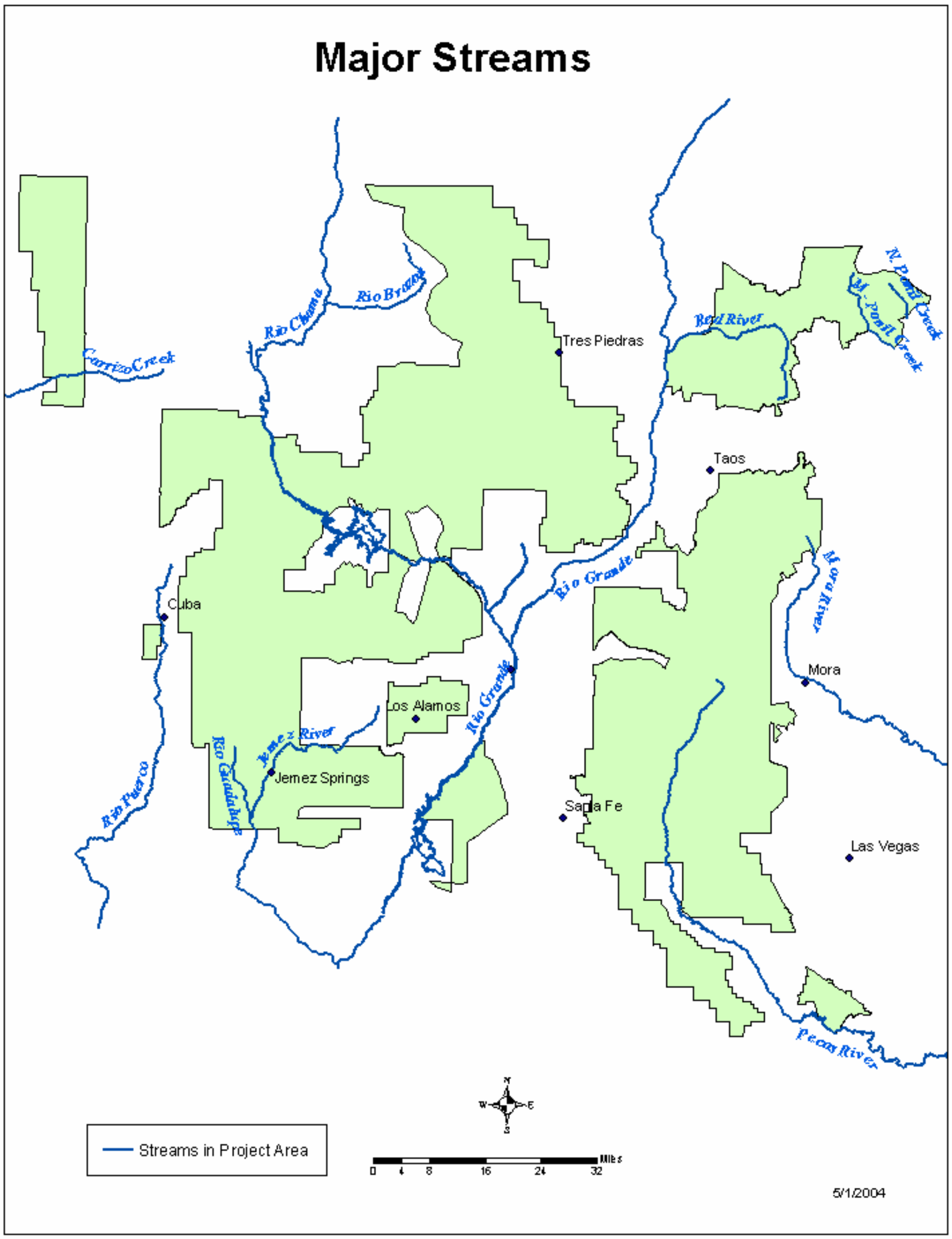


Figure 7. Major Streams

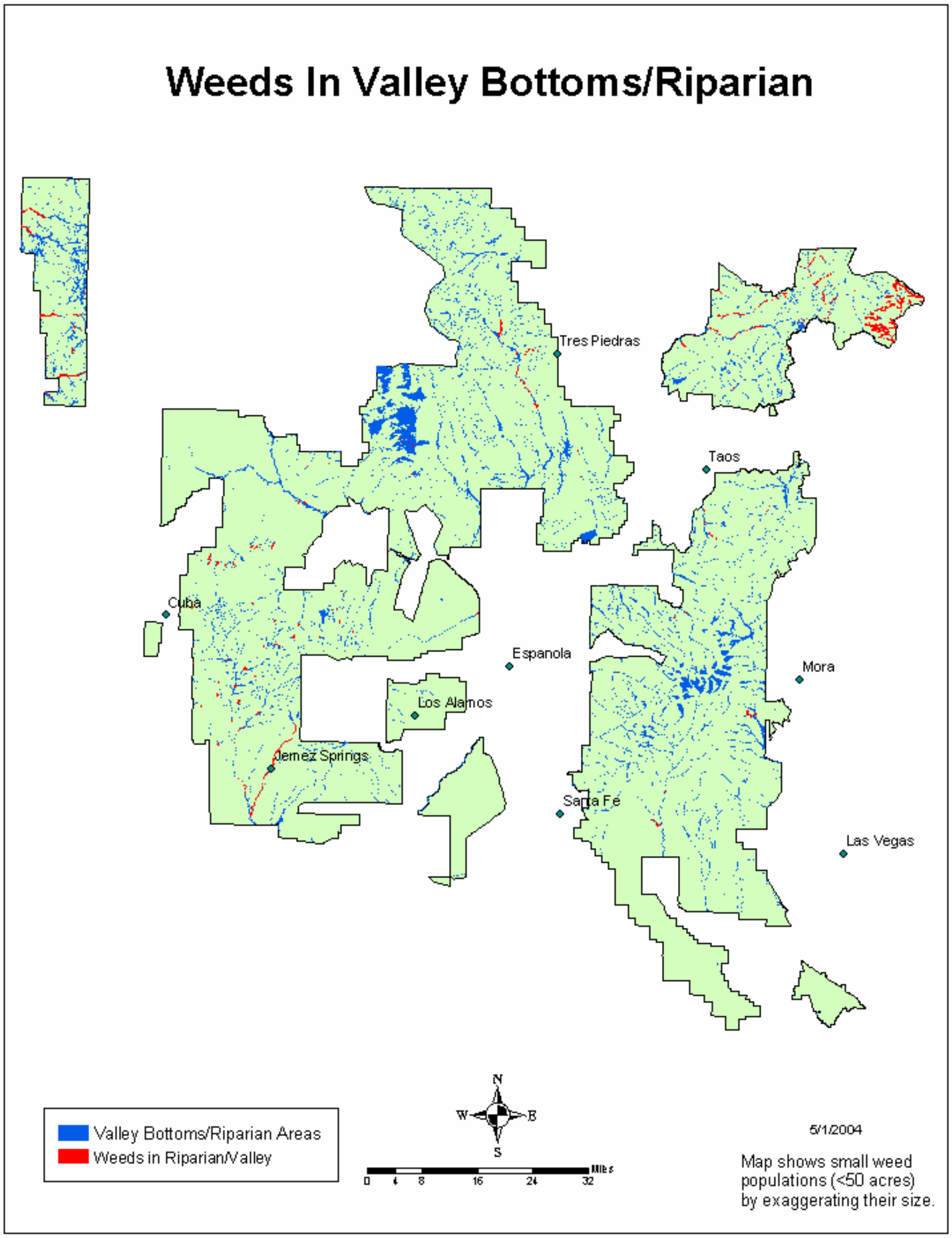


Figure 8. Weeds in Valley Bottoms/Riparian Areas

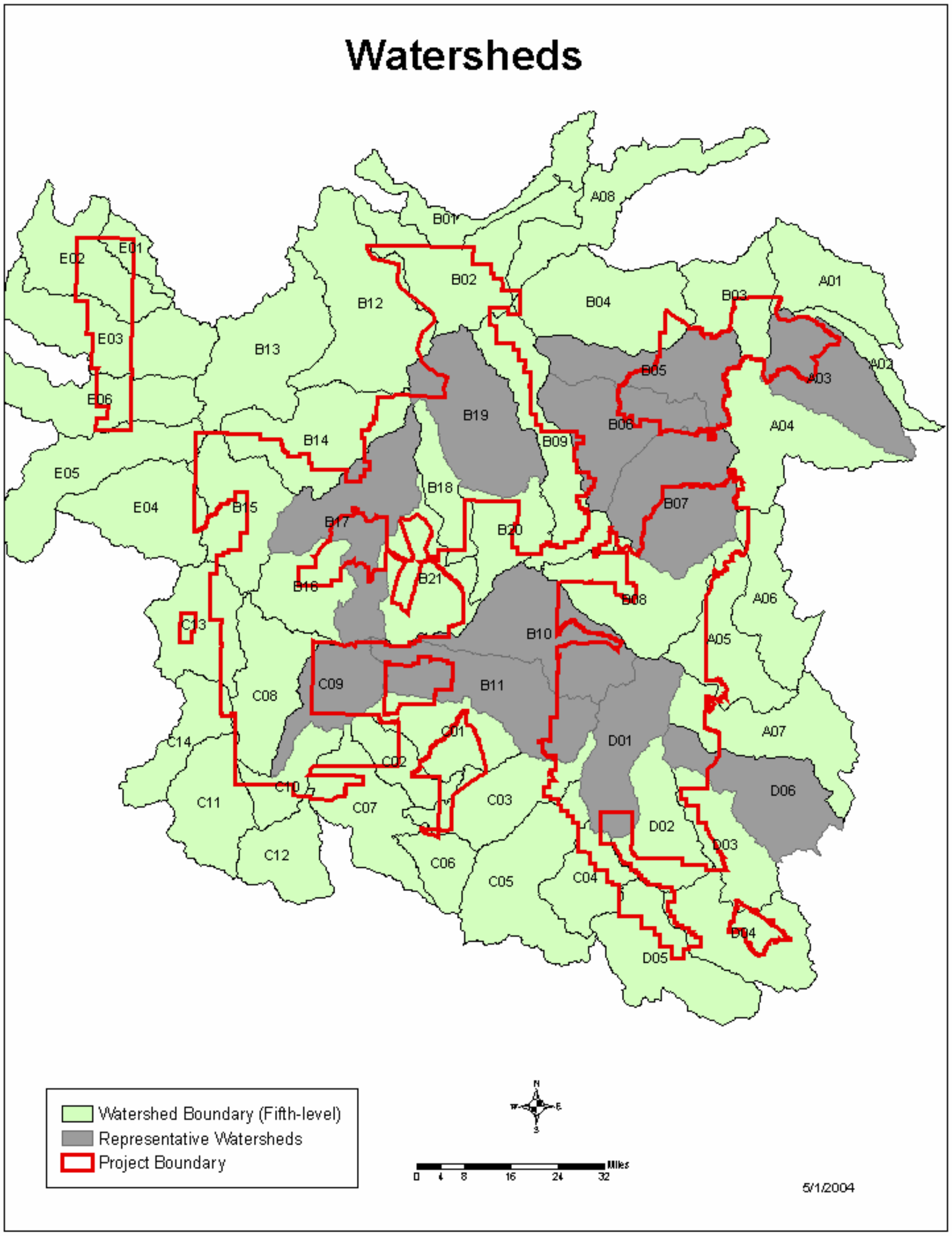


Figure 9. Watersheds, including Representative Watersheds

Water Resources

Affected Environment

This section describes watershed characteristics, existing water quality, and analysis methods used.

Watershed Characteristics

The Forests are located within the Rio Grande, Arkansas, and San Juan Basins of northern New Mexico. These major basins are divided into smaller, fifth-level watersheds that are identified by their Hydrologic Unit Codes (HUCs).

Table 31 shows the fourth-level basins and fifth-level watersheds for the project area, and Figure 9 shows the fifth-level watersheds including those selected as representative watersheds for this analysis. The project area intersects 55 fifth-level watersheds that total nearly 9.7 million acres (or about 15,160 square miles). The average size for these watersheds is 180,000 acres or about 281 square miles. Table 31 and Figure 9 show all of the watersheds on or intersecting the Forests. Several of these watersheds intersect a small fraction of the Forests, and have very little influence on these watersheds. Watersheds that overlap less than 2 percent of the Forests include El Vado Reservoir, Van Bremer Canyon, North Pinos, San Antonio, Lower Jemez, Cimarron Creek, Lower Galisteo Creek, Upper Vermejo River, and the Rio Salado. Another 13 watersheds cover less than 20 percent of the Forests, 20 watersheds cover 20 to 50 percent, and only 14 watersheds cover over 50 percent of the Forests. As many of these watersheds have headwaters sections on the Forests, activities on the Forests influence water quality downstream and outside the Forests' boundaries.

Table 31. Watersheds on or Intersecting the Forests

Fourth-level Basin	Fifth-level Watershed	Map Number	Acres	FS Acres
Canadian Headwaters	Upper Vermejo River	A01	157,148	2,399
	Van Bremmer Canyon	A02	57,514	53
Cimarron	Ponil Creek	A03	207,734	59,087
	Cimarron Creek	A04	217,293	2,212
Mora	Upper Mora River	A05	171,078	37,881
	Coyote Creek	A06	158,777	8,169
	Manuelitas Creek	A07	222,573	27,086
Alamosa-Trinchera	San Antonio-Rio Grande	A08	191,837	944
Rio de las Pinos	San Antonio- No. Pinos	B01	200,000	549
	Rio San Antonio	B02	243,338	126,428

Fourth-level Basin	Fifth-level Watershed	Map Number	Acres	FS Acres
Upper Rio Grande	Rio Costilla	B03	137,720	39,824
	Latir Creek	B04	249,377	13,439
	Red River	B05	180,138	109,469
	Rio Hondo	B06	205,065	58,951
	Rio Grande del Rancho	B07	268,623	126,952
	Rio Pueblo-Embudo Creek	B08	204,690	158,490
	Arroyo Aguaje de la Petaca-Rio Grande	B09	211,078	125,432
	Santa Cruz-Rio Grande	B10	255,454	92,546
	Pojoaque River-Rio Grande	B11	249,848	77,709
Rio Chama	Rio Brazos	B12	311,226	14,691
	Rio Chama-El Vado Reservoir	B13	250,904	193
	Rio Nutrias-Rio Chama	B14	229,954	81,871
	Rio Gallina	B15	179,843	131,582
	Rio Puerco	B16	130,821	95,258
	Canjilon Creek-Rio Chama	B17	271,162	221,194
	El Rito Creek	B18	85,941	73,021
	Rio Tusas-Rio Vallecitos	B19	249,949	230,265
	Rio Ojo Caliente	B20	117,901	50,066
	Rio del Oso-Rio Chama	B21	182,796	27,598
Middle Rio Grande	Frijoles Canyon	C01	145,417	56,009
	Cochiti Reservoir	C02	80,115	39,285
	Santa Fe River	C03	165,050	33,451
	Upper Galisteo Creek	C04	110,178	24,105
	Middle Galisteo Creek	C05	246,762	12,899
	Lower Galisteo Creek	C06	73,569	881
	Borrego Canyon	C07	179,060	38,913
Jemez River	Rio Guadalupe	C08	171,697	165,166
	Upper Jemez River	C09	129,234	121,394
	Middle Jemez River	C10	83,611	47,820
	Rio Salado	C11	158,801	2,706
	Lower Jemez River	C12	119,338	1,140
Rio Puerco	Rio Puerco-Arroyo Chijuilla	C13	165,489	54,944
	Rio Puerco-Arroyo Balcon	C14	112,181	5,480
Pecos Headwaters	Pecos River Headwaters	D01	183,620	154,435
	Cow Creek-Pecos River	D02	151,891	94,200
	Upper Tecolote Creek	D03	134,184	26,603
	Lower Tecolote Creek-Pecos River	D04	199,847	31,944
	Upper Canon Blanco	D05	214,193	43,234
	Uper Gallinas River	D06	200,317	30,836

Fourth-level Basin	Fifth-level Watershed	Map Number	Acres	FS Acres
Upper San Juan	Carracas Canyon	E01	45,918	13,057
	Canon Bancos	E02	180,372	59,100
	La Jara Canyon	E03	237,436	52,306
Blanco Canyon	Canada Larga	E04	190,216	7,928
	Tapicito Creek	E05	214,177	4,963
	Cereza Canyon	E06	204,015	31,069

Table 32 shows the characteristics of the 11 representative watersheds, including watershed name, HUC (watershed) number, total acres (within and outside the Forests), proposed weed treatment acres within the watershed, water flows in cubic feet per second, and the gauging station number.

Table 32. Characteristics of Representative Watersheds

Stream Name	Fifth Level Watershed number	Watershed Area (acres)	Proposed Treatment Area (acres)	$Q_{.20}$ Flow May/Sept (cfs)	USGS Gaging Station Number
Carson National Forest					
Red River – Upper Rio Grande Basin	1302010104	180,137	93	254 / 77	08266820
Rio Hondo – Upper Rio Grande Basin	1302010105	205,064	15	1471 / 293	08268700
Rio Grande del Rancho – Upper Rio Grande Basin	1302010106	268,622	128	373 / 23	08276000
Canjilon Creek – Rio Chama Basin	1302010206	271,162	3	106 / 5	08287000
Rio Tusas / Rio Vallecitos – Rio Chama Basin	1302010208	249,948	88	6613/1072	08289000
Ponil Creek – Cimarron Basin	1108000201	207,733	1,266	79 / 8	07207500
Santa Fe National Forest					
Santa Cruz – Upper Rio Grande Basin	1302010109	255,454	8	1679 / 554	08291500
Pojoaque River – Upper Rio Grande Basin	1302010110	249,848	5	571 / 16	08313000
Upper Jemez River – Jemez Basin	1302020202	129,234	1,591	115 / 24	08321500
Pecos River Headwaters	1306000101	183,620	116	512 / 96	08378500
Upper Gallinas River – Pecos Headwaters Basin	1306000107	200,317	0	24 /9	08382000

Note: HUC = hydrologic unit code; USGS = U.S. Geological Survey; cfs = cubic feet per second; $Q_{.20}$ = value for mean monthly streamflow exceeded in 20 percent of the years.

There are more than 1,000 miles of perennial streams on the Forests (refer to Figure 7 showing the major streams). The watersheds are snowmelt and rainstorm runoff dominated. Highest streamflows usually occur in May as a result of snowmelt runoff. Stream flows increase as snowmelt occurs, usually beginning in April or May, and reach peak levels typically in May, depending on weather conditions and temperature fluctuations. Highest precipitation typically occurs in July/August during short-duration, high-intensity rainstorms. Occasional brief, intense thunderstorms typically in July/August can cause sudden increases in runoff, sometimes causing flooding. Many drainages are ephemeral or intermittent—flowing primarily in response to storms and/or snowmelt runoff.

Average annual precipitation on the Forests ranges from about 10 to 35 inches, with the greater amounts occurring at higher elevations in the mountains (USDA FS 1986). The elevation range is approximately 7,000 to 12,000 feet. At lower elevations where valley bottoms widen and gradients become less steep, the streams generally are less confined and have developed flood plains. These lower stream segments usually carry sediment during high flow and deposit it during lower flow periods. The finer-grained alluvial deposits on beds and banks of wider valley bottom streams can be easily eroded each year during high flow. In these stream systems, streambank vegetation is important in maintenance of channel stability. Depending on condition of streambanks, bank erosion and channel migration may occur during periods of high flow.

Surface and Ground Water Quality

Surface water quality is generally good on the Forests. Sediment (suspended and bedload) and water temperature are the water quality parameters that most often can be affected by land management. Activities that disturb vegetation or soil surface have potential to produce sediment from increased erosion. Sediment in streams and rivers is naturally a highly variable parameter, with higher loads usually observed during spring runoff or summer storms.

Water uses on the forests include cold-water fisheries, livestock and wildlife watering, recreation, domestic uses, and irrigation diversion/supply. More common sources of increased sediment and other nonpoint impacts to streams include livestock grazing, off-road-vehicle use, and poorly located and/or maintained roads (USDA FS 1986a). Several stream or river segments within and near the Forests are on New Mexico’s 2002-2004 303(d) list of impaired water bodies (NMED 2003). Most of these impaired water bodies have turbidity, stream bottom deposits, and/or temperature listed as probable causes of impairment. Commonly listed probable sources of impairment are related to grazing and agricultural activities, bank modification, and removal of riparian vegetation.

Ground water on the Forests is typically at depths of several hundred feet, but in general can be highly variable. Drinking water wells found on the Forests range in depth from 55 feet to 150 feet or more (USDA FS 2003e). Yield of ground water from these formations usually is low (< 25 gallons per minute) (USDA FS 1986a). In contrast, most valley bottoms have shallow ground water in alluvial deposits. This ground water is most likely closest to ground surface in May/June, declining through the summer as streams approach low flow conditions.

Analysis Methods

Representative fifth-level watersheds were selected from each forest to perform appropriate analysis of water resources—six watersheds from the Carson and five from the Santa Fe. These watersheds were selected to represent the variety of conditions found on the Forests in terms of drainage area, aspect, geology, soil, vegetation, flow conditions and aquatic sensitivity. Information for watersheds was compiled from State and Federal agencies, including New Mexico Environment Department, U.S. Environmental Protection Agency (EPA), U.S. Geological Survey (USGS), and the Forest Service resource databases. The representative watersheds cover about 2,401,000 acres (about 3,752 square miles). The average size of the representative watersheds is 218,000 acres or about 341 square miles. As is the case with most of the watersheds in the analysis area, much of the total size of these watersheds lies outside and generally downstream from the Forests.

Drainage areas of each watershed were determined using geographic information systems (GIS) methods. Flow characteristics of streams were obtained from USGS gaging stations located near the subject watershed boundaries.

The analysis uses streamflow rates for two time periods of the year—spring high flow (May) and fall low flow (September)—to provide a range of dilution factors for herbicide runoff in the primary stream channels of each representative watershed. These two time periods approximate each end of the general season of herbicide application in the Forests. For each of the 2 months, the value for mean monthly streamflow exceeded in 20 percent of the years ($Q._{20}$) was used to simulate dilution of herbicide in each stream during that time of year. These flows were then used as input values to model resultant herbicide concentrations after mixing and diluting in the streams for each of the 11 representative watersheds (see Figure 9).

Environmental Consequences

Alternative A (No Action)

Without implementation of this weed control treatment project, water resource conditions would deteriorate. This alternative would not address Forest Plan goals for maintaining water quality and favorable water flows. Weeds would continue to spread and reduce the abundance and diversity of native riparian vegetation while destabilizating streambanks.

Where weeds invade areas along stream channels, riparian vegetative cover can be reduced or eliminated, causing greater streambank instability. Overall reductions in vegetative canopy cover can also cause increases in stream temperature and decreases in organic matter. The Forest Service (USDA FS 2001a) noted that the establishment of weeds within or adjacent to riparian habitats was increasing overland runoff and sediment yield. Lacey et al. (1989) reported a three-fold increase in sediment yield and a 50 percent increase in runoff at a knapweed-infested site compared to a noninfested site.

Studies on the Lolo National Forest in western Montana showed that a site with 80 percent knapweed cover yielded 5 times the amount of sediment as sites covered with bunchgrass (USDA FS 2003c). These same studies estimated the effects of a 20-minute thunderstorm (100-year event intensity) occurring on 1,648 acres of big game winter range infested with knapweed; such a storm could produce an additional 160 tons of sediment compared to a weed-free area. Increased sediment delivery to drainages can cause increased turbidity (suspended sediment) in a stream/river, as well as increased stream bottom deposits that may be detrimental to aquatic life and overall stream stability.

Because of the reduced vegetative cover from forest fires in some watersheds, increased runoff and sedimentation is occurring and will continue until adequate vegetation cover is established.

Treatment of weeds in these burn areas may further reduce vegetative cover for the short term; however, as weeds are replaced by native vegetation, the sedimentation problems would diminish. Also, refer to the related effects descriptions for Alternative A in the “Vegetation, Soils and Aquatic Resources” sections.

Without adopting the proposed amendment to the Forest Plan, weed control within the Santa Fe and Gallinas Municipal Watersheds would be very difficult, since the Santa Fe National Forest Plan currently prohibits the use of herbicides in municipal watersheds. The proposed amendment would allow herbicides to be used when city officials concur with the proposed treatment prescription and mitigation measures to be implemented. Herbicides are currently used by other agencies and environmental organizations in the lower portions of both watersheds (outside municipal watershed boundaries on national forest lands) in order to effectively control weeds in those areas. Prohibiting the use of herbicides would likely result in increased spread of salt cedar, Siberian elm, Russian olive and other weed species in the municipal watersheds, which would adversely impact water quality and quantity in the long term.

Alternatives B and D

The primary herbicides currently EPA-registered for use on the Forests have picloram, metsulfuron methyl, clopyralid, dicamba, triclopyr, or glyphosate as their active ingredients, and are described in detail in Appendix 3. Any liquid herbicide sprayed on weeds would fall primarily on the weed plant foliage with some landing on the surrounding soil. The fate and transport of herbicides include the following possible transfer and degradation mechanisms (Siegel 2000):

- Adsorption and detoxification by plants;
- Photodegradation by sunlight;
- Volatilization;
- Adsorption to soil particles and organic matter;
- Chemical degradation;
- Microbial degradation;
- Solubilization and dilution in surface runoff; and
- Leaching through soil horizon and potentially to ground water.

The extent to which each of the mechanisms listed above occurs is dependent upon a variety of factors, including meteorological conditions (e.g., magnitude and distribution of precipitation, sunlight, and wind); soil conditions (e.g., thickness, permeability, and organic matter content); land slope; depth to ground water; and chemical characteristics of herbicide. The combination of these mechanisms influences both magnitude and duration of impacts on water resources.

Microbial decomposition and volatilization are the predominant breakdown processes of herbicides in soil. Leaching of herbicides through the soil horizon is the least likely route for water resource impacts, particularly with the limitation on the type of herbicide that may be used on permeable soils with shallow water tables. Direct application of herbicides to surface water would be the route most likely to cause impacts on water resources; however, this is unlikely because the project prohibits application of herbicides to open water and mitigation measures are in place to avoid accidental introduction of herbicides into aquatic environments and live streams.

Mobilization in ephemeral channels also would affect water resources if runoff occurs soon after application. The combination of transfer and degradation factors previously listed, along with following label instructions and application rates, would likely result in herbicide concentrations that are not harmful to the environment. This determination is partly based on the results of the model used to simulate herbicide applications in 11 different types of representative watersheds.

Surface and Ground Water Impacts: Potential point-source impacts on surface or shallow ground water resources include accidental leaks and spills of liquid herbicides, and improper storage, handling, or rinsing of herbicide containers. One of the mitigation measures described in Chapter 2 states that herbicides would be stored away from wells, pumps, and any water bodies. Mixing and loading of chemicals would not occur within 200 feet of a water body. In addition, herbicide applicators would have a chemical spill plan and emergency cleanup kit onsite during treatments. These measures would be expected to prevent point-source impacts from accidental herbicide releases to water resources. The spill plan identifies methods to avoid accidental spills, as well as how to report and clean up spills. The cleanup kit would contain appropriate spill cleanup supplies.

No aerial application of herbicides would occur for any alternative, which greatly limits the risk from spray drift entering water bodies. With mitigation measures in place, the amount of herbicide drift that could reach a stream or other water body would be very small. The small amount of herbicide in the drift would likely be diluted to very low, nonharmful concentrations.

Some of the mitigation measures in Chapter 2 are specifically designed as “best management practices” to ensure the project does not violate State and Federal water quality standards. They include limiting herbicide spraying within a riparian area (hand application only), prohibiting picloram use near water and shallow ground water, limiting herbicides to those specifically registered for safe application near water, and several to minimize erosion and sediment impacts. Herbicide label instructions typically include these additional mitigation measures/best management practices: (1) no spray if precipitation is occurring or imminent; (2) no spray if air turbulence would affect normal spray pattern; (3) no spray if snow or ice covers target foliage; and (4) use only water as a chemical carrier.

In addition to the qualitative analysis just described, a model was used to simulate the mixing of herbicides with surface water (as previously described in the “Fish and Aquatic Resources” section, with details in Appendix 5). Two time periods were used (May and September) to calculate dilution of herbicides in streams for each representative watershed. Typical high and low flow conditions ($Q_{.20)}$) were obtained from nearby USGS gauging stations for the two modeled time periods. The measured $Q_{.20}$ flows were in the range of 9 to 6,613 cubic feet per second (cfs) for May, and 5 to 1,072 cfs for September.

The model assumes a “worse case” situation where during a single year all acres proposed for weed treatment within each watershed would be treated by picloram at an application rate of one-half pound per acre per year. Picloram was used in the simulation as the target herbicide because it is the only chemical that has a “high risk quotient” for fish—a sensitive indicator of water quality. While the model results show that 2 of the 11 watersheds would exceed the “safety factor” for picloram toxicity to fish, picloram would not actually be used in or near water, and weed infested acres would not all be treated with herbicides within a single year. Also, for Alternative B, only 30-40 percent of the weed infested acres would likely be treated with herbicides, and again, treatments would be spread out over the next 5 to 10 years.

In implementing the alternatives as proposed, the amount of herbicide and acreage treated with herbicides would not be allowed to exceed the thresholds determined by this model. Therefore, implementing any of the alternatives would have a very low risk of adversely impacting water quality. This low risk of adverse impacts applies to all surface water, wetlands and flood plains, including stream reaches identified as impaired in the State's 303(d) report.

Adverse impacts on ground water from herbicides are also not expected primarily because of the depth to ground water in much of the project area (greater than 50 feet), the attenuation and degradation factors previously listed, and the mitigation measures outlined in Chapter 2. Shallow ground water occurs in most valley bottoms in alluvial deposits, especially in May-June when streamflows are highest. In areas of wetlands, flood plains, and near streams, the mitigation measures in Chapter 2 would prevent adverse impacts on ground water from herbicide application in these areas. The primary mitigation measure that addresses ground water is: herbicide treatment areas that may be near water or have a high water table will be field checked to verify GIS data. If applying herbicides within 25 feet of a water body, or within a riparian area or other areas with a shallow water table, the herbicide must be specifically approved for application near water or in areas having shallow water tables (not picloram).

Sediment Impacts: If relatively large areas of weeds die rapidly from herbicides, mechanical methods, or burning, short-term increases in erosion and sedimentation may result until replacement vegetation is established. Due to the limited and widely scattered acreage proposed for treatment compared to total drainage areas, however, increases in runoff or sediment are expected to be too small to measure. In addition, most of the weeds occur on gentle terrain along roads, trails and in valley bottoms, which have lower runoff rates compared to steep slopes. The Forest Plan standards plus mitigation measures described in Chapter 2 include rapid revegetation of areas subject to excessive erosion or sedimentation. Restoration of ground cover vegetation that would minimize erosion would typically be expected within the first growing season. Seeding, mulching, planting and other cultural methods to restore ground vegetation would be used where needed to ensure that appropriate ground cover is rapidly reestablished. Vehicle and foot traffic during treatment activities would be limited in extent and magnitude and, therefore, not likely to increase erosion and sedimentation. No new roads or trails would be constructed and overall ground disturbance from project activities would be negligible.

The proposed Forest Plan amendment would allow herbicides to be used when city officials concur with the proposed treatment prescription and mitigation measures to be implemented. Herbicide treatments currently applied by other agencies and environmental organizations in the lower watershed portions outside the national forest boundary would become more effective since weeds would be less likely to spread from the upper to lower watershed sections. Allowing the use of herbicides would likely result in effectively eradicating or minimizing spread of salt cedar, Siberian elm, Russian olive and other weed species in the municipal watersheds, which would contribute to improving water quality and quantity in the long term. The amendment would not change the Forest Plan standard that limits herbicide use to "areas where the chemicals will not violate State water quality standards."

Alternative C (No Herbicides)

Alternative C utilizes nonchemical treatment methods that would also have a low risk of adversely impacting water resources because they would involve only short-term, low magnitude ground-disturbing activities that would occur in widely dispersed sites on the Forests.

Compared to Alternative B, this alternative would result in an additional 50-60 percent of the weed treatment acreage subject to somewhat greater ground disturbance. Reliance on these treatment methods would increase soil erosion and sedimentation because of the amount of burning, digging, pulling, mowing, grazing, etc. Because these methods are generally less effective than integrated methods that include herbicides, a higher frequency of repeat treatments would occur on the same sites. However, for the reasons described in Alternatives B and D, these disturbances would be relatively minor, especially within the context of treating 500-1,500 acres per year scattered over a 3-million-acre project area.

The nonherbicide methods would be particularly difficult in controlling common species of weeds such as knapweeds and Canada thistle. If weeds are not controlled using nonherbicide methods, effects would be similar to Alternative A (no action). In those areas, weeds would continue to reduce native ground cover and increase the amount of erosion and runoff.

Alternative C would avoid the additional chemical loading to the environment from herbicide application. This would also avoid the risk of adverse effects on water resources from herbicides. This difference is small because the additional chemical loading associated with Alternatives B and D is small, especially considering the limitation on the amount of herbicide application that may be used within each watershed.

Cumulative Effects

The analysis area for cumulative effects on water resources is the area in and immediately adjacent to the two forests. This boundary represents the portions of the watersheds where the actions proposed in this project are most likely to interact with other activities, in particular the weed treatments on both forest and other lands (private, State, BLM, etc).

Direct and indirect effects estimated to occur from this project include an insignificant increase in ground disturbance and sediment transport. Nearly all other ongoing and foreseeable future activities on the Forests would continue to contribute to erosion and sediment, including vegetation and fuel management projects, road maintenance or reconstruction, wildland fires, livestock grazing, and all recreational uses (see cumulative actions listed at the beginning of this chapter).

Other activities on the Forests that contribute to the spread of weeds would combine cumulatively with the effects of Alternative A (no action), and together would increase the loss of desirable plant species and biological diversity, which in turn results in increasing surface water runoff, erosion, and sedimentation in affected watersheds. Also, as weed infestations become more severe throughout the forest, more intensive and extensive herbicide applications (probably with aerial methods) would likely be required to control later stages of weed growth.

Herbicide application conducted by adjacent landowners and agencies would cumulatively result in minor and short-term herbicide loading to the environment. The additional acres add a small amount that would not exceed EPA standards (refer to Appendix 1 for a list of past, ongoing and foreseeable future weed control treatments in northern New Mexico).

Considering these additional impacts from other land use activities in or near the Forests, overall water quality and quantity goals for the Forest Plan would be met.

Soil Resources

Affected Environment

Soil landscapes on the Forests can be subdivided into three provinces with distinct soil assemblages: Colorado Plateau Semi-Desert, Southern Rocky Mountain Steppe, and Southwest Plateau Provinces (Bailey, 1995). The Rocky Mountain Steppe assemblage dominates the north-central region of New Mexico, the Colorado Plateau dominates the southern and western areas, and the Southwest Plateau occurs primarily in the Pecos-Canadian Plains and Valleys in the eastern part of the State. Specific soils associated with each assemblage on the Forests are described as follows.

- **Colorado Plateau Province:** Immature soils that lack vertical development of horizons occur along the flood plains of major streams. Soils having shallow development and limited humus addition from vegetation cover plateau tops, older terraces, and alluvial fans. Because of limited rain and high temperatures, soil water tends to migrate in these soils in an upward direction. This condition causes the deposition of salts carried by water at or near ground surface because of evaporation. These properties give soils in this assemblage a tendency to contribute to high runoff rates.
- **Rocky Mountain Steppe Province:** Soils in the montane zone tend to exhibit relatively high base saturation and range from soils with thick, dark surface horizons that are high in organic matter to those with relatively little organic matter. These soils tend to allow higher infiltration during storm events. In the foothill zone, there is a tendency toward poor and shallow soil horizon development with limited humus additions from vegetation. Because of limited rain and high temperatures, soil water tends to migrate in these soils in an upward direction. This condition causes the deposition of salts carried by water at or near ground surface because of evaporation. Areas above timberline or on steep slopes show evidence of the beginning of weathering processes on parent material. Soils include areas of young, poorly developed soils similar to those found in arctic tundra environments, and relatively recent deposits of stream alluvium.
- **Southwest Plateau Province**: Most soils in this province are relatively low in organic matter, but contain distinct developed soil horizons. Some exhibit an accumulation of clay in the subsurface. Many are calcareous and have a notable carbonate accumulation layer. Some soils are high in soluble salts, but generally are well drained and moderately fine textured to moderately coarse textured. Many soils in this group are classified as having intermediate potential for transport of herbicide to surface water.

Major factors in soil formation include type of parent material, climate, overlying vegetation, topography or slope, and time. Type of parent material influences the soil pH, structure, color, etc. High rainfall climates tend to have more acidic and less fertile soils, due to leaching of nutrients to lower levels of the soil profile. Low rainfall climates tend to accumulate salts near the surface and have generally higher soil pH. Soils that form under coniferous forests tend to be more acidic than those under deciduous forests, and root action is also critical in soil formation. Soils generally have a harder time forming on steep slopes, due to runoff of soil particles during rain events. The longer a soil has to form, the deeper its profile will be.

Information about soil conditions on the Forests was determined using Forest Service Geographic Information System (GIS) and Terrestrial Ecosystem Surveys (USDA FS 1987c and USDA FS

1993). This information includes soil type, texture class, mineral class, soil depth class, rock fragments, slope, and soil development class. Based on consideration of these soil conditions, it was concluded that soil development class established according to soil type sufficiently characterized soil conditions for the purposes of this analysis. Two other key soil properties in the Terrestrial Ecosystem Surveys influence the expected impacts: the soil erosion hazard rating and revegetation potential.

Figure 10 shows the soils mapped according to erosion hazard rating, and Figure 11 shows soils by revegetation potential rating. Tables 33 through 40 show the respective treatments as described by these soil properties.

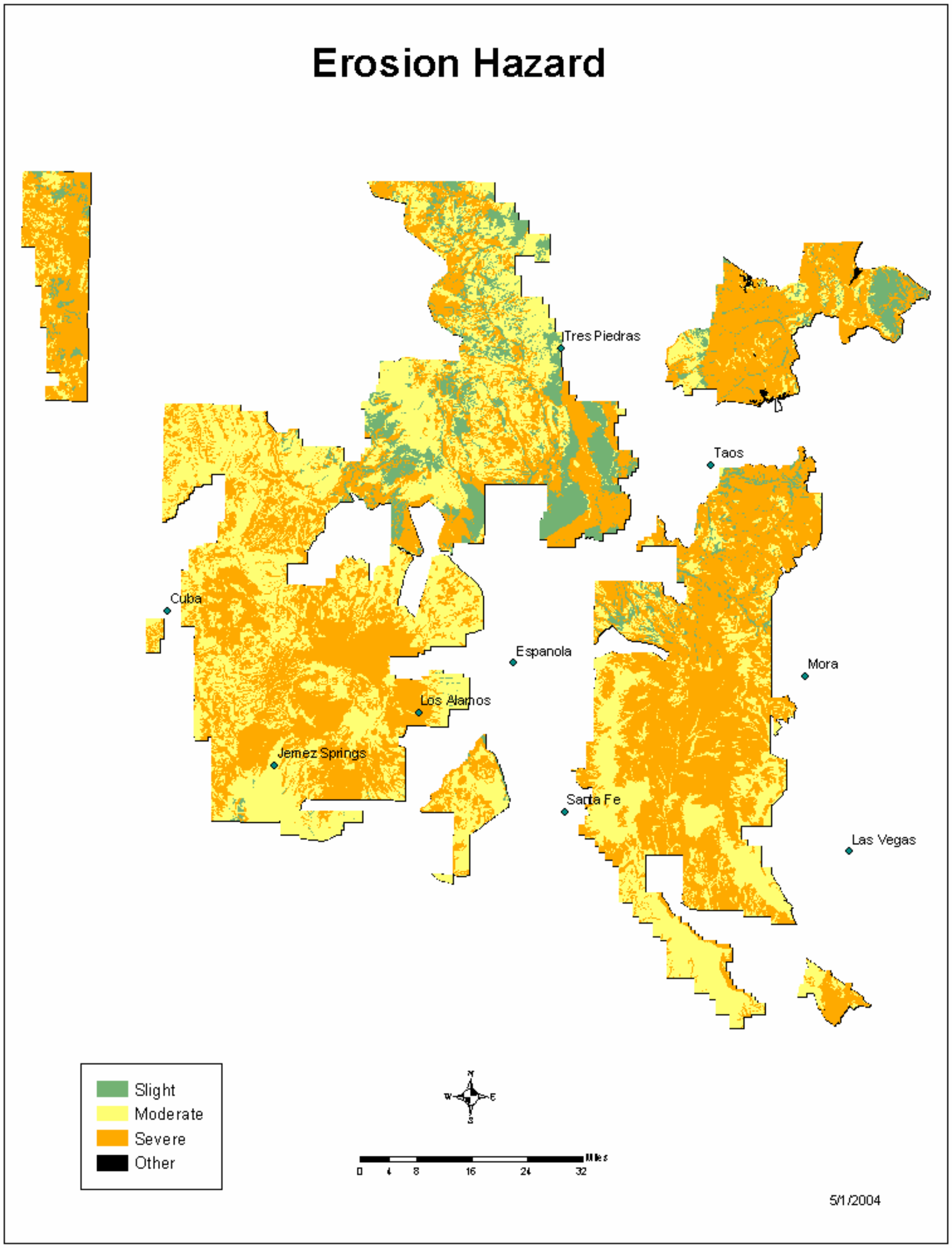


Figure 10. Soil Erosion Hazard

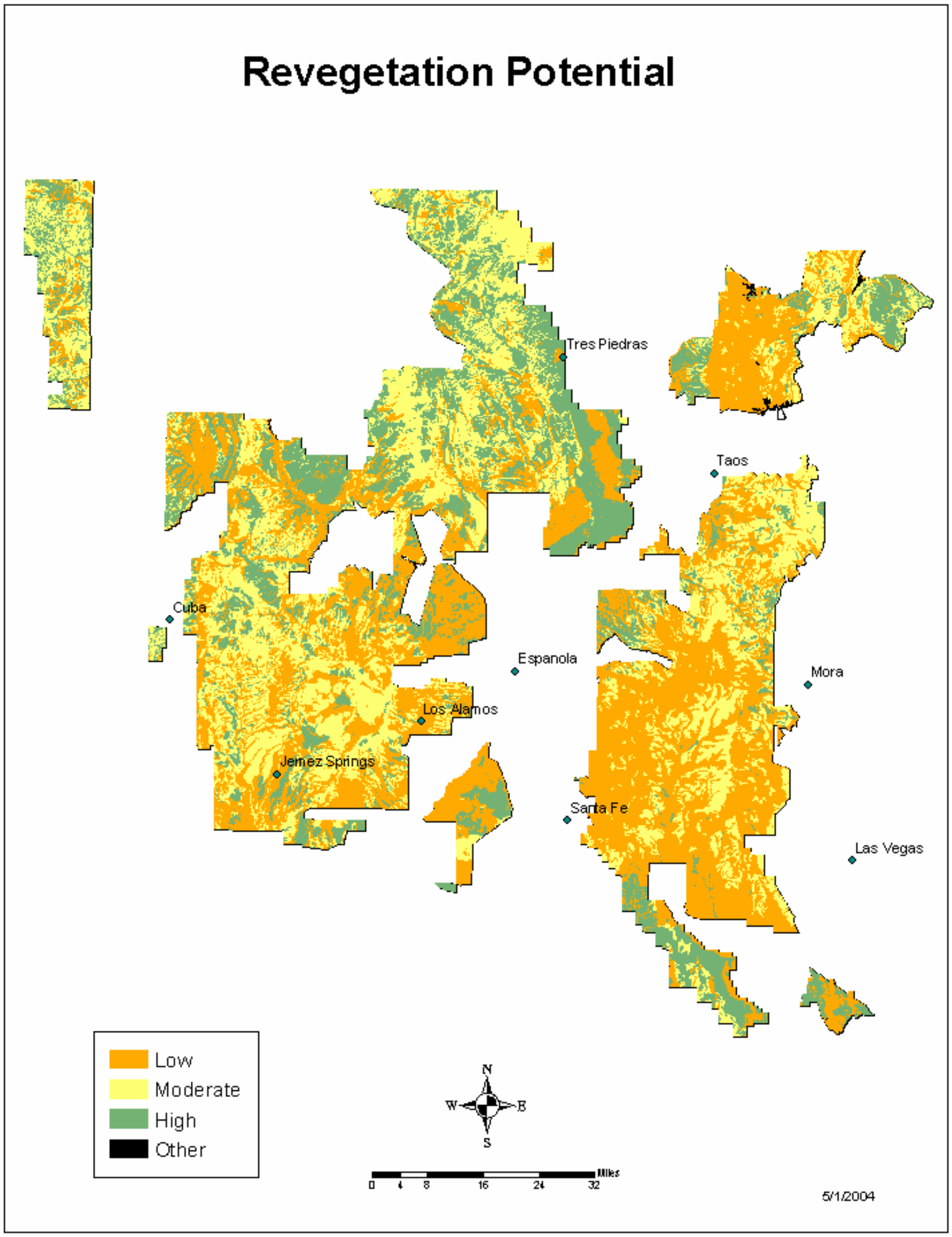


Figure 11. Soil Revegetation Potential

Environmental Consequences

Alternative A (No Action)

Without the proposed weed control treatments, weeds would continue to spread where they occur and potentially invade other areas. Weeds would continue to affect soil because they can out-compete native species for water and nutrient resources in the soil (Olson 1999). Broadleaf weeds often produce deeper taproot systems and less canopy cover compared to the native species that they displace (DiTomaso 1999). Weeds often reduce organic matter and microbial biomass production such that weed-infested soils support smaller populations of microorganisms than noninfested soil (Brady and Weil 1999). In addition, weeds have high nutrient uptake rates and can deplete soil nutrients to very low levels (Olson 1999). Weeds would continue to reduce water infiltration to the soil and increase surface runoff and sediment production because weeds have lower canopy cover and allow crusting of exposed soil (Lacey et al. 1989; DiTomaso 1999; Olson 1999). With less cover than native species, weeds are less able to dissipate the kinetic energy of rainfall, overland flow, and wind that cause soil erosion (Torri and Borselli 2000; Fryrear 2000). Tap-rooted weeds can reduce infiltration because they do not have the dense, fine root system of grasses. Due to these physiologic and morphologic differences, the uncontrolled expansion of weed infestations can have long-term and cumulatively adverse effects on soil properties, productivity, and overall soil quality.

Table 33. Acres Treated by Soil Erosion Hazard Rating

Erosion Class	Alt. B	Alt. C	Alt. D
Slight	1,153	1,153	1,107
Moderate	4,112	4,113	2,623
Severe	2,077	2,077	1,704
Totals	**7,342**	**7,342**	**5,434**

Table 34. Acres Treated by Severe Soil Erosion Hazard Rating

Treatment	Alt. B	Alt. C	Alt. D
Biological-grazing	0	0	0
Biological	28	79	0
Biological: Jemez RD	311	311	0
Prescribed fire	0	765	0
Prescribed Fire-mechanical	9	9	0
Herbicide	1,154	0	1,704
Herbicide-grazing	6	0	0
Manual	13	392	0
Manual-grazing	10	15	0
Manual-herbicide	469	0	0
Manual-mechanical	0	154	0
Mechanical	23	348	0
Mechanical-biological-grazing	4	4	0
Mechanical-herbicide	50	0	0
Totals	**2,077**	**2,077**	**1,704**

Table 35. Acres Treated by Moderate Soil Erosion Hazard Rating

Treatment	Alt. B	Alt. C	Alt. D
Biological-grazing	16	16	0
Biological	95	164	0
Biological: Jemez RD	1,459	1,459	0
Prescribed fire	0	1,283	
Herbicide	2,349	0	2,623
Herbicide-grazing	21	0	0
Manual	28	171	0
Manual-grazing	48	69	0
Manual-herbicide	59	0	0
Manual-mechanical	0	12	0
Mechanical	1	931	0
Mechanical-biological-grazing	8	8	0
Mechanical-herbicide	28	0	0
Totals	**4,112**	**4,113**	**2,623**

Table 36. Acres Treated by Slight Soil Erosion Hazard Rating

Treatment	Alt. B	Alt. C	Alt. D
Biological-grazing	18	17	0
Biological	12	12	0
Prescribed fire-mechanical	73	73	0
Herbicide	4	0	1,107
Herbicide-grazing	10	0	0
Manual	2	976	0
Manual-grazing	33	43	0
Manual-herbicide	955	0	0
Manual-mechanical		24	0
Mechanical		4	0
Mechanical-biological-grazing	2	4	0
Mechanical-herbicide	44		0
Totals	**1,153**	**1,153**	**1,107**

Table 37. Acres Treated by Revegetation Potential

Revegetation Class	Alt. B	Alt. C	Alt. D
Low	2,307	2,310	1,288
Moderate	2,542	2,549	1,706
High	2,488	2,489	2,437
Totals	**7,337**	**7,348**	**5,431**

Table 38. Acres Treated by Low Revegetation Potential

Treatment	Alt. B	Alt. C	Alt. D
Biological-grazing	2	2	0
Biological	119	207	0
Biological: Jemez RD	968	968	0
Prescribed fire	0	559	0
Prescribed fire-mechanical	4	4	0
Herbicide	1,008	0	1,288
Herbicide-grazing	26	0	0
Manual	27	152	0
Manual-grazing	15	41	0
Manual-herbicide	77	0	0
Manual-mechanical	0	40	0
Mechanical	1	336	0
Mechanical-biological-grazing	0	1	0
Mechanical- herbicide	60	0	0
Totals	**2,307**	**2,310**	**1,288**

Table 39. Acres Treated by Moderate Revegetation Potential

Treatment	Alt. B	Alt. C	Alt. D
Biological-grazing	12	12	0
Biological	6	6	0
Biological: Jemez RD	802	802	0
Prescribed fire	0	1038	0
Prescribed fire-mechanical	6	6	0
Herbicide	1,377	0	1,706
Manual	6	368	0
Manual-herbicide	296	0	0
Manual-mechanical	0	20	0
Mechanical	0	285	0
Mechanical-biological-grazing	3	3	0
Mechanical-herbicide	34	0	0
Totals	**2,542**	**2,549**	**1,706**

Table 40. Acres Treated by High Revegetation Potential

Treatment	Alt. B	Alt. C	Alt. D
Biological-grazing	21	19	0
Biological	10	43	0
Prescribed fire	0	447	0
Prescribed fire-mechanical	71	71	0
Herbicide	1,120	0	2,437
Herbicide-grazing	10	0	0

Treatment	Alt. B	Alt. C	Alt. D
Manual	10	1,020	0
Manual-grazing	75	86	0
Manual-herbicide	1,110	0	0
Manual-mechanical	0	130	0
Mechanical	23	662	0
Mechanical-biological-grazing	10	11	0
Mechanical- herbicide	28	0	0
Totals	**2,488**	**2,489**	**2,437**

Alternative B (Proposed Action)

Data indicate that herbicides can affect diversity and relative biomass of individual species of soil microorganisms. Exposure to herbicides can influence soil microbial populations (Forlani et al. 1995, Ka et al. 1995; Wardle and Parkinson 1991). It is likely that a temporary shift in the soil microbial community would occur immediately following herbicide applications. Presumably, this is caused by microorganisms that are resistant or adapted to utilize the herbicide as an energy source, allowing them to gain a competitive advantage over nonadapted microorganisms.

However, other researchers found that herbicide additions had no effect on soil bacteria, nematodes, or collembola beyond what could be expected due to the associated reduction in ground cover (Wardle et al. 2001). Clearly, the complex interactions between soil biota, environment, and herbicide type make predictions of impacts on soil biota difficult.

While herbicide exposure can influence the diversity of soil microorganisms, the reported data indicate that this influence is transient as long as adequate time is allowed for the soil community to rebound between exposures. Brady and Weil (1999) report that negative effects of most pesticides on soil microorganisms are temporary and populations generally recover after a few days or weeks.

Considering this short recovery time, the soil microbial community is expected to return to pre-herbicide levels within a year of herbicide application under the proposed schedule. Even in the presence of more highly persistent herbicides, microbial populations are expected to rebound in the short term (1 to 3 years after treatment begins) once the herbicide application program enters the maintenance mode and applications occur less frequently. Additionally, only a relatively small portion (600 to 1,600 acres) of the 3-million-acre project area would be treated for weeds each year.

Certain herbicides, such as glyphosate and dicamba, have been observed to cause weight reductions or mortality in earthworms. Surviving earthworms would be expected to recover, but the population may be decreased after each herbicide application. Soils with reduced earthworm populations would exhibit reduced water infiltration, nutrient cycling, and fewer stable soil aggregates compared to similar soils with greater earthworm populations (Brady and Weil 1999). In areas where earthworms are susceptible to the type of herbicide applied, the population may remain suppressed until application ceases. A study of the effects of herbicide on soil arthropods found that no significant change in the arthropod population occurred due to herbicide exposure (Fuhlendorf 2001). The arthropod population was extremely variable from year to year regardless of herbicide application.

Surfactants may be used to increase the efficiency of herbicides. Limited data are available for use in predicting the effects of surfactants on soil quality. Oakes and Pollak (1999) found that the surfactant used in Tordon-75D caused damage to submitochondrial particles when applied in the presence or absence of the remaining ingredients of the herbicide. This indicates that damage to eucaryotic soil organisms would occur. However, in this case, it is presumed that the damage would be limited to that described above for herbicide effects on soil biota. It is unknown whether surfactants added to herbicides would cause additional impacts on soil quality beyond those already discussed for herbicides.

Overall in the long term, herbicide applications would improve soil quality by controlling weeds and minimizing the negative effects of weeds (Lacey et al., 1989; Olson, 1999; Olson and Kelsey, 1997).

The foot traffic, off-road vehicles and other ground disturbance associated with Alternative B would expose soil to minor amounts of compaction and erosion in small, localized treatment sites. Some soil disturbance would occur on soils with a severe soil erosion rating. Treatments on soils having a severe erosion hazard rating include approximately 1,150 acres of herbicide methods, 470 acres of manual-herbicide methods, and 80 acres of mechanical-herbicide methods.

A short-term increase in soil erosion would occur from ground-disturbing control methods where weeds are eradicated until native vegetation becomes established. Most of the known weed infestations lie near roads, camping sites, trails and other areas with a pre-existing level of soil disturbance. These weed infestation areas are also currently experiencing increased erosion and soil degradation as a result of weed infestation, so any additional increase in erosion resulting from weed removal should be inconsequential and would cease once native vegetation is established. The common presence of loam or sandy loam soils with rock fragments would also help minimize erosion and promote reestablishment of native vegetation. Mitigation measures prohibit the use of heavy equipment such as mowers or mechanized diggers, as well as off-road vehicles, on slopes over 40 percent which further reduces the potential for excess erosion to occur.

The mitigation measure and best management practice that requires revegetation of bare soil where needed following weed control treatments, would contribute to ensuring long-term soil productivity goals are met. Revegetating with mulch or seeds after weed control treatment would most likely occur on less than 1,000 acres of soils proposed for herbicide treatment on soils with a low revegetation potential. Where revegetation potential is moderate or high, there is an increase in the ability to reestablish and maintain the desired native plant communities.

The magnitude of soil disturbance impacts would be limited to the treatment area and duration would be limited to the recovery period (typically ranging from a few months to a year). Erosion rates would not exceed tolerance threshold levels established in the Forest Plans (USDA FS 1986, 1987). The Santa Fe National Forest Plan (USDA FS 1987) requires the forest to be within tolerance for soil loss rates within 2 years. The Santa Fe National Forest Plan (USDA FS 1987) shows the expected annual soil loss as 20,000 to 24,000 tons per year, with about 3,500 tons per year being from natural erosion. The tolerance limit for the Forest is 6,670,500 tons per year.

In summary, these soil disturbances or impacts would not be considered detrimental when considered together with the beneficial, long-term improvements in soil quality and productivity in areas where weeds are treated and native vegetative cover is reestablished. The nonherbicide treatment methods would likely not be as effective as herbicide application in eradicating weeds and, therefore, may require more repeat treatments.

The proposed Santa Fe National Forest Plan amendment would slightly modify the soil resource standards and guidelines. This alternative would eliminate the prohibition on using herbicides on soils with a low revegetation potential, since it would be counterproductive to meeting the purpose and need for this project and is not necessary in order to adequately protect soil resources. The proposed amendment would instead allow herbicide use on any soil type "provided that effective ground cover is quickly restored and soil erosion on that site is not reduced to below the tolerance level identified in the Terrestrial Ecosystem Survey for the affected soil unit." The amended language would not be expected to result in adverse impacts to soil qualities or long-term productivity when vegetation management projects such as this are implemented. The proposed amendment also deletes a very outdated standard that prohibits herbicides on soils with low cation exchange capacity. Cation exchange capacity is not a measure used by the Forest Service and is, therefore, not appropriate as a criterion for vegetation management activities. Deleting that sentence in the Forest Plan would not be expected to result in an impact to soil resources when vegetation management projects such as this are implemented.

Alternative C (No Herbicide)

As herbicides would not be used, this alternative would not result in any of the minor, short-term effects of herbicides on the soil microbial community that were described for Alternative B. This benefit to soil quality, however, would be minor compared to the positive effects to soil from more promptly reducing weed infestations using herbicides.

Since Alternative C involves more digging, mowing, burning, grazing and other nonherbicide treatment methods, and more repeated treatments on the same sites, more soil disturbance would result. In Alternative C, approximately 1,700 acres of mechanical, manual, burning and grazing treatments would be applied on soils with severe erosion hazard rating. Repeated treatments would continue to disturb the site and would extend the duration of time that these soils are vulnerable to erosion. However, the short-term effect on soil quality would be countered in the long term by the benefit of curtailing the ongoing spread of weed populations across the Forests. Desirable vegetation would have the chance to re-establish, thereby protecting against erosion. Mitigation measures that require revegetation by seeding or mulching where needed to prevent excess erosion would minimize the minor, short-term increases in erosion expected under this alternative, even on soil with low revegetation potential.

Because Alternative C would not eradicate or successfully control weeds across the Forests as quickly as the other action alternatives, weed populations would continue to spread and create a large impact to soils. In those areas, adverse effects on soil properties and quality would be similar to that described under Alternative A, although on fewer acres. These effects include reduced organic matter and microorganism populations, depleted soil nutrients, reduced water infiltration capacity, and increased evaporation.

Alternative D (Herbicide Only)

The effects of herbicides would be virtually the same as described for Alternative B, in terms of the low magnitude, short duration impacts on soil microorganisms and earthworms. There would be a much more significant beneficial effect from using herbicides to control and eradicate weeds in improving long-term soil quality and productivity.

As described for Alternative B, application of herbicides from ground-based vehicles has the potential to have minor soil disturbing or compacting effects. While 1,700 acres of treatment would be on soils with severe erosion hazard rating, a small portion of those acres would involve off-road-vehicle use that has the most effect on soil disturbance. Herbicide application conducted by personnel with backpack sprayers or from vehicles on existing roads would not noticeably increase soil disturbance. Native vegetation and other ground cover is expected to become established even on sites with low revegetation potential using the mitigation measures described for Alternative B in Chapter 2. Other effects would be similar to those described for Alternative D, erosion rates would be within “tolerance rates” for the Forests and long-term soil productivity would be maintained.

In considering potential effects of the proposed amendment to the Santa Fe National Forest Plan regarding herbicide use under specific soil conditions, there would be no impact to soil resources expected (as described for Alternative B).

Cumulative Effects

The analysis area for cumulative effects on soil resources is the area in and immediately adjacent to the two forests. This boundary represents the areas where the actions proposed in this project are most likely to interact with other activities, in particular the weed treatments and ground disturbance on both forests and other lands (private, State, BLM, etc).

Past, present and foreseeable future actions that may have cumulative effects on soil are listed in the beginning of this chapter and include grazing, recreational uses, wildfire, and other vegetation altering activities. These actions may have a cumulative effect on soil erosion, compaction, or other indicators that define soil quality and provide for the spread of weeds.

Activities that contribute to the spread of weeds would add to effects of Alternative A (No Action), which would add to the reduction in soil quality caused by weeds. Soil degradation would increase commensurate with the amount of weed spread. For the short term, these additive effects would not cause a large-scale loss of soil productivity. Over the long term, as weed infestations become more dominant, loss of soil productivity would become evident.

All activities and land uses on the forest contribute to soil disturbance and some level of erosion. Those activities would add to the minor, short-term increases in erosion associated with the action alternatives. Because land management activities are controlled and mitigated to avoid excessive rates of erosion and maintain soil productivity, cumulative effects of weed treatments with these other activities is expected to be negligible. Cumulatively, soil erosion rates should remain within tolerance thresholds established in the Forest Plans and would not impair long-term soil productivity.

In addition, most ongoing and foreseeable future activities have objectives aimed at enhancing and restoring ecosystem functionality and healthy water and soil conditions. Many recent projects have successfully improved soil productivity. These projects include road decommissioning and closures, reduced grazing in riparian areas, reduced motorized use, and reduced camping in riparian areas. These would cumulatively combine with the long-term beneficial effects of the proposed weed treatment project in reducing soil erosion and sediment sources.

Cumulative effects on soil quality also would occur for Alternatives B and D from the herbicide loading added from other public agencies and private landowners in the area. Cumulative effects may occur to soil organisms from herbicide applications; however, these adverse impacts are expected to be short term and limited in extent to the treatment sites. Cumulatively, treatments would not affect soil organisms located away from treatments (on forest or off). Beneficial cumulative effects would occur for weed treatment areas where native vegetation communities increase and long-term soil qualities improve.

Ongoing weed control programs conducted by State and Federal highway authorities and others in the general area have very similar effects, contributing to cumulative effects. Off-road vehicles used for weed treatment in particular would add to soil compaction caused by off-road vehicles used in other recreational and land management activities throughout the Forests. The additional impact from this project would be undetectably small because off-road vehicles used for weed control would typically be a single pass through an area compared to the off-road vehicle trail creation that often results from recreational off-road-vehicle use.

Air Quality

Affected Environment

New Mexico and the Federal Government have established air quality standards for specific criteria air pollutants. The criteria pollutants are carbon monoxide (CO), lead (Pb), sulfur dioxide (SO_2), particulate matter smaller than 10 microns (PM_{10}), and particulate matter smaller than 2.5 microns ($PM_{2.5}$), ozone (O_3), and nitrogen dioxide (NO_2). Of those seven criteria pollutants, the pollutants of concern for this project are the particulate matter pollutants $PM_{2.5}$ and $PM10_{10}$.

Air quality in the project area is classified as attainment for all criteria pollutants. A "nonattainment" designation means that violations of standards have been documented in the region. The only nonattainment areas in New Mexico are the southern part of the State.

Table 41 lists Federal and State air quality standards.

Table 41. Ambient Air Quality Standards

Pollutant/Time-weighted Period	Federal Standard [1]		New Mexico Standard
	Primary [2]	Secondary[2]	
PM_{10}			
Annual Arithmetic Mean	50 µg/m^3	50 µg/m^3	(same as Federal)
24-hour Average	150 µg/m^3	150 µg/m^3	"
$PM_{2.5}$			
Annual Arithmetic Mean	15 µg/m^3	15 µg/m^3	"
24-hour Average	65 µg/m^3	65 µg/m^3	"
Sulfur Dioxide (SO_2)			
Annual Average	0.03 ppm	- -	0.02 ppm
24-hour average	0.014 ppm	- -	0.10 ppm
3-hour average	- -	0.50 ppm	- -
Carbon Monoxide (CO)			
8-hour average	9 ppm	- -	8.7 ppm
1-hour average	35 ppm	- -	13.1 ppm
Ozone (O_3)			
1-hour average	0.12 ppm	0.12 ppm	- -
8-hour average	0.08 ppm	0.08 ppm	- -
Nitrogen Dioxide (NO_2)			
Annual Average	0.053 ppm	0.053 ppm	
Annual Arithmetic Average	- -	- -	0.05 ppm
24-hour Average	- -	- -	0.10 ppm

Pollutant/Time-weighted Period	Federal Standard [1]		New Mexico Standard
	Primary [2]	Secondary[2]	
Lead (Pb)			
Quarterly Average	1.5 µg/m^3	1.5 µg/m3	- -
Total Suspended Particulate			
24-hour average	- -	- -	150 µg/m^3
7-day average	- -	- -	110 µg/m^3
30-day average	- -	- -	90 µg/m^3
Annual Geometric Mean	- -	- -	60 µg/m^3

[1] µg/m3 = micrograms per cubic meter; ppm = parts per million
[2] Primary standards are set at levels to protect human health; secondary standards are set to protect public welfare

Source: EPA NAAQS, State of New Mexico

Areas within and around the project area are a mix of designated Class I and Class II airshed areas as defined by the Federal Prevention of Significant Deterioration of Air Quality program. The Class II designation allows for moderate degradation of air quality within certain limits above baseline air quality. A Class I designation provides the most protection to pristine land, limiting the increment above baseline pollution levels. The standards are much stricter for Class I than Class II areas. Class I areas located near or within the project area include the Wheeler Peak Wilderness, Pecos Wilderness, and San Pedro Parks Wilderness, and Bandelier National Monument. Class II wilderness areas located in or near the project area are the Chama River Canyon Wilderness and Cruces Basin Wilderness.

Southwesterly winds typically blow across the mountainous region of northern New Mexico. Industry and power generation from as far away as California or as nearby as the Four Corners region contribute plume blight and haze. Temperatures vary from an average daily maximum of 86 ^{o}F in July in Jemez Springs to an average daily minimum of 3 ^{o}F in Dulce in January (data from Western Regional Climate Center).

Table 42 summarizes the range of $PM_{2.5}$ and PM_{10} pollutants found in or near the project area from 1993-2003, from the State's air quality monitoring data.

Table 42. Air Quality 1999-2003: PM_{10} PM_{25} Pollutants

Site	Annual Geometric Mean (µg/m3)	24-Hour High (µg/m3)	24-Hour 2nd High (µg/m3)
Runnels Building, Santa Fe	13-14	34-71	28-42
Fire Station Santiago Road, Taos	14-21	33-67	31-66
Runnels Building, Santa Fe	4.6-4.9	11-19	10-15

PM_{10} = Particulate Matter < 10 Microns; $PM_{2.5}$ = Particulate Matter < 2.5 Microns; µg/m3 = micrograms per cubic meter
Source: EPA Ambient Air Quality Data

There are many offsite sources (facilities) capable of impacting air quality over the project area, such as power plants and oil and gas operations in the Four Corners area, natural gas compressor stations and refineries in the San Juan Basin, mining operations in Taos, Santa Fe, and Rio Arriba

Counties, and other sources such as foundries and landfills (EPA National Emissions Inventory). Table 43 provides total particulate emissions from all sources in 1999 for selected northern New Mexico counties, from EPA National Emissions Inventory.

Table 43. Particulate Emissions in Northern New Mexico, 1999

County	PM_{10} (tons per year)	$PM_{2.5}$ (tons per year)
San Juan	74,689	16,637
Rio Arriba	47,103	8,073
Taos	34,474	5,838
Colfax	11,245	2,213
McKinley	63,970	10,829
Sandoval	33,954	6,103
Los Alamos	1,551	350
Santa Fe	53,292	9,037
Mora	8,200	1,496
San Miguel	20,767	3,783

Environmental Consequences

Alternative A (No Action)

Under the No Action Alternative, there would be no impact to air quality.

Alternative B (Proposed Action)

Gaseous emissions, including sulfur dioxide (SO_2), carbon monoxide (CO), oxides of nitrogen (NOx), and volatile organic compounds (VOCs), would result from combustion of fuel used to transport workers to and from project sites and during ground applications. The amount of gaseous exhaust emissions depends on size, age, and fuel efficiency of the engines. The amount of Hazardous Air Pollutants (HAPs) released during combustion of fossil fuels is very low and would pose no threat to health or the environment. Emissions from combustion of fossil fuels during vehicle applications would be insignificant.

Road dust would be generated from vehicle traffic on dirt roads during various weed treatment methods. Road dust during spraying activities would be limited due to relatively slow vehicle speeds necessary for herbicide application or other weed control treatments. Similarly, dust generated from mowing or root plowing would be limited due to relatively slow vehicle speeds.

During ground application, spray drift of herbicides is possible. This drift is not expected to produce any long term ambient air quality impacts. Spray drift is short term in nature and limited to areas immediately adjacent to the plant populations being sprayed. The quantity of herbicide released to the atmosphere would not be expected to have a long-term impact on air quality.

Prescribed burning would result in particulate matter (PM_{10} and $PM_{2.5}$) emissions in smoke. However, all prescribed burning must comply with the New Mexico smoke management system to maintain levels of emissions within standards, and burn permits are required prior to implementation of burning activities on the Forests.

Criteria pollutant emissions have been estimated for alternatives based on treatment activities presented in Chapter 2. Since impacts will be distributed across both forests and over time, concentrations of air contaminants will not accumulate to the point of violating air quality standards for any area. Air quality standards identified in the previous section would all be met.

Emissions were calculated based on the proposed treatments for each area, with the exception of the particulate emissions from vehicles. For vehicle treatment areas, vehicle miles were estimated based on assumed travel of 1/8 mile per acre. Road dust emissions were calculated using unpaved road emission equations in EPA AP-42, Section 13.2.2. Calculations are based on uncontrolled road dust emissions, assuming no road watering or chemical dust suppression. This overestimates the likelihood of dust emissions as road watering to suppress dust emissions is often employed during forest management activities. Smoke emissions from prescribed burning of weeds were calculated using EPA's AP-42 emission factors.

Table 44 summarizes total emissions for each alternative. The total estimated emissions are for the entire life of the project, estimated at approximately 10 years, not annual totals.

Table 44. Summary of Total Emissions by Alternative

Criteria Pollutant	Estimated Emissions (tons)			
	Alt. A	Alt. B	Alt. C	Alt. D
PM_{10}	0.00	0.54	5.1	0.18
$PM_{2.5}$	0.00	0.32	4.1	0.03

Note: PM_{10} = particulate matter smaller than 10 microns
$PM_{2.5}$ = particulate matter smaller than 2.5 microns

Visibility is one air quality related value that has been identified as being important for each of the three Class l areas. Visibility conditions are affected by scattering and absorption of light by particles and gases. Fine particles most responsible for visibility impairment are sulfates, nitrates, organic compounds, soot, and soil dust. Fine particles are more efficient per unit mass than coarse particles at scattering light (Malm 1999). Emissions previously described would be very short term and not expected to degrade visibility. Emission reduction techniques would be employed during burning to mitigate smoke impacts to visibility.

Alternative C (No Herbicide)

Implementation of Alternative C would result in potentially greater amounts of dust from mowing and root plowing, and more particulate emissions from prescribed burning than Alternatives B or D. This would result in a slight increase in PM_{10} and $PM_{2.5}$ from dust and smoke. Otherwise, effects would be similar to Alternative B. Because estimated emissions are low and these emissions would be distributed across the forest and over time, concentrations of air contaminants will not accumulate to the point of violating air quality standards for any area.

Alternative D (Herbicide Only)

Impacts on air resources from implementation of Alternative D would be similar to those under Alternative B, except less dust would be created and there would be no smoke emissions.

Cumulative Effects

Other activities and natural occurrences (such as wildfire) that occur at the same time as weed control activities and in the same general areas would add to the direct and indirect air quality effects described. Those activities include all prescribed burning activities, and offsite activities such as upwind industrial sources. The dispersion in the air and the small amount of emissions produced by treatments at any given time and place would result in no noticeable cumulative increases in emissions within the airshed, even when considered with other ongoing and foreseeable future activities.

Heritage Resources

Affected Environment

Introduction

The National Historic Preservation Act of 1966 (NHPA) and the Forests' plans provide the primary requirements applicable to situations where proposed management activities could potentially affect heritage resources on the Forests. Other applicable requirements come from the Archaeological Resources Protection Act, American Indian Religious Freedom Act, Executive Orders (11593, 13175 and 13287), and other laws, regulations and policies.

Under Section 106 of NHPA, the Forests are required to evaluate effects of proposed management activities to historic properties (archaeological sites and ethnographic resources including traditional cultural properties). The Forests must also follow Forest Plan standards and guidelines for protecting heritage resources and coordinating with Native American tribes.

This document analyzes proposed weed treatment activities in accordance with NEPA, and tiers to a programmatic agreement developed for this project to address applicable Section 106 NHPA process requirements. The programmatic agreement between the Forests, New Mexico State Historic Preservation Office (SHPO) and the Advisory Council on Historic Preservation specifies that heritage clearance and/or survey will be completed prior to implementation of weed treatments. The programmatic agreement specifies the process to be followed prior to implementation to identify historic properties, evaluate the significance of a property, evaluate the effects from site-specific activities, and identify ways to avoid or mitigate adverse effects to heritage resources. Tribal consultation requirements are also addressed in the programmatic agreement, as well as monitoring requirements. If adverse effects cannot be avoided, then the Forests would consult with the SHPO, the Advisory Council and interested parties and develop an appropriate mitigation plan.

Weed control methods such as manual and mechanized ground-disturbing treatments would need to follow the steps outlined in the agreement. Other methods, such as biological methods or direct hand application of herbicides to target weed species, were considered to have little or no effect on heritage resources and are exempt from further consideration under Section 106. The agreement is available in the project record.

The affected environment considered for this weed control project includes all areas containing heritage resources (archaeological and ethnographic resources) on the Forests, since new weed infestations may occur virtually anywhere on the Forests. However, the number of known heritage resource sites that overlap inventoried weed infestation sites is low.

Table 45 illustrates the number of known heritage sites intersected by currently inventoried weed infestations for three standardized site sizes. The point data are for the geographic center of the site and do not reflect site size but site location. For this analysis, however, each point is considered to represent one acre. The 50 meter data reflect standardized site size at a 50-meter radius (1.9 acres) and the 100-meter data at a 100-meter radius (7.8 acres). The standardized site sizes do not represent the full variability of actual site size but are intended to be illustrative of the potential for sites to be affected by weed treatments.

Table 45. Affected Heritage Resource Sites by Relative Site Size

Known Sites		Point Data		50-Meter Radius		100-Meter Radius	
Forest	Total Sites	No. of Sites Affected	Cumulative Size (acres)	No. of Sites Affected	Cumulative Size (acres)	No. of Sites Affected	Cumulative Size (acres)
Carson	4,156	13 (0.3%)	13	67 (1.6%)	127.3	187 (4.5%)	1,458.6
Santa Fe	7,965	63 (0.7%)	63	169 (2.1%)	321.1	480 (6.0%)	3,744.0
Total	**12,121**	**76 (0.6%)**	**76**	**236 (1.9%)**	**448.4**	**667 (5.5%)**	**5,202.6**

Heritage resource surveys have been conducted on approximately 150,000 acres (10 percent) of the 1.5-million-acre Carson National Forest, and 460,000 acres (30 percent) of the 1.6-million-acre Santa Fe National Forest. Approximately 4,200 heritage resource sites have been recorded on the Carson National Forest and 8,000 heritage resource sites have been recorded on the Santa Fe National Forest. It is estimated that the Forests have over 45,000 and 35,000 total heritage resource sites (respectively).

In general, the distribution of sites reflects the distribution of heritage resource survey, such that known sites that overlap inventoried weed infestations serve as an indicator of the extent of weeds within heritage resource sites. Since weeds have not been systematically inventoried and the distribution of heritage resource survey is a function of where projects have occurred, the existing sample of weed infestations compared to site distribution may not accurately reflect the true distribution of weeds across heritage resources.

Heritage resource site density across the Forests varies tremendously depending on a number of factors. Site density on the Carson National Forest averages approximately 18 sites per square mile. Site density on the Santa Fe National Forest may average 3 to 4 sites per square mile on the east side and 15 sites per square mile on the west side. Because of varying settlement factors, site density in ideal locations on either forest may be considerably higher. Some areas in the Jemez Mountains have a very high site density of 100 sites per square mile, and site density on the Jicarilla Ranger District can be comparable.

Heritage resource sites that may be affected by weed treatment activities fall broadly into two categories: (1) archaeological, and (2) ethnographic resources (including traditional cultural properties). These resources are described in the following two sections.

Archaeological Resources

Archaeological resources are generally defined as the nonrenewable evidence of human occupation or activity (as indicated by sites, buildings, structures, artifacts, ruins, objects, works of art, petroglyphs/pictographs, architecture, or natural features) that were important in human history at the State, local, or national level. Archaeological resources consist of the material remains of human activities on the Forests, including prehistoric and historic sites. Generally, prehistoric sites include those dating to prior to the entrance of European populations in the area; prior to A.D. 1541. Historic sites include those dating after European contact from A.D. 1541 up to modern times, that are 50 years or older. The Forests have a long history of human use. Site types are diverse across both forests and include, but are not limited to, small artifact scatters, agricultural fields, pit houses, field houses, quarry and other resource procurement sites, pueblos, historic cabins, logging camps, homesteads, and mines. Historic sites range from the Spanish exploration period, through the Pueblo Revolt, Spanish Colonial, Mexican, and American periods, representing a wide variety of activities that include logging, mining, ranching, exploration, trade, railroading, and homesteading.

Archaeological sites occur in moderate to high site densities across the western portion of the Santa Fe National Forest. For the Carson National Forest, sites commonly occur along river corridors and on the Jicarilla Ranger District at lower elevations. Archaeological sites are sometimes visible due to having weeds growing on the site, since many disturbance species thrive on soils that have been modified by human occupation and use. Artifact scatters and architectural remains often appear as ruined mounds covered with vegetation. At higher elevations, archaeological site visibility decreases due to an increase in vegetative cover. Sites at higher elevations tend to be of shorter use and leave fewer material remains, and so are often more difficult to recognize. There also tend to be fewer weed infestations at higher elevations.

In Table 45, the 50-meter and 100-meter buffers are more accurate approximations of acres of sites since sites generally have broader areas than what is reflected by the point data. In the case of the 50-meter buffer, approximately 450 acres of archaeological sites may be currently affected by weeds. At the 100-meter buffer, approximately 5,200 acres of sites are affected by weeds. Since the Forests' inventories of heritage resource sites and weeds are both incomplete, these numbers are used as approximations.

Both prehistoric and historic archaeological sites may exhibit surface characteristics with the potential to be affected by weed treatments. Perishable remains that could be affected include wood, paint, and other organic materials. In addition, sites may contain sources of information that could be potentially affected, such as datable remains, including wood for C_{14} dating, obsidian for hydration dating, intact thermal surfaces for archaeomagnetic dating, and residual materials on artifact and feature surfaces.

Ethnographic and Traditional Cultural Property Resources

Ethnographic and Traditional Cultural Property (TCP) resources include sites and resources generally associated with living communities that have traditional and long-standing ties to an area. These remains must meet the definition of a TCP in Bulletin 38 of the National Register Guidelines to be considered under the implementing regulations of Section 106 of NHPA. The Forests will consider other traditional or tribal concerns, especially if they fall within the purview of executive orders and other legislation. These may consist of physical remains such as shrines and material procurement areas, but they can also include areas of cultural importance such as communal or ceremonial locations without an obvious physical context.

On the Forests these types of sites are generally associated with areas traditionally used by Hispanic or land grant communities (Abiquiu, Penasco, and Coyote for example), pueblos (Cochiti, Hopi, Jemez, Nambe, Picuris, Pojoaque, San Ildefonso, San Juan, Santa Clara, Santo Domingo, Taos, and Tesuque, Zia and Zuni), and other tribal communities (Jicarilla Apache, Ute, Kiowa, Comanche and Navajo). Indian reservations adjacent to the Forests include the Cochiti, Jemez, Nambe, Pojoaque, San Ildefonso, San Juan, Santa Clara, Santo Domingo, Tesuque, Zia, Taos, Picuris, Southern Ute and Jicarilla Apache.

The Forests have a unique relationship with Federally recognized American Indian tribes, and other traditional communities. As Federal agencies undertake activities that may affect a tribe's rights, property interests, or trust resources, they carefully implement those activities in a manner that respects the tribe's sovereignty and resource needs. In addition, the NHPA requires an agency to evaluate effects to traditional cultural properties and practices within a project area.

There are no formal Indian Trust Assets on the Forests. However, the majority of the Forests cover traditional lands used by several tribes and other traditional communities. During consultation for this project, relevant concerns arose about the potential impacts from weed control treatments, such as: (1) potential loss of plant species that have a traditional, religious, or other use, and (2) potential health risks to those who collect herbicide-treated plants.

Native Americans and other groups use the Forests to collect plants and animals for food, medicine and religious ceremonies, clay for ceramics, minerals for ceramic paint, and wood for fuel and construction. Weed species proposed for treatment in the Forests do not appear to be those collected for traditional uses by Native American tribes located in the upper Rio Grande. However, Navajos traditionally use some of the weed species proposed for treatment, although individual species were not specifically identified (Begay 2000).

Recognition of traditionally used or sacred areas requires coordination with tribes and other traditional use groups. Places of elevation and line-of-sight connections are important in pueblo cosmology. The puebloan worldview includes specific places of traditional activity, considered to be historic properties. Similar concerns exist for other tribal communities that attach traditional and religious significance to parts of both forests. For Hispanic communities, areas of use in the Forests are tied to patterns of land tenure and land grant development. These areas continue to be used for ceremonial processions or gatherings.

Traditional cultural properties are often difficult to identify during standard heritage resource surveys, and none have been identified in the areas of potential affect during scoping and tribal consultation activities conducted to date for this project. Scoping and consultation for this project EIS was initiated in December of 2000, and an additional solicitation of comments was mailed to tribes in December of 2003, prior to release of the DEIS for public review.

Because the project can be designed to avoid direct impacts to archaeological sites, it is anticipated that all sites will be avoided by mechanical treatments. If sites cannot be avoided, or if human remains are found during project implementation, the tribes, SHPO, and the Advisory Council will be contacted, and mitigation measures will be developed.

Environmental Consequences

Alternative A (No Action)

If the proposed weed control project does not occur, there would be minimal, if any, impact to heritage resources. By not implementing proposed weed control actions, there would be no risk to heritage resource impacts from ground-disturbing activities.

All plant species are capable of disturbing soil stability and subsurface remains through invasive root growth. However, the effect of weed growth on the physical condition of sites has not been shown to be different than that of native plant growth.

Weeds would continue to spread and over time would likely reduce or endanger native plant species used traditionally. If weed removal is not implemented, then the Forests may be asked by traditional or tribal communities to eradicate weeds that threaten traditional use plants. If a weed is used traditionally, then no action may lead to enhanced growth and production of the plant, as well as use by the traditional community.

Alternative B (Proposed Action)

Heritage resources are nonrenewable resources easily damaged by ground-disturbing activities. Although some artifacts are susceptible to damage from heavy equipment use, ground disturbance, or burning, it is the provenience of artifacts and features, or their horizontal and vertical location in relation to each other and to the soil deposits that is most important. Disturbance or movement of features and artifacts in relationship to each other disturbs or destroys the context of the information inherent in the site.

Impacts from weed control activities could lessen the value of heritage resources by destroying important scientific data and diminishing the physical setting of sites. Heritage resources can be diminished by any change in their historical, architectural, archaeological, cultural character or ecological setting. Under the NHPA, an impact is considered significant if it results in an adverse effect to a heritage resource that is on or eligible for the National Register of Historic Places. An adverse effect would occur if a management activity alters the characteristics of a historic property that qualifies for inclusion on the National Register of Historic Places (NRHP).

Archaeological Resources: Mechanical, manual, grazing and burning treatments have the highest potential for ground disturbance to archaeological sites. Mechanical digging, mowing or tilling pose the greatest threat. Manually digging or pulling weeds could cause surface disturbance and displacement of buried archaeological materials. Sheep or goat grazing could cause trampling of artifacts and disturbance to features. Prescribed burning could affect sites with fire-sensitive materials.

Herbicides and surfactants used with herbicides could impact the analytical potential of perishable materials such as wood, ceramic paint, and datable materials, although these effects have not been studied and the overall effect is not likely to be adverse. In general, herbicides do not have the resident time of pesticides and would not affect the chemical structure of archaeological remains. Biological methods would not be expected to damage sites, wooden beams or historic structures, since these herbivorous insects have a high degree of target host specificity.

Removal of weeds by any method could expose bare soil and increase soil erosion for a short time (typically a year or less), which could cause minor disturbance or damage to archaeological site features.

While the adverse effects described for archaeological resources could potentially occur, there is a low risk of adverse impacts occurring. These effects would primarily be mitigated by avoidance of significant sites. Site-specific heritage resource survey and evaluation would be completed prior to implementing weed treatments (other than for exempt actions such as biological methods and hand application of herbicides). Sites would be identified for avoidance or other specific mitigation measures. The programmatic agreement requires forest archaeologists to ensure that effects to historic sites are mitigated to avoid adverse effects while meeting weed control objectives. For example, if burning is used, fuel loading would be reduced on sites with fire-sensitive materials.

If based on survey and evaluation it is predicted that adverse effects to archaeological resources cannot be avoided, the Forests would consult with the SHPO and other interested parties including tribes, concerning the steps to be taken to mitigate adverse effects. In addition, monitoring would be used to ensure that mitigation measures are followed and adequately protected heritage resources. If damage to an archaeological site is discovered during implementation, the activity would be immediately halted and SHPO notified about the resolution of adverse effects. These and other requirements to protect heritage resources are spelled out in the programmatic agreement previously described.

Ethnographic Resources: Effects on ethnographic resources including traditional cultural properties are difficult to estimate because traditional communities are sometimes unwilling to provide location data as well as information on the nature of impacts. In some instances the mere presence of Forest Service workers or contractors in the area of a traditional cultural property can be an effect. Mitigation measures to alleviate auditory, visual, or other impacts on traditional cultural places require continuing consultation with traditional communities and flexibility in implementation.

The habitat of traditional plants would be affected by weed control activities that occur in the same area. The timing of weed treatment would take into account the traditional cyclic calendar of local communities. This timing would be accounted for through mitigation measures that include notification of tribes before use of herbicides occurs. This would also reduce the risk to those who use certain plants for traditional/cultural purposes and to the health of Native Americans who gather these plants.

Drift or chemical odor from herbicide applications or noise and dust from mechanical treatments may cause short-term adverse effects on traditional or religious sites. Mitigation measures that would minimize this impact include: using methods that reduce herbicide spray drift, posting signs during treatment activities, using direct hand application of herbicides onto target plants (avoiding surrounding plants), and notifying tribes.

Those same mitigation measures would be expected to greatly limit the risk of adverse impact to plants that have cultural importance. While there may be short-term removal of important plants, measures require reestablishment of desired vegetation, which would compensate for the short-term reduction in the species, unless the treatment extirpates the plant species.

Mitigation measures would also be effective in avoiding impacts to fire sensitive areas of traditional concern if those areas are identified through additional consultation with traditional and tribal communities. A schedule of burning could be developed to reduce threats to traditionally used plant species or account for traditional practices in an area. For all treatment activities, monitoring will ensure that site treatment recommendations are followed and adequate to protect heritage resources.

Although effects to heritage resources associated with weed removal are estimated to be minor, they cannot be fully assessed until heritage resource survey and evaluation has been completed.

Alternative C (No Herbicide)

Under this alternative, the greater reliance on mechanical, manual, grazing, and burning methods would slightly increase the risk that archaeological sites would be damaged by ground-disturbing treatments. There would be no potential impacts from spraying herbicides under this no herbicide alternative. It eliminates the potential health risks to those who collect and use traditional plants. Otherwise, effects to both archaeological and ethnographic resources would be the same as described for Alternative B.

Alternative D (Herbicide Only)

Eliminating ground-disturbing weed control treatments (other than herbicide spraying using off-road vehicles) would reduce the risk of damage to archaeological sites. Effects from herbicides on the analytical potential of perishable materials such as wood, ceramic paint, datable materials, and residues on artifacts has not been studied, but the overall effect is not likely to be adverse. No other effects would occur from herbicide application. Since little is known about the effects of herbicides on archaeological sites, monitoring will be used to collect additional data on this treatment method.

Effects to ethnographic resources would be the same as those described for Alternatives B and C except this alternative would eliminate the noise, dust and visual impacts to traditional use areas associated with nonherbicide methods such as mechanical, grazing, or burning.

Cumulative Effects

Other past, ongoing and foreseeable future activities that could cumulatively impact heritage resources are listed in the beginning of this chapter and include: facility or road construction, maintenance, and use: thinning and prescribed burning projects, firewood harvest, livestock grazing and recreation activities. These activities all disturb plants and can impact both archaeological and ethnographic resources. Livestock grazing and recreation activities may have a higher risk of impact as they tend to occur in the same location over a long period of time.

When added to effects of all the other public use and management actions on the forest, which all contribute to a risk of inadvertent impacts to heritage resource sites, the minimal effects from proposed weed treatment activities would increase the long-term risk of damage to heritage resources. However, the effects from this weed control project would not substantially increase the level of impact from ongoing and future activities. Because site avoidance is the typical method used during most land management activities on the Forests, and because the proposed treatment acreage is small relative to the total acreage on the Forests, the cumulative effects would be inconsequential. The same is true for ethnographic and traditional use areas.

Recreation and Wilderness Resources

Affected Environment

Dispersed Recreation

The Forests support a large demand for dispersed recreation activities such as hiking, driving for pleasure, viewing scenery and wildlife, riding horses, riding motorcycles, gathering forest products, waterplay, snowmobiling, bicycling, camping and picnicking, cross-country skiing, backpacking, and photography. It also includes a diverse array of hunting and fishing opportunities, as well as wildlife viewing, photography, painting or drawing. Much of the dispersed recreational uses originates in the small villages around the forest perimeter and contributes significantly to their way of life. The Forests are also a major attraction to the nearby population centers of Albuquerque, Santa Fe, Los Alamos, Espanola, Taos, and Farmington, as well as to visitors from west Texas, Oklahoma, southern Colorado, and Kansas.

There are 1,002 miles of Forest Service system trails on the Santa Fe National Forest and 540 miles on the Carson, with over 50 percent in or adjacent to wilderness areas. The Carson National Forest also has 2,818 miles of system travel ways used as 4-wheel-drive roads for recreation, livestock trails, fire access routes, etc.

Three nationally designated scenic byways are located on the Forests: Enchanted Circle Scenic Byway, Jemez Mountain National Scenic Byway, and Santa Fe National Forest Scenic Byway.

Most of the dispersed recreation occurs along streams and around water bodies, as well as in wilderness and designated roadless recreation areas (see “Wilderness” subsection for more information on wilderness recreation). Camping and other recreational activities in undeveloped areas often result in removal of native vegetation and creation of disturbed soil conditions that are more susceptible to weed establishment. Horses and other pack animals frequently used for recreation tend to transport weeds, especially if hay and feed are brought in. Off-road-vehicle use is another common way for weed seeds to be spread throughout the forest.

Developed Recreation

Developed recreation facilities include campgrounds, picnic areas, trailheads, and other areas containing specialized recreation facilities that are planned to accommodate a fixed number of people at one time. Currently the Forests manage approximately 105 developed recreation sites.

Developed recreation facilities include campgrounds, picnic areas, trailheads, and other areas containing specialized recreation facilities that are planned to accommodate a fixed number of people at one time. On the Santa Fe National Forest, most weeds mapped in or near developed recreation sites are located along the Jemez River, where salt cedar, Russian olive and Siberian elm have overgrown fishing access sites and campgrounds. Although there are limited populations currently mapped within developed recreation sites, the potential for expansion into more sites is high because of weed populations along roads leading to recreation facilities on the two forests. The Carson National Forest has weeds—including bull thistle and Canada thistle—in the June Bug, Elephant Rock and Cebolla Mesa Campgrounds (Questa Ranger District), and Canada thistle at the Santa Barbara Campground (Camino Real Ranger District).

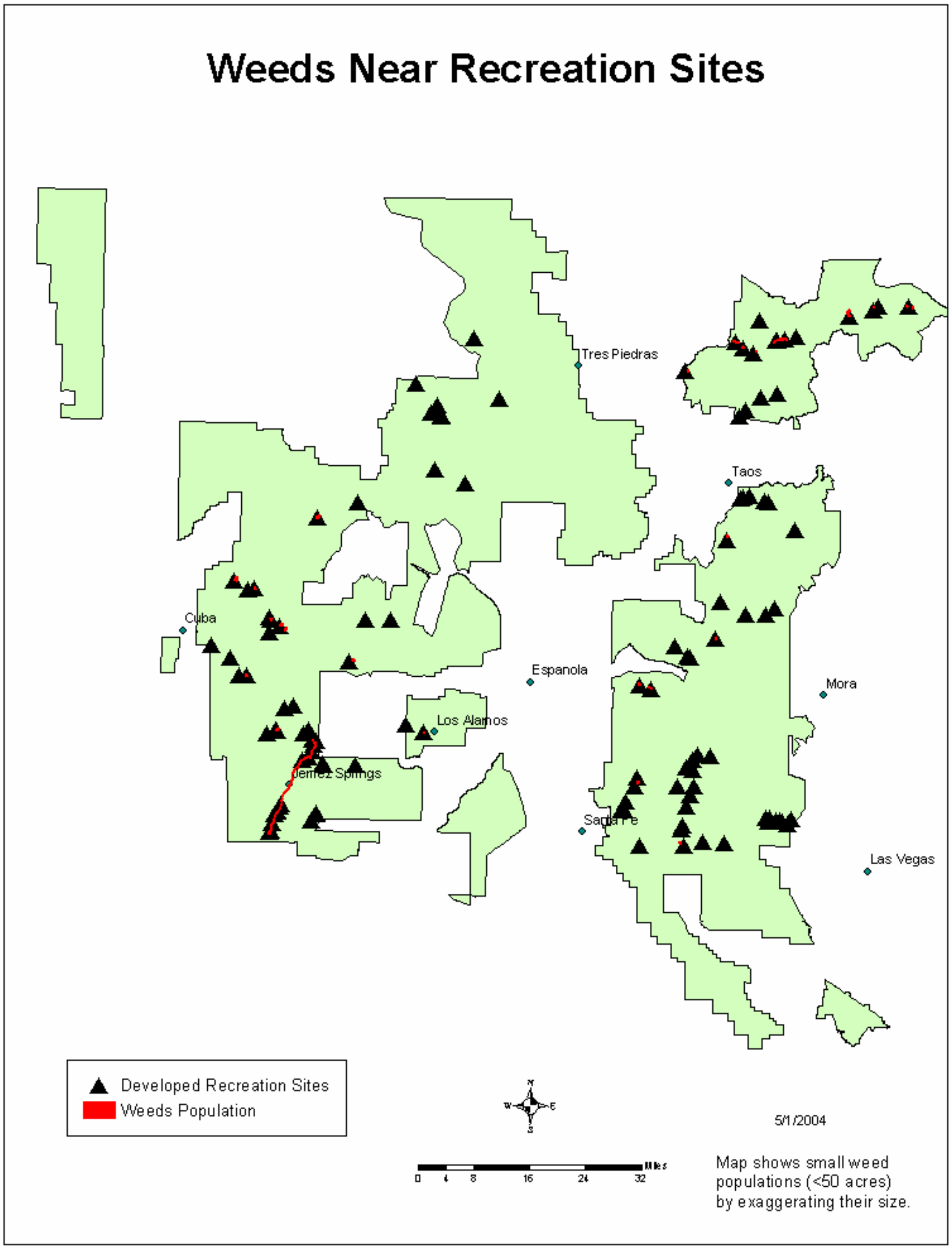


Figure 12. Weeds Near Recreation Sites

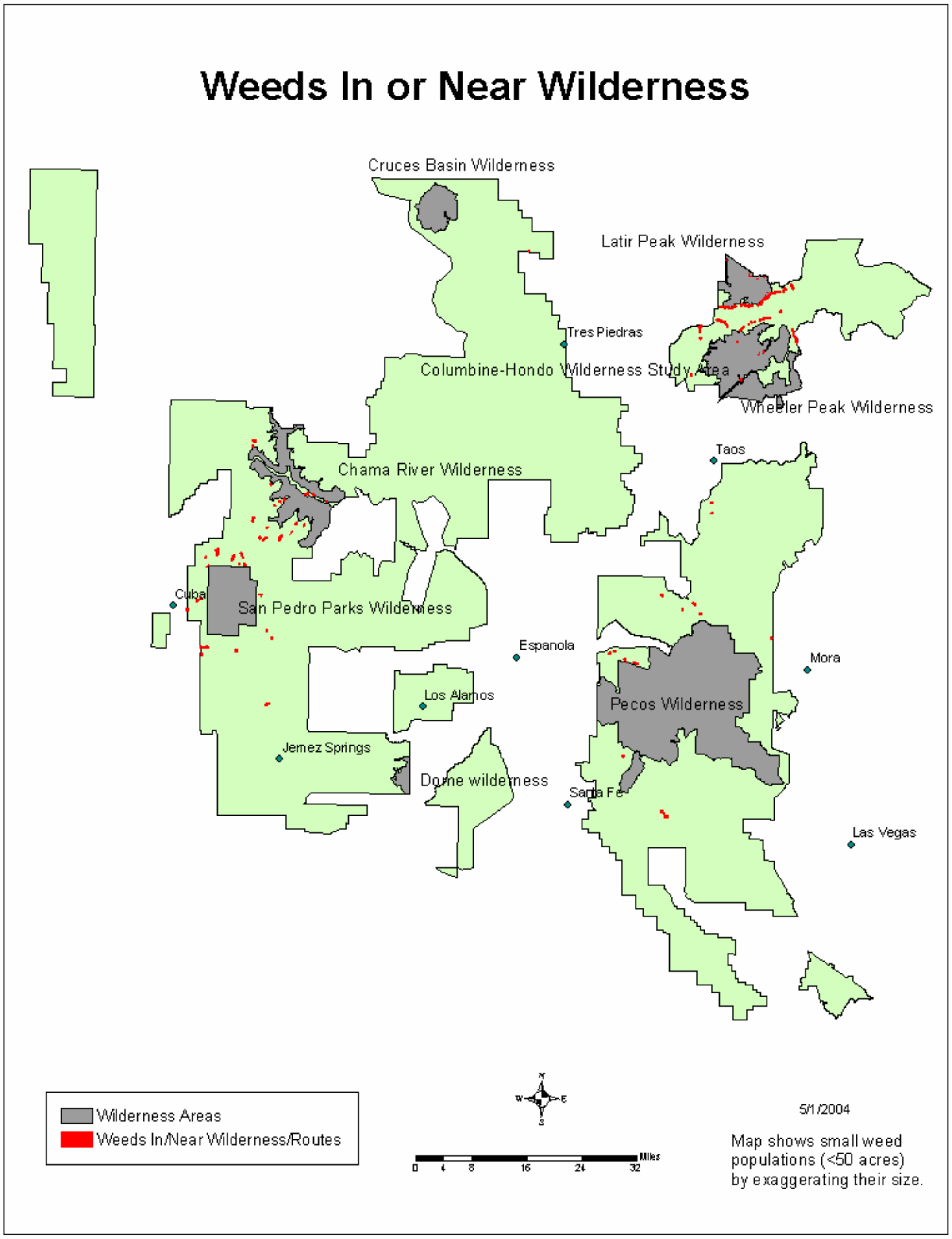


Figure 13. Weeds in or Near Wilderness

Ski areas on the Forests are: Santa Fe Ski Area, Taos Ski Valley, Red River Ski Area, Enchanted Forest Cross Country Area, and Sipapu Ski Area. There is one Boy Scout camp, one Girl Scout camp, one YMCA camp, and six recreation residences located within the Forests. Leafy spurge and bull thistle occur on the Philmont Boy Scout Ranch, and yellow starthistle is growing on the Rancho del Chaparral Girl Scout Ranch.

Wilderness

The seven congressionally designated wilderness areas on the Forests are: Wheeler Peak, Latir Peak, Cruces Basin, Pecos, Chama River Canyon, San Pedro Parks, and Dome, and there is one Wilderness Study Area—Columbine-Hondo. There are 25 acres of weeds mapped within wilderness areas on the Forests. Most of the weeds are bull thistle located near the boundaries of the wildernesses they are in, although there is a small patch, approximately 1.2 acres, of yellow toadflax mapped at the junction of trails 69 and 71 within the Columbine-Hondo Wilderness Study Area. The largest is an approximately 5.6-acre patch of bull thistle in the Latir Peak Wilderness. There is an approximately 3.4-acre patch of bull thistle in the northwest corner of the Pecos Wilderness. The others are mostly one acre or less in size, located within the Columbine-Hondo, Latir Peak, Wheeler Peak, or Pecos Wilderness areas. Approximately 300 acres of weed infestations (Canada thistle, musk thistle and Russian knapweed) are located one mile or less outside the San Pedro Parks Wilderness.

While there are limited inventoried weed infestations within or just outside the wilderness areas, there is a high potential for further weed expansion into and within the wildernesses due to the existence of numerous weed infestations along roads and trails that provide wilderness access.

Motorized and mechanized weed treatments are not allowed within wilderness. Forest Service Manual (FSM) 2323.26b allows control treatments of weeds by digging or with herbicides when they threaten lands outside wilderness or when they are spreading within the wilderness, provided that it is possible to effect control without causing serious adverse impacts on wilderness values.

Environmental Consequences

Alternative A (No Action)

Weeds would continue to spread at rates from 5 to 30 percent per year. By out-competing and gradually reducing the abundance and diversity of native plants on the Forests, the spread of weeds would result in deteriorating the natural condition of the recreational values for some people, within and outside wilderness. Weeds would reduce the variety and amount of native flora to observe, study, or photograph. Wildlife viewing and hunting opportunities would be reduced in the long term as weeds reduce the quality of forage and cover habitat for some wildlife species (refer to “Wildlife Resources” section).

Weeds such as spotted knapweed, Scotch thistle, and yellow starthistle would tend to diminish the desirability of using recreation sites because the stiff plant stalks, thorns, or sharp bristles can discourage or prevent walking, sitting, or setting up a camp. Recreational experiences and values would especially decline where tall, dense weeds such as salt cedar dominate and limit access to riparian areas. Recreational experiences for some people would be diminished by weed species that create allergies or skin reactions.

On the other hand, this alternative avoids any potential short-term, negative effects of weed treatments on recreational experiences, such as short-term increases in noise or traffic, and temporary closures of some recreation sites, trails or roads during and/or immediately after treatment activities.

Alternative B (Proposed Action)

Under Alternative B, weed treatments would decrease establishment and expansion of aggressive weed species and reduce weed related impacts that were described for Alternative A (No Action). In the long term, the currently diverse, noninfested plant communities within and outside wilderness areas would be protected by the proposed weed treatments, which would enhance wilderness and recreational experiences.

Herbicide applications and other treatments may cause temporary visual disturbances to some people who encounter weed treatment personnel, however, on most sites treatments would only last a few days or less. Temporary closure of roads, trails or recreation sites during and immediately after herbicide applications would have a minimal impact on recreational opportunities because they would not typically last more than a day or two, and would occur during the weekdays. Odors emitted by herbicides could cause anxiety in persons unaware of their presence, although it is unlikely that herbicides would be applied along trails or in recreation sites during a time when visitors are present. Signs would be posted at access points to recreation sites, roads or trails where herbicides would be used. (Refer to “Human Health and Safety” section regarding effects of herbicides on human health).

Areas of wilting, dying or dead weeds, and weeds removed, cut or burned, would be apparent for a short time in the localized treatment sites. Within a growing season or two, early seral vegetation would fill in and become more noticeable than the dead plants or bare soil areas.

Impacts on recreation, both within and outside of wilderness, resulting from implementation of the action alternatives would include short-term encounters with weed treatment crews and visual impacts from wilting plants. There would be an insignificant increase in the amount of noise and traffic associated with these treatment activities, primarily due to the short timeframe needed to treat weeds at most weed infestation sites, and the relatively small number of personnel needed to implement treatments. Proposed treatments typically do not require large crews of workers such as those frequently used on the Forests for thinning, prescribed burning, watershed restoration and other common projects. For some people, the sight of agency personnel spraying herbicides within a wilderness may diminish the quality of their wilderness experience. For others, wilderness values would be enhanced by the elimination of nonnative plants in or near wilderness areas.

Alternative C (No Herbicide)

Aggressive nonherbicidal treatments could, over time, reduce existing populations of some weed species and prevent establishment of new populations if detected early. However, this type of program would require a larger, more highly organized labor force, working throughout spring, summer, and fall months. Due to the need for additional repeat treatments, and in some cases nearly continuous or annual repeat treatments to contain or control weeds without herbicides, there would be a substantial increase in the amount of noise and traffic on the Forests.

This alternative avoids having to temporarily close some roads, trails or recreation sites because herbicides would not be used, although the difference in impacts to recreational opportunities would be small due to the short closure times expected under Alternative B.

Nonherbicidal treatments are ineffective or very difficult on some species because they have very limited times when they can be manually treated (e.g. black henbane must be hand pulled within 10 days of emergence) or they are aggressive root sprouters (such as Canada thistle) that are actually promoted by incomplete hand treatments. Subsequently, weed populations which are largely unaffected by these treatment methods would continue to expand. Populations of weeds which are located in remote, difficult to monitor sites would also be more likely to expand. In the long term, this alternative would not be effective and would contribute to the negative impacts to recreation experiences as described for Alternative A.

Other effects would be the same as those described for Alternative B.

Alternative D (Herbicide Only)

Effects under Alternative D would be most similar to effects under Alternative B. A slight difference in effects would involve the fact that ground-disturbing activities such as mowing, tilling, digging, or burning, which most often need to be repeated in order to meet objectives, would not be implemented. Thus, this alternative would result in less noise and traffic compared with the other two alternatives, which would improve the quality of the recreational experience for some people.

Cumulative Effects

The analysis area for cumulative effects on recreation/wilderness is the area in and immediately adjacent to the two forests. This boundary represents the areas where the actions proposed in this project are most likely to interact with other activities, in particular the weed treatments and ground disturbance on both forests and other lands (private, State, BLM, etc).

The main past, present and foreseeable future activities affecting this same area that could cumulatively impact recreation opportunities or experiences are listed in a table at the beginning of this chapter. All forest management activities, particular for large vegetation management projects, would continue to add to the noise and traffic levels in the forest environment. Motorized recreational activities such as use of off-road vehicles, snowmobiles and similar equipment would add to the noise in the environment. Motorized and nonmotorized recreational activities would continue to noticeably increase over the next 10 years. Spraying pine trees to prevent further spread of bark beetles is also occurring across all jurisdictions and on private lands in northern New Mexico. This would have some similar effects as spraying herbicides in terms of very temporary closures of certain recreation sites where and when spraying occurs, potential for odors, and the visual effect of people spraying chemicals onto plants.

Other agencies and landowners within and adjacent to the Forests would continue to treat weeds, primarily using herbicides, which would add to both the positive and negative effects described for the weed control alternatives. The most noticeable effect would be the long-term preservation of biologically diverse native plant communities outside and within wilderness. This cumulative and long-term effect would particularly enhance the natural integrity of and recreational experience in wilderness and back-country roadless areas. The beneficial cumulative effect, when combined with weed treatments on other land ownerships, would be much greater for Alternatives B and D than for Alternative C, because Alternative C would not be as effective in meeting weed treatment objectives.

Under Alternative A (No Action), other agencies and landowners who are investing in weed control efforts would probably become frustrated with the Forest Service for not participating in the collective effort that is needed to control the aggressive spread of weeds across all neighboring jurisdictions. Although biological control insects released on neighboring lands would likely have a beneficial effect in controlling the same weed species on the Forests, they would not be as effective if the Forest Service does not participate as a cooperating partner in the biological weed control projects.

Visual Resources

Affected Environment

The Forests contain a complex variety of landscapes, ranging from high alpine meadows and rugged peaks, forested mountains of spruce, fir, and pine, rolling grasslands dotted with piñon and juniper, to red rock formations, narrow canyons and tumbling mountain streams. People often derive pleasure and enjoyment from observing the intermingled patterns of old growth vegetation and landscape accents such as aspen, oak, grassland meadows, and geologic features. The presence of water is distinctive wherever it occurs, and people tend to congregate around streams and lakes.

Visual Quality Objectives (VQOs) were identified in the Forests' plans, which categorize lands according to scenic quality and viewer sensitivity. The VQOs are: Preservation, Retention, Partial Retention, Modification, and Maximum Modification. On the Forests, Preservation is the VQO in wilderness areas, and Retention is the VQO in areas such as roadless areas managed for semi-primitive recreation opportunities, portions of wild and scenic river corridors, along scenic by-ways and in other sensitive viewsheds. See "The Visual Management System" (USDA FS 1984) for definitions and descriptions of the VQOs, and the Carson and Santa Fe Forest Plans (USDA FS 1986b and 1987b) for how VQOs were applied in each management area of the two forests.

There are four key visual elements used in describing landscapes with the visual management system—form, line, color and texture. They each exert differing degrees of visual influence, power or dominance.

- Form: Landscape forms are determined by topography and vegetative pattern.
- Line: Line is anything that is arranged in a row or sequence. It can be the silhouette of a form, the edge of a meadow, a ridgeline, a tree trunk, a river, the path of an avalanche.
- Color: Color enables us to distinguish among objects of identical form, line and texture.
- Texture: Textures in the landscape are determined by geology, soils, topography and vegetation.

The weed infestations on the Forests are relatively small and visually indiscernible beyond the foreground views (up to one-half mile) or possibly middle ground views (up to 5 miles) and, therefore, do not dominate the viewpoint or viewshed. Weed infestations normally conform to texture, line, and color of surrounding vegetation throughout the seasons.

Environmental Consequences

Alternative A (No Action)

Under the No Action Alternative, weeds would spread unchecked, eventually infesting all suitable habitats within and outside the Forests, including sites that are presently weed free. Weeds would out-compete native vegetation and often form monocultures. The appearance of large monocultures of the same weeds and associated decline in the richness or diversity within native plant communities would have a long-term negative impact on visual quality.

Weeds primarily affect the foreground views rather than middle ground and background views, having both positive and negative effects. Weeds may appear to be out of scale, visually out of place, and often associated with land disturbance activities. To those unaware they are looking at weeds, the yellow toadflax, flowering musk thistle or lacy salt cedar may appear as attractive components of the landscape, whereas other weeds, such as Russian knapweed, may detract from the natural beauty of the landscape for some people. Landscapes where positive or negative effects of weeds would be seen by the most viewers tend to be along river corridors (which are often also highway or road corridors), lakes, main trails, dispersed recreation sites, and key destination points.

Alternatives B, C, and D

For all action alternatives, the visual impacts resulting from mowing, hand digging, and hand pulling would be a slight change in the form, color and texture in the foreground view because these methods not only kill or remove the weed plants, but also result in minor amounts of localized soil disturbance. If root plowing is used there would be more noticeable soil disturbance. Biological methods would not be visually noticeable in the foreground other than dead or dying weed plants. Use of prescribed fire would cause the burned vegetation to appear brown or blackened for a short period of time, and may result in patches of bare soil until the site is revegetated, similar to the visual effect of a naturally-caused surface fire. Herbicide use under Alternatives B or D would cause short-term visual impacts when treated vegetation turns brown, and there would be some patches of newly exposed soil until the site is revegetated. Selective herbicides such as picloram and 2, 4-D would kill or burn broadleaf plants, leaving grasses unaffected. Overall, there would be a very short-term reduction in visual quality for some people associated with patches of dying, wilting, or dead weeds or exposed bare soil. The extent and duration of this effect would be minor, especially due to the small weed treatment sites and estimation that only 600-1,600 acres would be treated each year of the 3-million acres on the Forests.

Nontarget native plants would remain mostly unaffected by the ground-based herbicide applications proposed, assuming all EPA label limitations are adhered to. Visual effects would not be noticeable in the middle ground and background views such as from high elevation viewpoints overlooking forest landscapes. Overall, the weed control treatment sites are fairly small and localized, and would not alter overstory tree cover, thus there would be minimal changes in form, line, color or texture in the environment. In the long term, revegetation with more diverse native plant populations would enhance visual quality for most forest visitors.

All alternatives would be consistent with the VQOs assigned to specific areas throughout each forest, as well as other Forest Plan management direction for maintaining and enhancing visual resource values. Even weed control treatments applied in designated wilderness would be expected to conform to the VQO of Preservation, as treatments would not substantially alter the form, line, color or texture of the landscape, or create a stark contrast with the surrounding vegetation, and would enhance the diversity and growth of native plant communities.

Cumulative Effects

Other past, present and reasonable foreseeable activities that affect visual resources on the Forests were considered. They include public land use activities as well as resource management activities such as thinning and prescribed burning, and are listed at the beginning of this chapter.

The majority of vegetation management treatments that would alter the appearance of the landscape—such as thinning, prescribed burning other ecosystem restoration projects—typically enhance the visual diversity and quality of forested landscapes in the long run. Visual conditions are also being noticeably improved by current and future trends in recreation management. Most recreation projects are aimed at reducing soil, vegetative and watershed impacts caused by frequent camping and other recreational activities outside developed sites, along with off-road driving and off-trail hiking which create numerous new road and trail networks.

Past construction of forest roads added to many user-created, two-track roads, which together have negatively altered many viewsheds, as has the continued construction of homes and human developments on private lands within and surrounding the Forests. However, the current and future trend is toward closing and obliterating roads, which would continue to improve visual quality. The minor visual effects of this project would not noticeably add to the visual effects of these other activities that create more apparent changes in the natural landscape.

Current and future weed control treatments conducted by other government agencies and landowners in and around the Forests would cumulatively add to the beneficial visual effects of this weed treatment project. There would be a cumulative reduction in total acres infested with weeds and an increase in more diverse, native plant communities.

Alternative A, No Action, would cumulatively add to undesirable visual effects from other activities, due to the continued and exponential increase in the spread of weeds over time and the associated increases in soil erosion and degradation of water quality and wildlife habitat.

Cumulative impacts on visual resources resulting from implementation of the action alternatives would be an overall reduction in acres infested with weeds and an increase in native plant communities, which would have a positive impact on visual resources.

Livestock Grazing

Affected Environment

Domestic livestock grazing on the Forests has not been found to be a major contributor to the spread of weeds within affected range allotments. The overall trends indicate that human activity along roads, trails, and recreation areas, along with disturbance at oil and gas well pads and the movement of seed or other vegetative propagules by water along riparian corridors, are the main transportation vectors at this time. However, this human activity can include the hauling of livestock on trailers which could contribute to the spread of weeds if the vehicle comes from an infested area or drives through an infested area. Livestock permittees are not allowed to feed hay to their livestock on National Forest System lands, which could be a potential source of new infestations if it was allowed.

The Carson National Forest administers 76 grazing allotments, of which 72 are active, 3 are vacant, and 1 is closed to permitted livestock grazing. There currently are weed populations mapped on 51 of these including on 1 of the vacant allotments and the closed allotment.

The Santa Fe National Forest administers 81 grazing allotments, of which 75 are active, 1 is vacant, and 5 are closed to permitted livestock grazing. There currently are weed populations mapped on 39 of these, including on the vacant allotment and 2 of the closed allotments. See Tables 46 and 47 below.

Table 46. Grazing Allotments with Known Weed Infestations on the Carson National Forest

Allotment Name	Invasive Weed Species	Total Acres Infested[1]
Arroyo Hondo	Bull thistle, Canada thistle	2.03
Bancos	Musk thistle, Scotch thistle	0.12
Black Copper	Bull thistle, Canada thistle	2.20
Bobcat	Bull thistle, Canada thistle	2.66
Capulin	Musk thistle	0.08
Cebolla	Canada thistle	0.08
Deer Creek Complex	Bull thistle, Canada thistle	1.13
English	Musk thistle	0.08
Flechado	Musk thistle	0.23
Goose Creek (closed)	Bull thistle, Canada thistle	2.45
La Lama	Bull thistle, Canada thistle	8.66
Lakefork Baldy	Bull thistle, Canada thistle	28.16
Main Fork (vacant)	Bull thistle, Canada thistle	2.07
Red River	Bull thistle, Canada thistle	0.10
Rio Chiquito	Musk thistle	5.97
Rio Pueblo	Canada thistle	1.99
Rito Segundo	Bull thistle, Canada thistle	5.29
San Antonio Mountain	Black henbane	0.23

Allotment Name	Invasive Weed Species	Total Acres Infested[1]
San Cristobal	Bull thistle, Canada thistle	10.40
Santa Barbara	Canada thistle	97.65
Sublette	Canada thistle	0.08
Apache	Musk thistle, Canada thistle	0.05
Canjilon	Musk thistle, Canada thistle	0.54
Columbine	Bull thistle, Canada thistle, yellow toadflax	1.57
El Rito Lobato West	Musk thistle, bull thistle	0.31
Jarita Mesa	Musk thistle, leafy spurge	25.75
Jawbone	Musk thistle, Canada thistle	0.54
Mesa	Musk thistle, Canada thistle	0.54
Midnight Mallette	Bull thistle, Canada thistle,	65.91
Miranda	Musk thistle, Canada thistle	26.22
Mogote	Musk thistle, Canada thistle	0.84
Mogotito	Musk thistle, Canada thistle	0.15
Servilleta	Russian knapweed, hoary cress	2.00
TCLP	Russian knapweed, hoary cress	8.78
Cabresto	Musk thistle, Scotch thistle, salt cedar	62.77
Carson Mojino	Russian knapweed, hoary cress, musk thistle	10.75
E. Pinon	Russian knapweed, field bindweed, yellow toadflax	0.56
Santos	Russian knapweed, hoary cress, musk thistle	4.98
Vaqueros	Musk thistle, field bindweed, salt cedar	7.43
Carracas	Russian knapweed, musk thistle, Scotch thistle, bull thistle	15.14
Olla Ranchos	Hoary cress, bull thistle, musk thistle, Scotch thistle	168.10
San Antone	Hoary cress, musk thistle, Canada thistle, bull thistle	1.32
Tusas	Hoary cress, Canada thistle, bull thistle, yellow toadflax	91.25
Spring Creek	Russian knapweed, hoary cress, Canada thistle, leafy spurge, yellow toadflax	54.16
Tio Grande	Hoary cress, musk thistle, black henbane, perennial pepperweed	0.77
Valle Vidal	Musk thistle, yellow starthistle, Canada thistle, bull thistle, black henbane	1,805.23
Laguna Seca	Russian knapweed, musk thistle, Scotch thistle, Canada thistle, field bindweed, salt cedar	36.47
Tio Gordito	Russian knapweed, hoary cress, musk thistle, Canada thistle, leafy spurge, yellow toadflax	26.85
Valencia	Russian knapweed, musk thistle, Scotch thistle, Canada thistle, field bindweed, salt cedar	41.06

[1] Use of acreage figures carried out to the 1/100th-acre does not reflect the precision of acreage estimates and is only used because many infestations are less than an acre or two in size.

Table 47. Grazing Allotments with Known Weed Infestations on the Santa Fe National Forest

Allotment Name	Invasive Weed Species	Total Acres Infested
Barbero	Bull thistle, Scotch thistle	432.2
Capulin	Bull thistle	230.1
Cebolla San Antonio	Russian knapweed	15.25
Chama Canyon	Spotted knapweed, saltcedar	13.37
Chiquito	Musk thistle, Canada thistle	4.71
Coyote	Canada thistle, musk thistle	298.65
Cuba Mesa	Musk thistle, Canada thistle	5.41
Erosion	Saltcedar, Siberian elm	107.82
French Mesa	Canada thistle, musk thistle	107.5
Gallina River	Musk thistle, Canada thistle	293.21
Jarosa	Musk thistle, Canada thistle, bull thistle	81.92
La Jara	Russian knapweed, musk thistle	30.35
La Presa	Canada thistle, musk thistle	110.57
Llaves	Spotted knapweed, diffuse knapweed, Canada thistle, bull thistle	38.75
Los Indios	Canada thistle, musk thistle	76.2
Macho	Bull thistle, Scotch thistle	90.71
Mesa Alta	Canada thistle, musk thistle	186.35
Mesa Del Medio	Canada thistle, musk thistle	168.19
Mesa Poleo	Canada thistle, musk thistle	119.07
Ojito Frio	Musk thistle, Canada thistle, bull thistle, dalmation toadflax	36.93
Oso Vallecitos	Russian knapweed	0.46
Penas Negras	Canada thistle, bull thistle, dalmation toadflax, Scotch thistle	46.67
Pine Springs (closed)	Musk thistle, Canada thistle, bull thistle	4.63
Pollywog	Canada thistle, salt cedar	26.44
Polvadera	Saltcedar, Russian knapweed	21.05
Quemado	Bull thistle, Russian olive	7.52
Red Top	Musk thistle, Canada thistle, Scotch thistle	8.98
Rio De La Casa	Bull thistle	17.49
San Diego	Russian knapweed, hoary cress, field bindweed, musk thistle, bull thistle, Canada thistle, poison hemlock, Siberian elm, Russian olive, saltcedar	1,676.75
San Miguel	Bull thistle, musk thistle	35.64
Santa Fe Watershed (closed)	Canada thistle	3.2
Senorito	Musk thistle, diffuse knapweed, bull thistle	129.4
Soldier Creek (vacant)	Bull thistle, Scotch thistle	24.36
South Ojitos	Musk thistle, Canada thistle, bull thistle	38.4

Allotment Name	Invasive Weed Species	Total Acres Infested
Springs	Bull thistle	173.83
Vacas	Musk thistle, Canada thistle	7.72
Youngsville	Canada thistle, musk thistle	411.15

The tables show that the Valle Vidal (Carson National Forest) and San Diego (Santa Fe National Forest) Allotments have the largest weed infestations. This is primarily due to the extra large size of these allotments, and the fact that the majority of weed infestations on the Valle Vidal Allotment are within the 2002 Ponil Fire burn complex. Weeds tend to invade recently burned areas. Bull thistle is the primary species becoming established, primarily along drainages and at the base of burned evergreens within the high intensity burned areas (versus moderate or low intensity). Within the San Diego Allotment, the majority of the weed acreage consists of salt cedar and other species along the Jemez River corridor. Permitted livestock grazing has not been allowed along the lower Jemez River area since 1980. Prior to that time, much of it was privately owned. Since then, it has been designated as a National Recreation Area and several recreation sites have been developed.

The Forests also administer five wild horse territories and one wild burro territory. Three of the wild horse territories are occupied and two are not occupied by wild horses. The wild burro territory is not occupied by wild burros. There currently are weed populations mapped on two of the occupied territories (see Table 48 below). As mentioned previously, certain weed species, such as Russian knapweed and yellow starthistle, are known to be toxic to horses, which could be a concern if they were to become widespread within a territory. The population of Russian knapweed mapped within the Jicarilla Wild Horse Territory is currently less than one acre in size.

Table 48. Occupied Wild Horse Territories with Known Weed Infestations on the Forests

Wild Horse Territory Name	Invasive Weed Species	Total Acres Infested
Jicarilla Wild Horse Territory	Musk thistle, Scotch thistle, salt cedar, Russian knapweed, bull thistle	78.03
Jarita Mesa Wild Horse Territory	Musk thistle, leafy spurge	25.75

Environmental Consequences

Alternative A (No Action)

Without treatment, weeds would likely continue to displace palatable native vegetation and reduce forage on affected grazing allotments and wild horse territories. As certain weed species are known to be toxic to various classes of permitted livestock, the continued spread of weeds in active allotments would be expected to result in some toxic impacts to livestock. Canada thistle has the potential to concentrate nitrates and cause nitrate poisoning in ruminants. Field bindweed contains tropane alkaloids and may also accumulate toxic levels of nitrate. It is most likely to cause poisoning in animals when it becomes the predominant plant available for the animals to eat. Russian knapweed and yellow starthistle both produce a unique poisoning of horses that is generally fatal. Black henbane is a member of the nightshade family (*Solanaceae*) and has the potential to cause poisoning, but because it is unpalatable, it is rarely eaten. Poison hemlock is toxic to a wide variety of animals including man, birds, wildlife, cattle, sheep, goats, and horses. The poison can be transmitted through milk of animals that have eaten poison hemlock. Leafy spurge can cause excessive salivation and diarrhea in cattle. It does not appear to affect sheep and goats (Knight & Walter 2003).

Loss of native plant communities would continue to occur as weeds occupy and out-compete native grass and forb species. Once weeds begin to dominate these communities, a loss of species diversity, composition, and ecosystem function could occur. Weeds would continue to spread into areas that are not currently infested, such as recently burned areas, as witnessed in the Ponil Fire Complex on the Valle Vidal Unit of the Carson National Forest, and areas of new disturbance, such as new oil and gas well pads on the Jicarilla or Cuba Ranger Districts. Once weeds become established, these areas would likely serve as weed seed source for other areas of the Forests.

Alternatives B and D

Alternative B, C, or D would result in long-term beneficial effects on 90 grazing allotments and 2 wild horse territories. There would be increases in density and vigor of native and desired forage grasses within proposed treatment areas (See “Vegetation Resources” section for more detail). It would have beneficial effects on soil and water resources that are important in maintaining quality rangeland conditions (See “Water Resources” and “Soil Resources” sections for more detail). There would be a reduction in the risk of toxic effects of certain weed species, as previously described. The Forests are not currently at a level of infestation where weeds are displacing grazing opportunities except in very small, localized situations. Over the long term, control measures taken now would avoid more significant impacts in the future.

The application of the herbicide 2,4-D has been shown to increase the nitrate content of plants and the palatability of the plants, increasing the potential for poisoning. Mitigation measures that defer the use of pastures treated with herbicides would avoid this impact.

Alternative C (No Herbicide)

Alternative C would result in the same type of beneficial effects as Alternatives B and D, but to a lesser extent. Because the effectiveness of Alternative C in eradicating or controlling weed establishment and spread is expected to be less than with alternatives that use herbicides, this alternative would not realize the same level of benefit. In the long term, weed spread could exceed the rate of weed control, so effects would be more similar to those described for Alternative A. Some weed species are not effectively controlled without herbicide methods and some weed infestations are too large to control without herbicides. Other weed infestations are too remote to consistently monitor for needed repeat treatments.

Cumulative Effects

Cumulative impacts relative to grazing resources include past, present, and future grazing and range management activities that occur on grazing allotments. In areas where cattle tend to concentrate, grazing by domestic livestock on the affected allotments would reduce native forage abundance and diversity, which would add to the reductions caused by the spread of weed species (under Alternative A). Livestock are probably a minor contributing factor in the spread of weed seed in the allotments, but add to other sources of weed spread by human activities, particularly along roads, trails and water ways. Weed spread caused by other activities on the forest would cumulatively add to the risk of weed-related toxic effects to certain types of livestock.

Weed control treatments conducted by the Forest Service combined with those conducted by other entities would cumulatively and substantially improve vegetative conditions within the range allotments (see “Vegetation,” “Water,” and “Soil” resources sections for details on these improvements). Other rangeland improvement projects ongoing and planned in the foreseeable future would add to the beneficial effects to grasslands, meadows and other areas in the grazing allotments. Refer to the “Vegetation Resources” section for a more detailed description of effects to vegetation, including vegetation utilized for livestock grazing in allotments on the Forests.

Social-Economics

Affected Environment

Historic Context

The social environment for this analysis comprises the people living in and adjacent to the Forests within northern New Mexico, hereafter referred to as the "study area." Northern New Mexico can be described as mostly rural with large tracts of open lands and small communities that rely on commercial centers such as Taos, Espanola or Santa Fe to augment their lifestyles. (The affected social environment associated with human health and safety is described in a separate section that follows this socioeconomic discussion.)

People have lived on lands in the study area for over 12,000 years. The arrival of Europeans had a catastrophic effect on native populations, as was the case throughout the New World. During the colonization of the New World by Spain, the non-Indian population grew very slowly and was estimated to be no more than 20,000 to 25,000 by the late 18th century (Simmons 1979). Throughout this period, small nonintensive agriculture farms were the staple for the community and family. The basic goal of the village economy was for local subsistence, not for commercial production (Raish 1995).

There has been a long history of human use of the Forests. Prehistoric Anasazi made their homes on rivers and plateaus in the Sangre de Cristo Mountains from about A.D. 475 to 1100. Pueblo groups have farmed these lands for over 1,000 years. Spanish Land Grants were granted over many years until Mexico ceased to be part of the Spanish Empire. The land grant tradition continued with Mexico Land Grants. Former land grants include portions of both forests. The people influenced by forest resources live in nearby villages, rural areas, or urban areas. These communities are interwoven into the landscape, typically with private lands lying in the valley bottoms of the two mountainous forests.

Few generalizations can be made about the communities across the Southwest. They are as diverse as the people who live there. The ever increasing popularity of the Southwest as a highly desirable living location continues to increase the region's diversity (see Table 49 for the 40-year trend in population growth). Within each community, there is a strong sense of independence and self-sufficiency. Most of the time people like to solve their own problems (Eastman and Gray 1984, BeBuys and Harris 1990, DeBuys 1985, Horgan 1970). No matter what its size, there is no single viewpoint on most topics; each community has groups with varying opinions.

Demographics

The Forests cover portions of eight northern New Mexico counties: Colfax, Rio Arriba, Taos, Los Alamos, Santa Fe, San Miguel, Mora, and Sandoval Counties. The total populace of the study area is estimated to be 358,200 persons. The ethnic or racial makeup of populations in these counties is shown in Figure 14.

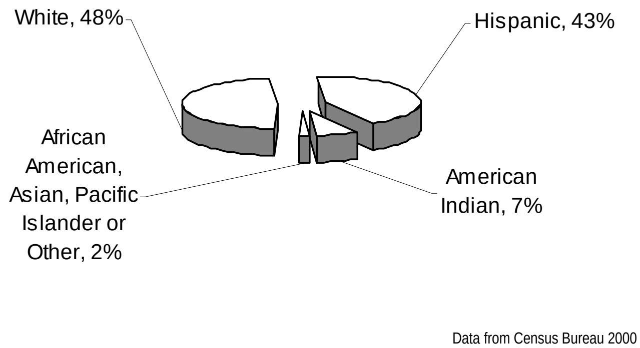


Figure 14. Ethnicity

Two racial groups comprise nearly equal proportions of the population of the study area, similar to the statewide population. No one group comprises over 50 percent of the State's population. New Mexico is one of the few states where this occurs. A detailed breakdown of ethnicity by county is contained in the project record.

Population growth in these northern New Mexico counties are all increasing, but at different rates. The more urbanized areas such as Sandoval and Santa Fe Counties have experienced tremendous growth in the past 30 years (Sandoval averaged about 14 percent annually). Growth in the more rural counties has been slow to stagnant. The increase in population has resulted in greater demands for various recreational opportunities and other uses on the Forests. Table 49 shows the population growth in the eight affected counties through 2000, based on U.S. Census Bureau data.

Table 49. Population Growth of Affected Counties by Census Year

County	1970	1980	1990	2000
Colfax	12,170	13,667	12,925	14,189
Los Alamos	15,198	17,599	18,115	18,343
Mora	4,673	4,205	4,264	5,180
Rio Arriba	25,170	29,282	34,365	41,190
San Miguel	21,951	22,751	25,743	30,126
Sandoval	17,492	34,400	63,319	89,908
Santa Fe	54,774	75,519	98,928	129,292
Taos	17,516	19,456	23,118	29,979

The counties involved are not uniform in size. They vary in size from a mere 109 acres to nearly 5,900 acres. Larger counties like Rio Arriba and San Miguel tend to have more lands included within the jurisdiction of the Forests. The population density within a county indicates the size of the county and the likelihood of urban areas. Table 50 shows the county land base in square miles and population per square mile of land in each of the affected counties (U.S. Census Bureau, 2002). Los Alamos and Santa Fe, which have the highest population densities, have the largest urban areas.

Table 50. County Land Base and Population Density

County	Land Area (sq. mi.)	People Per Square Mile
Colfax	3,757	10.1
Los Alamos	109	167.8
Mora	1,931	2.7
Rio Arriba	5,858	7.0
San Miguel	4,717	6.4
Sandoval	3,709	24.2
Santa Fe	1,909	67.7
Taos	2,203	13.6
New Mexico State Total	121,356	15.0

County populations in and around the Forests differ widely in their income levels. Mora and Rio Arriba Counties have both the lowest per capita income level and the highest percentage of their residents living below poverty level. Los Alamos County is unique in northern New Mexico in terms of it's higher than average income and education level, and primarily anglo ethnicity (82 percent). The Los Alamos community was built and established around the Department of Energy's Los Alamos National Laboratories, where most of its residents continue to work.

Figure 15 shows the per capita income and percent of the population living below the poverty level for each county involved. It is based on the most recent census data available (New Mexico Fact Book 2003).

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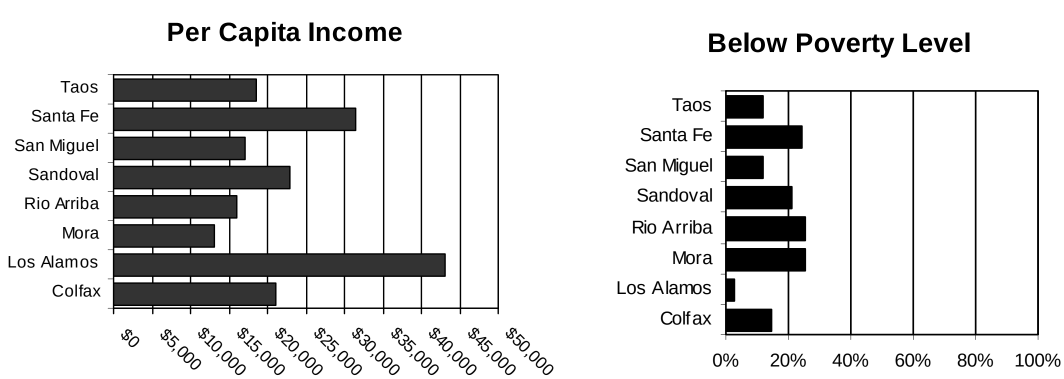

Figure 15. Per Capita Income (U.S. Census Bureau 2001) and Population Percentage below Poverty Level (U.S. Census Bureau 1999)

Another aspect to the demographics is where the people live or prefer to live. Within the study area comprising the Forests, approximately 67 percent live in urban zones and 34 percent live rurally. Mora County is unique in the study area since there is no defined urban zone. The other counties contain some areas defined as urban. Los Alamos, Sandoval and Santa Fe Counties are different in that less than 25 percent of their population lives in rural zones. Four counties have at least 50 percent of their population living rurally. Table 51 provides the breakdown between urban and rural populations.

Table 51. Urban and Rural Populations

Geographic Area	Total Population	Percent Urban	Percent Rural
Colfax County	14,189	48.5	51.5
Los Alamos County	18,343	88.5	11.5
Mora County	5,180	0	100
Rio Arriba County	41,190	43.2	56.8
Sandoval County	89,908	76.7	23.3
San Miguel County	30,126	59.4	40.6
Santa Fe County	129,292	75.4	24.6
Taos County	29,979	40.5	59.5
Study Area Totals	**358,207**	**66.7**	**33.7**
New Mexico	1,819,046	75.6	24.4
United States	281,421,906	79.9	20.1

Rural Forest Communities

Rural forest communities have long been known for their cultural distinctiveness, independent spirits and comparatively high poverty rates. The more rural counties have per capita incomes below the statewide average and a high percentage of persons living below poverty level (refer to Figure 15).

Forest resources play an important social and economic role, particularly for the rural residents of northern New Mexico. Rural areas contain primarily Hispanic-dominated villages and Native American pueblos. People from these communities utilize the Forests for livestock grazing, gathering essential firewood for heating and cooking, using and selling posts, poles, and other wood products. Studies of villages in the study area, such as Vallecitos, El Rito, La Madera, Canjilon, Mountainair and Coyote, support the contention that these rural communities depend heavily on the natural resources in the area. Subsistence uses of forest products can be critical to rural families, especially during difficult economic times (Emery 1999). These low-income rural residents also use the Forests to gather plants for arts, crafts, food, medicines and spiritual purposes. They hunt and fish on the Forests, and dig clay and rock materials.

Community pastures and woodlands were an integral part of the socioeconomic fabric of northern New Mexico during Spanish times (Emery 1999, deBuys 1985, Eastman and Gray 1987). At one time approximately 22 percent of the Forests were grant lands. Spanish is the main language spoken throughout many rural communities in the area. The Forests also contribute substantial employment in these communities through firefighting, timber crews, and rangeland work.

Forest products also have important cultural and traditional values. Most of these communities were established as Spanish or Mexican “colonies.” They developed a cultural value of land “stewardship” through generations of interacting with the natural resources in the area. Quite often it is imperative for these residents to have hands-on relationships with the forest that sustained them for generations, as it is part of their cultural identity. Another common thread woven through these communities is a sense of place. Few want to leave the area. For some, property has been handed down from one generation to another for centuries. Some regard the national forests as communal land once belonging to their ancestors (deBuys 1985). Activities such as gathering firewood, latillas or pinyon nuts are traditional recreational and subsistence activities in these communities (Eastman and Gray 1987).

In addition to using forest resources to support a subsistence rural lifestyle, many of the residents now commute to larger commercial centers for employment opportunities in manufacturing, construction, retail and government sectors. However, four of the affected counties—Colfax, Mora, Rio Arriba, and Taos—continue to have very high unemployment rates, averaging 20 percent above the average unemployment rate for all states during the previous 2 years (New Mexico Labor Market Annual Social and Economic Indicators, June 2001).

Urban Forest Communities

Urban areas adjacent to forested communities have been known for their distinctiveness, independent spirits, and value placed on recreational opportunities on the Forests. These communities tend not to rely on economic opportunities found on the Forests. Los Alamos, Espanola, and Santa Fe County residents tend to rely on private business and government work in the cities for most of their income. Some use local forest products such as plant collecting to manufacture value-added items. Service industries also provide opportunities in the urban areas. The more urbanized counties are at or above the average statewide per capita income (refer to Figure 15).

Urban residents tend to use the Forests mostly for recreation or spiritual renewal opportunities (Leisure-Time Physical Activity among Adults: United States, 1997-1998, Department of Health and Human services, Centers for Disease Control and Prevention, National center for Health Statistics, April, 2002). However, most of these urban communities were also originally established as Spanish or Mexican “colonies” and many residents have established a traditional and cultural land “stewardship” value through many generations of interactions with the natural resources in the area.

As with their rural counterparts, a number of these residents enjoy having a hands-on relationship with the forest and share a sense of place similar to the rural residents. For some, property has been handed down from one generation to another for centuries. Some take advantage of the opportunities for gathering and selling or trading special forest products similar to the rural residents. However, as growth continues in Santa Fe, Taos and other urban centers, the proportion of residents who share these values and economic needs is declining.

Economic Efficiency

In addition to considering the socioeconomic history, demographics and rural versus urban community factors just described, the economic efficiency of the proposed project was also considered.

The economic efficiency consideration is not an exhaustive economic analysis and determination, but rather an estimate of economic efficiency from which alternatives may be compared. Some economic values are unknown, others are difficult to determine, still others depend on the individual gathering the data; therefore, readily available Forest Service publications and estimated values from the forest or district level experiences were used. It should be noted that the purpose and need for this project is based on ecological considerations rather than economics. Since the resource values and qualitative environmental factors are of primary importance for this project, the economic efficiency analysis carries little weight relative to other considerations (per 40 CFR 1502.23).

In addition, the environmental consequences of weed control project actions cannot be accurately expressed in monetary terms, and tend to lose meaning when put into an economic present-net value analysis. NEPA regulations make clear that an economic analysis of all impacts, values, and amenities associated with a project is not required, although due consideration was given to the key interactions between environmental, social and economic consequences. The Forest Service has established monetary values for several market and nonmarket outputs that were used in the cost/benefit and present-net-value estimates.

Economic efficiency relates to those items such as benefit cost ratios (B/C), present net values (PNV), and other measures that can be expressed in quantitative monetary terms. Economic impacts are items such as sustainability, jobs, and incomes. The primary analysis tool used for economic efficiency was the Quicksilver program, which is readily available to the public. The Implan analysis tool was not used due to various limitations in its applicability to this type of project (see project record for details).

Table 52 presents the cost assumptions used in the economic estimates for this project.

Environmental Consequences

Alternative A (No Action)

With the No Action Alternative, weed expansion would continue and weeds would rapidly become more difficult to control. As weed infestations become more extensive and dominant on the landscape, more aggressive and higher cost methods (like aerial herbicide applications) may eventually need to be employed.

In the short term (approximately the next 5 to 10 years), this No Action Alternative would not have a measurable impact on the economy of northern New Mexico. In the long term (in approximately 20 or more years), weed populations would become much larger and more dominant components of plant communities throughout the Forests. Previous sections of this document described the negative long-term impacts that weeds have on rangelands, livestock, big-game and other wildlife habitat, recreation experiences, riparian areas, water and fish habitats, and native plants that are traditionally collected and often used for food, medicines, arts, crafts and other income-producing uses. The adverse impacts to natural resources would reduce the social and economic values of the land. Rural, low-income residents, particularly Hispanic and Native American populations in the area, would primarily be affected due to the change in vegetation. Livestock grazing permittees and those who collect native plants would likely be the most impacted.

Alternatives B, C, and D

Weed treatments proposed in the action alternatives would provide little short-term economic benefit. With the long term control of weeds and restoration of desired plant communities, the local economy—particularly in rural areas—would benefit by avoiding the loss of economic opportunities tied to natural resource uses on the Forests. As Alternatives B and D would be more effective in eradicating or controlling weed infestations than Alternative C (as described in the "Vegetation Resources" section), those two alternatives would yield more positive social and economic benefits to forest-dependent communities over the long term.

The positive social and economic effects expected from this project would primarily benefit rural Hispanic and Native American populations who have a greater reliance on using forest and rangeland resources for social, cultural, economic and spiritual purposes. In consideration of environmental justice factors (in accordance with Executive Order 12898), there would be no significant adverse impacts anticipated from this project that would disproportionately fall on minority or low-income populations.

It is anticipated that this project would be implemented primarily by small numbers of Forest Service employees on a part-time basis, along with the possibility of using small crews of contractors or volunteers. Treatments would not be expected to provide a significant number of jobs to New Mexico residents or noticeable increases in indirect revenues to counties.

Table 52 gives a list of the rough estimated costs for each treatment method (details for cost assumptions are in the project record). These costs are neither exact nor all inclusive. They provide an indicator of relative treatment costs. They overestimate actual costs by multiplying the costs of several combinations of methods on the same treatment acreage, when often each method would be applied to a different acreage. Also, not every acre of a weed infestation site would be treated.

The list of treatments is also not all inclusive of potential combinations or methodologies, but includes those most likely to be used. As implementation and monitoring progress, some of the methods may be shown to have limited effectiveness in eradicating or substantially controlling the spread of weeds, and treatment methods may need to be modified (discussed in the adaptive strategy discussion in Chapter 2).

Costs shown in the table assume a paid workforce for weed control efforts. Public interest has been expressed in reducing weeds through use of a volunteer workforce, and such an effort would help reduce costs on a case-by-case basis. However, a volunteer effort would require intensive management by the Forests and availability of a volunteer workforce would be highly variable from season to season. Weed control for many infestations are likely to be beyond the capabilities of volunteer efforts because of timing demands (treatments are applied during specific weed life-cycle stages), logistics, and long-term availability of volunteers (who may wear down if overused). The effort to eliminate or control weeds on a given infestation could take several years (5 to 10) because of weed seeds remaining in the soil. Hence, volunteers would be used for some of the control efforts in certain circumstances, but this workforce option has not been considered as an economically influential factor.

Additional startup costs for developing the necessary goat or sheep herds to meet project objectives were not factored in. Although some herds of sheep and goats currently exist in the project area, they are substantially reduced from historic levels. Several individuals have been reported to be developing herds of sheep and goats for weed control and so it is assumed that the resource would be available sometime during the next 10 years and beyond.

Table 52. Estimated Treatment Costs

Treatment	Cost ($) per Unit (rounded)	Cost Assumptions Used
Burning		
Broadcast Burning	12/acre	Crew of 1 GS-7, 1 GS-5, 2 GS-4; engine @ $100/day; total cost of $600/day; do 50 acres/day
Hand Torch/Spot Burning	22/acre	Crew of 1 GS-7, 1 GS-5, 2 GS-4 @ $500/day + equipment @ $125/day (truck and burners); do 30 acres/day
Herbicide		
Herbicide (backpacks, vehicle-mounted or other methods)	87/acre	Crew of 1 GS-7 applicator and 1 GS-5 @ $240/day; vehicle @ $15/day; herbicide @ $5.00/day; do 3 acres/day
Biological		
Biological	100/acre	100 insects/acre @ $1/insect; do release in 1 day
Grazing		
Goats, Sheep or Other	100/acre	$1/head/day; 1,000 head eat 10 acres/day or 100 head/acre
Mechanical		
Mowing or Tilling	37/acre	Operator @ $90/day; equipment moving @ $45/day; tractor-mower @ $50/day; do 5 acres/day
Mowing and Herbicide	123/acre	Operator @ $90/day; equipment moving @ $45/day; tractor-mower @ $50/day; do 5 acres/day; + herbicide @ $87/acre
Manual		
Hand Digging, Clipping, Girdling	240/acre	Crew of 1 GS-5, 4 GS-4 @ $430/day; vehicle @ $15/day, tools @ $3/day; do 2 acres/day
Hand Pulling	430/acre	Crew of 1 GS-5, 4 GS-4 @ $430/day; do 1 acre/day
Hand Digging, Clipping, Girdling and Herbicide	480/acre	Crew of 1 GS-5, 4 GS-4 @ $430/day; vehicle @ $15/day; tools @ $3/day; + herbicide @ $87/day; do 1 acre/day
Hand Pulling and Herbicide	517/acre	Crew of 1 GS-5, 4 GS-4 @ $430/day; herbicides @ $87/day; do 1 acre/day pulling, then 1 acre/day herbicides
Cutting (Chain saw)	800/acre	1 person cutting 1/4 acre/day (salt cedar) @ $200/day, includes chain saw, fuel, and transportation
Cultural		
Seeding	105/acre	1 person @ $200/day; grass seed @ $10/acre; do 2 acres/day
Newspaper Mulching and Unprinted Newspaper or Printed Newspaper	445/acre +120 tons or +4 tons	Crew of 5 @ $430/day; vehicle @ $15/day; do 1 acre/day + 0.24 ton/acre @ $500/ton (no ink); 1,538,888 sheets or 0.24 ton/acre @ $15/ton (with ink); 1,538,888 sheets
Vinegar Application	32/acre	Same as hand torch/spot burning costs plus $10 for vinegar

Treatment	Cost ($) per Unit (rounded)	Cost Assumptions Used
Weed Barrier Fabric	4,240/acre	Crew of 1 GS-5, 4 GS-4 @ $430/day; fabric and pins @ $4,000/acre; vehicle @ $15/day; tools @ $3/day; do 2 acres/day
Annual Monitoring	5,100/ Forest	1 GS-9 @ $200/day; vehicle @ $15/day; data entry 1 day for 5 in field; visit 10 sites/day; do 20 days in field/forest

Using the cost assumptions in Table 52, the Quicksilver model was used to calculate present net value based on costs and benefits of the treatments contained in each alternative. Only costs and benefits contained in published Forest Service documents that relate directly to this project were included. Planning or other “sunk costs” were not part of the analysis. Nonmarket values such detoxification and decomposition of toxic waste or potential property value changes that are not in Forest Service publications were not used in the Quicksilver calculations (State of the Southern Rockies—San Juan-Sangre de Cristo Bioregion, 1998).

Using a benefit-to-cost (B/C) ratio for ecosystem restoration projects such as this one can be very misleading, since ecological and other resource and social benefits for this project are not readily quantifiable. The B/C ratio was often used in the past for timber sale projects as an indicator to determine whether the project pays for itself (e.g. a timber sale with a B/C of less than 1 was considered a “below cost sale,” where costs exceed expected revenues).

Many other factors enter into economic considerations for this weed control project, such as anticipated funding levels, timing of the treatments, and availability of qualified agency personnel (versus contracting). Since a B/C ratio for this weed treatment project would not represent a good measure of economic efficiency, it has not been included in this discussion. Details are found in the project record.

Table 53 shows the Quicksilver calculation results for present net value (PNV), which was driven by treatment cost and benefit variables including the anticipated timing of treatments. Present net values give an indication of costs and benefits in the future to the present. The time period used for this economic analysis is 20 years.

The base cost figures in Table 53 show the estimated cost-per-acre for a treatment, without accounting for differences in the effectiveness of methods used or need for repeat treatments. The economic efficiency cost figures show a more realistic cost estimate, accounting for the expected repeated treatments if some methods are used instead of others. For instance, an herbicide treatment in an established patch of Scotch thistle would require several repeat entries until the seeds stored in the soil are exhausted (6 to 10 years). Treating the same patch without herbicide would require more visits per year to accomplish the same objective. Thus, although Alternative C has a lower single treatment cost than Alternative B, its costs increase substantially when the effectiveness (or repeat treatment cost) is factored in. Monitoring treated sites along with existing and new weed infestations was included as a cost for all alternatives.

Table 53. Present Net Value and Economic Efficiency

	Alt. A	Alt. B	Alt. C	Alt. D
Present Net Value ($)	-$150,613	$1,235,649	$-769,878	$44,124
Base Costs of Treatments	0	$1,215,000	$758,000	$497,000
Economic Efficiency Cost of Treatments		$1,313,000	$1,585,000	$550,000

Alternative A (No Action) has a negative present net value due to the need to continue to monitor known and new weed infestations. The Forests would also continue to treat weeds under previously approved environmental documents.

Alternative B has the highest present net value because it uses the integrated treatment strategy that uses different methods including herbicides. That strategy provides for more rapid treatments of infestation sites.

Alternative C, using no herbicides, has a lower net value and higher efficiency costs because treatments would need to be frequently repeated on the same sites. The treatments under this alternative would require a much longer timeframe to achieve effective control, if “effective control” could be achieved at all.

Alternative D, using primarily herbicides, allows for treatments to be of shorter duration and last for fewer years on the same site. However, some herbicide treatments are not as effective when used alone, without the addition of a manual, mechanical or other method.

Cumulative Effects

The analysis area for the social-economic cumulative effects includes the eight counties described in the demographics section that cover portions of the Forests. All ongoing and future activities on the Forests affect people socially. As described in “Affected Environment,” people from both rural and urban areas enjoy multiple uses on the Forests.

The only real measurable social or economic effects of the weed control project are the indirect beneficial, long-term effects of improving vegetative/ecological composition, structure and function. Thus, the effects of the project would have a cumulatively beneficial effect when combined with many other ongoing and foreseeable future activities on the Forests, such as: wildlife and fish habitat improvement projects, fuel and fire risk reduction projects, and other ecosystem restoration projects. The positive social and economic effects described for Alternatives B, C or D would also be magnified when added to past, current and future weed treatment and prevention activities conducted by the Forests, as well as by other adjacent jurisdictions and landowners.

The weed control alternatives would cause some minor, short-term increases in noise and traffic, adding cumulatively to other sources on the Forests (as described in the “Recreation Resources” section). Weed control activities would also result in minor exposure risks to human health and safety, cumulative when added to other weed control projects expected in northern New Mexico, as described in the subsequent “Human Health and Safety” section). In addition, effects of the weed control alternatives when considered with other actions occurring in the affected counties of northern New Mexico, would not have a disproportionate adverse impact on minorities and low-income populations.

Alternative A (No Action), by contributing to a long-term decline in the health and sustainability of native plant communities, would add to the effects of any other land use activities that reduce the abundance or diversity of native vegetation, such as construction projects, off-road vehicle use, dispersed camping activities, and others.

It should be noted that the proposed Santa Fe National Forest Plan amendment (applicable to Alternatives B and D) modifies the standard and guideline regarding limitations on herbicide use under certain social-economic conditions, for this project as well as foreseeable future projects that involve herbicide use on the Santa Fe National Forest. Rather than limiting herbicide use to "when determined through an environmental analysis to be environmentally, economically and socially acceptable," the amendment limits herbicide use to "when determined through an environmental analysis to have no long-term adverse environmental, economic or social impacts." The modified language would be more clearly and consistently interpreted than the vague original language. The modified language would also provide for greater consistency with environmental analysis requirements under NEPA and other regulations and policies, which is appropriately based on estimated impacts rather than on the "acceptability" of a proposed action. No other social or economic impacts would be expected.

Human Health and Safety

Affected Environment

Approximately 10 to 15 percent of the United States population suffers from allergy symptoms from weed species such as knapweed. Knapweed pollen is a common and powerful allergen that peaks in August and produces strong allergy symptoms. Knapweed pollen has been implicated in causing allergic rhinitis (Gillespie and Hedstrom 1979). Allergies to airborne seeds may also complicate or trigger asthma that may take up to 2 years to get completely under control (Nielsen 1999). Highly allergic individuals can have serious complications when exposed to allergens (weeds or pollen), including constriction of the airway and anaphylactic shock. Some species of weeds, such as bull thistle and knapweeds, also cause minor scrapes and irritations. Leafy spurge contains a latex-bearing sap that irritates human skin and has the rare potential to cause blindness upon contact with the eye (Callihan et al. 1991).

Weed infestations increase the risk of wildfire and where this fire risk increases in populated areas, it poses an increased risk to human health and safety. An example is the major salt cedar invasion of riparian areas throughout New Mexico and other western states. Albuquerque’s 2003 Bosque Fire burned at a much higher than normal intensity and severity due to the amount of salt cedar and other weeds that dominated the riparian area.

Herbicides proposed for use in this project would be limited to those tested and registered by the EPA as being safe for use in areas where people live, work and recreate. They pose little to no risk of adverse health impacts when used according to label instructions. However, a small percentage of the population reports a hypersensitivity to a wide variety of pesticides, perfumes, household cleaners, construction products or industrial chemicals, including the herbicides proposed for use by the Forests (Gibson 2000, Barrett and Gots, 1998). A 1997 New Mexico Behavioral Risk Factor Survey completed by the New Mexico Department of Health, Office of Epidemiology indicates 2 to 3 percent of those responding to the survey instrument are chemically sensitive with up to 16 percent of the New Mexico population possibly sensitive (MCS Task Force 2000).

Environmental Consequences

Alternative A (No Action)

Under this alternative, weeds would continue to spread and become more dominant on the Forests. As weeds spread, there would be an increase in the discomfort and ill health effects to people who get allergies, asthma, contact dermatitis or other skin irritations from certain weed species.

With this alternative, ongoing weed treatments on the Forests would continue. However, this alternative would avoid the potential for additional herbicide exposure that could affect chemically sensitive individuals.

Alternatives B and D (Proposed Action and Herbicide Only)

Alternatives B and D include the use of herbicides. Appendix 3 provides a review of the herbicides, including their “half-life” (duration they remain viable) and human health risks. For all of the proposed herbicides, the risk to human health for the general population is low. Despite the limited risk of adverse health effects predicted based on EPA testing and label restrictions, people who suffer from hypersensitivity to chemicals in the environment may be inadvertently exposed to and adversely affected by herbicide residues if they use the localized sites where an herbicide has been applied. Individuals with this ailment are generally aware of their sensitivities, and could avoid herbicide treated areas during the time that the chemical residue is active. Some herbicides would only remain detectable in the environment for a few days while others remain active and detectable in the soil for several years. For example, picloram has a half-life of up to 3 years. Herbicide exposure to chemically sensitive individuals would be minimized through the public notification requirements described in Chapter 2. Oftentimes because of the personal variability in the reaction to treatments, notification provides the best means of allowing people to determine when to enter such an area. Generally, a safe re-entry period passes in treated areas after the herbicide has dried on the leaf surface.

Chemically hypersensitive individuals may also be subject to exposure and ill health effects from oil, gasoline, diesel, or propane engine fuels and exhaust from motorized equipment and vehicles used for weed control activities. Oil, gas, diesel and propane fuels used in equipment and vehicles for management and recreational activities would occur as background exposure throughout the Forests and in the surrounding public and private lands.

The risk of adverse health effects from herbicides for the general population would be low. (USDA FS 1992, USDA FS 1997, SERA 1995, SERA 1996, SERA 1997, SERA 1998a, SERA 1998b, SERA 1999a, SERA 1999b, SERA 2000, SERA 2001, SERA 2002, SERA 2003a, SERA 2003b, SERA 2003c).

Potential adverse effects would be minimized by using only herbicides registered by EPA as having a low risk to human health, along with notifying the public so they can avoid treated areas for an appropriate amount of time, following all label instructions, prohibiting aerial spraying, and other measures described in Chapter 2. Label information and requirements include: user safety; first aid; environmental hazards; directions for use; storage and disposal; general information; mixing and application methods; approved uses; weeds controlled; and application rates. Additional mitigation measures developed by forest resource specialists and described in Chapter 2 that reduce herbicide risks to wildlife, fish and other natural resources would also reduce the risks of exposure to humans. It is assumed from past experience that the label requirements and other mitigation measures would be carefully followed, and that overall the mitigation measures would exceed the minimum requirements on EPA labels.

The general public may be secondarily exposed to a spill or release should it reach surface or ground water. The risk of an herbicide spill or accident would be greatest under Alternative D, which exclusively uses herbicides to treat weed infestations. The indirect effects of a spill in the form of public exposure and disruption would be commensurate with the proximity of the spill area to the public and public exposure pathways. The risk of exposure from this means is low due to mitigation measures that limit exposure of the herbicides to water and avoid accidental spills or leaks (refer to Chapter 2).

Workers applying herbicides, especially with backpack sprayers, have a greater potential for exposure to herbicides. They have less potential exposure when using vehicle-mounted spray equipment. Handling and mixing the herbicides or working in close proximity to the spray nozzle would result in a greater exposure and health risk to the worker. However, worker exposure to adverse effects would be limited as chemically-sensitive individuals would not be allowed to work on herbicide spray crews, and human health risks associated with the herbicides to be used is considered low.

A summary of scientific assessments regarding human health risks from exposure to herbicides is contained in Appendix 3. Risk assessments indicate that there is no route of exposure or exposure scenario suggesting that the general public would be at risk from longer-term exposure to herbicides. However, there are too many variables (receptor sensitivity, dose received, use of personal protection, etc.) for precise predictions of the health effects from herbicide exposure. Given this uncertainty, the risk of adverse health effects is managed by following a process of continual review of toxicological data on herbicides. The EPA, using very conservative assumptions, has determined a dose they believe would not result in an adverse health effect for herbicides proposed for this project. The Forest Service develops and maintains risk assessments to determine the estimated dose a worker or person of the general public might be exposed to under varying exposure scenarios. A comparison of EPA established safe doses and estimated exposures concludes that the estimated dose that workers or the general public may be exposed to on this project would be below that determined to be safe by the EPA for a lifetime of daily exposure.

In addition to the risk associated with herbicide use, all weed treatment methods pose a risk of worker injuries from accidental slips or falls on rough mountainous terrain. This risk of accidental injury would be lessened by taking precautions including the use of personnel accustomed to working in rough terrain, protective equipment, and other standard safety practices.

Workers conducting weed treatments with mechanized equipment (to mow, till, or dig) could also potentially be harmed by breathing gas or diesel emissions, or getting cuts, burns, allergies, and skin irritations. Workers may also be exposed to dust and chaff during seeding operations. However, those risks would be very low due to the required personal protective equipment such as gloves, long sleeved shirts, boots, and safety glasses, along with not using workers having a heightened sensitivity to allergens or skin irritations. Risks to the general public during mechanical treatments would be mitigated by avoiding treatments during high use times or closing campgrounds during treatment.

As the abundance of weeds is diminished over time, there would be a decrease in the discomfort and ill health effects to people who get allergies, asthma, contact dermatitis or other skin irritations from certain weed species.

Alternative C (No Herbicides)

There would be minimal health and safety risks associated with implementing this alternative, as described for the mechanical and other nonherbicide treatments in Alternative B, due to the mitigation measures to be employed.

Without the use of herbicides, weeds would likely continue to spread on the Forests and impact individuals affected by allergies, asthma, and minor skin irritations caused by certain weed species, as previously described.

Use of prescribed burning is an emphasis of Alternative C not found in Alternative B or D. The burning of a large number of acres in this alternative adds to the health risks associated with fire and smoke. Because the burning program would be managed to maintain air quality, this additional risk is not expected to be measurable.

Alternative C would require more repeated entries into the same weed infestation areas to achieve an acceptable level of weed control. Thus, there would be a slight increase in the risks to workers and the public from exposure to these hazards when compared with Alternative B or D.

Cumulative Effects

The analysis area for cumulative effects on human health and safety is the area in and immediately adjacent to the Forests. This boundary represents the areas where the actions proposed in this project are most likely to interact with other activities, in particular the weed treatments and ground disturbance on both forests and other lands (private, State, BLM, etc).

Past, present and reasonably foreseeable activities that may have cumulative effects on human health include weed control efforts (aerial and ground application of herbicides) on private and public lands in northern New Mexico, as outlined in Appendix 3. Potential for public exposure to weed treatments would come from other weed treatment activities currently underway and planned in the foreseeable future.

Cumulatively, risks to human health from the additive effects of herbicide exposure would likely remain low. Alternative B or D, combined with ongoing and foreseeable applications by other jurisdictions, would affect less than 0.5 percent of the Forests' 3 million acres of public lands over the next 10 years, and the duration of potential human contact with herbicides on plant or soil surfaces is typically less than a day. Application rates permitted by the EPA use a process to determine toxicity and exposure, with the use of the "reference dose" to account for cumulative exposure. These doses represent a very small dose that, when given over a lifetime (70 years), would show no effect. Risk assessments indicate that when considered with each treatment under Alternative B or D and added to other herbicide treatments ongoing or foreseeable, the likelihood is extremely low that any individual would be exposed to an amount of herbicide that exceeds the reference dose. Workers who apply the herbicide are at the greatest risk, but with use of protective clothing and equipment along with following label restrictions, they are not expected to exceed this dose. The risk to the general public is even lower, even when all the amounts are considered cumulatively.

All alternatives are consistent with EPA, OSHA and Forest Service regulations regarding herbicide use and worker safety.

Other Required Disclosures

Short-term Uses and Long-term Productivity

NEPA requires consideration of “the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity” (40 CFR 1502.16). All practicable mitigation measures were incorporated into this project design to create or maintain favorable environmental conditions and avoid adverse impacts. The project may cause some people to temporarily avoid specific areas on the Forests during implementation of weed control treatments, particularly for individuals with a hypersensitivity to chemicals. Some wildlife species would temporarily avoid treatment areas due to noise and human presence. Multiple use activities on the Forests, including recreational activities, collection of wood and other forest products, livestock grazing, forest management activities, and others would not be substantially altered by this project. The analysis indicates that eradicating and controlling weeds on the Forests would provide substantial long-term benefits to forest and rangeland vegetation, soil and water quality, wildlife habitat, and the sustainability of ecosystem structures and functions.

Unavoidable Adverse Effects

Minor and short-term adverse effects predicted for this project would be a reduction in nontarget native vegetation, exposure of bare soil, and minor increases in erosion on a portion of the 600-1,600 acres per year expected to be treated. However, the requirement to ensure recovery of desired vegetation where needed following treatment would limit these effects to typically less than a year, and soil erosion rates would remain within Forest Plan standards. No significant, long-term adverse effects were predicted for this project, and long-term soil productivity would be maintained or enhanced.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road. No irreversible and irretrievable commitments of resources have been identified through the analysis.

Chapter 4 • List of Preparers and Document Distribution

List of Preparers

From 1999-2002, the Forest Service worked with a team of contractors to develop a preliminary draft of the EIS. Those contractors were: Bill Hevron (project manager/botanist), Mike Tremble (biologist), Phillips Banks (weed specialist), Roy Carson (forester), and Kenneth Brown (archaeologist). From 2003-2004, an expanded IDT from the Forest Service along with additional contractors conducted and completed the environmental analysis documented in this DEIS. The table that follows lists the key individuals responsible for this DEIS.

Table 54. List of Preparers

Name	Position	Contribution	Education and Experience
Lucy Aragon	Natural Resources Planner, Carson National Forest	Livestock Grazing, Recreation and Wilderness	BS Range and Forest Management 13 years experience
Blaze Baker	Botanist, USFS-T.E.A.M.S.	Vegetation and Special Status Plants	BS Botany 5 years experience
Gretchen Barkmann	Air Quality Specialist, National Forests of New Mexico	Air Quality	BA Biology; MS Environ. Engineering 15 years experience
Michael J. Bremer	Forest Archaeologist, Santa Fe National Forest	Heritage Resources	BA Anthropology; MA Anthropology 28 years experience
Susan Bruin	Forest Planner, Santa Fe National Forest	NEPA Compliance and Editing	BS Natural Resource Mgt. MS Res. Policy and Law 18 years experience
Jack Carpenter	Natural Resources Planner, Carson National Forest	Social-Economic, Health and Safety	BS Forestry 27 years experience
Daniel Erskine	Senior Geochemist, Maxim Technologies, Inc.	Soil & Herbicide Delivery Calculations	BS Geology; MS Geol. and Geochemistry PhD Earth Sci. and Geochem. 16 years experience
David Highness	GIS Programmer and Analyst; Maxim Technologies, Inc.	Geographic Info. Systems Analysis and Maps	BS Anthropology; MA Geography 10 years experience
Sandy Hurlocker	Natural Resources Planner, Santa Fe National Forest	Project Leader, NEPA Compliance, Writer/Editor	BS Science Education MS Journalism 20 years experience
Barry Imler	Forest Range Program Mgr., Santa Fe National Forest	Vegetation Resources, Livestock Grazing	BSR Renewable Natural Resources; MS Watershed Management 13 years experience
David M. Johnson	Forest Archaeologist, Carson National Forest	Heritage Resources	BA Anthropology; MA Anthropology 29 years experience
Lee Johnson	Forest Wildlife/Fish Biologist, Santa Fe National Forest	Wildlife Resources	BS Fisheries 23 years experience

Greg Lind	Natural Resources Planner, USFS-T.E.A.M.S.	Writer-Editor	BS Botany 20 years experience
Alfred Medina	GIS Specialist, Espanola Ranger District, Santa Fe National Forest	Geographic Info. Systems Analysis and Maps	BS Mgt. Info. Systems 12 years experience
Greg Miller	Soil Scientist, Carson National Forest	Soil and Water Resources	BS Agriculture/Soils 20 years experience
Patrick Mullen	Natural Resource Specialist; Maxim Technologies Inc.,	Fish and Aquatic Resources	BS Biology; MA Zoology/Wildlife Biology 16 years
Mary Orr	Acting Forest Biologist, Santa Fe National Forest	Biological Assessment and Evaluation	BS Wildlife Biology 24 years experience
Melissa Powell	Forest Archaeologist, Santa Fe National Forest	Heritage Resources	Ph.D Archeology 10 years experience
David Rogness	Senior Hydrologist, Maxim Technologies, Inc.	Water Resources	BS Earth Sci./Geology; MS Hydrology 23 years experience

Document Distribution

This section discusses the agencies, organizations and persons to whom copies of the DEIS are sent, in accordance with 40 CFR §1502.19.

Copies of the DEIS will be furnished to any government agency or Native American tribe with a jurisdictional or other interest in the proposed project, as well as any person or organization requesting a copy of the DEIS. A Notice of Availability will be published in the Federal Register as well as in the Albuquerque Journal.

As a minimum, copies of the entire DEIS will be sent to agencies such as the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Bureau of Land Management, Bureau of Indian Affairs, National Park Service, New Mexico Game and Fish Department, New Mexico Environment Department, New Mexico Department of Agriculture, New Mexico State Historic Preservation Office, County Extension offices, and several others.

In May of 2004, a postcard was sent to over 300 potentially affected or interested parties on the project's mailing list notifying them of the upcoming availability of the DEIS and DEIS Summary on the Internet or by mail as a paper copy (upon request). The mailing list for those who request a paper copy of the entire DEIS or DEIS Summary will be available for public review in the project record.

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Appendix 1 • Past, Present and Future Weed Control Activities

Previous weed treatments on the two forests consisted of:

- Manual control (hand digging rosettes and clipping seed heads) of thistles (musk, Scotch, and bull) on the Jicarilla, Questa, and Camino Real Ranger Districts, Carson National Forest, and on the Espanola, Jemez, and Cuba Ranger Districts, Santa Fe National Forest. Ongoing, as labor has been available. (Totaled 88 acres for FY2003, Santa Fe National Forest and 150 acres for FY2003, Carson National Forest).
- Herbicide treatment of salt cedar on the Jemez Ranger District, Santa Fe National Forest. Started 1999, ongoing through 2002. (Equipment failure caused no acres to be treated on this project in FY2003).
- Goat grazing of yellow toadflax, Russian knapweed, and hoary cress on highway right-of-way south of Tres Piedras. One time treatment, 2002.
- Mowing of U.S. Highways 64 and 285 by NMSH&TD. Ongoing for visibility. When the mowing occurs prior to seed heads maturing, it assists in limiting the spread of the weed populations. When this is done at the “incorrect” time (seed heads already mature), it has the potential to exacerbate the weed problem by spreading the weed seeds to noninfested sites.

Reasonably foreseeable activities within the cumulative effects area include weed control projects proposed by private landowners, county, State and other Federal agencies:

- **Voluntary Cooperative Weed Management Areas (CWMAs):** The New Mexico Department of Agriculture (NMDA) lists 12 Volunteer Noxious Weed/Invasive Plant Management Organizations within the state of New Mexico. The following three are located in the northern portion of New Mexico, in the vicinity of the Forests: Colfax County Weed Management Area, San Juan County Weed Management Area, and Sandoval County Weed Management Area.
- **Colfax County:** There have been biological controls released on spotted knapweed and leafy spurge within Colfax County. These have also been treated with herbicide. Angel Fire also has a population of leafy spurge on which they have released biological control. There is spotted knapweed in Cimarron Canyon that had a biological control released on it. The Carson National Forest is a signer of the MOU for the Colfax County Weed Management Area.
- **Colfax County:** Their biggest concerns to date are musk thistle, leafy spurge, spotted knapweed and hoary cress. Water and roads are the primary transportation modes of the weeds. Money is a constraint and they are applying for a Pulling Together Grant this fall. The hoary cress has not been mapped, due to a lack of mapping labor in the spring, but has been noted as an increasing problem.
- **San Juan County:** During the past 3 years they have been conducting mapping on 3 million acres. They have a USFWS Pulling Together grant ($104,000) which they have been using to cost-share with private landowners on treatment of weeds. They have accomplished 1,872 acres of treatment on private lands (76 private landowners) within the CWMA in the past 3 years. Water appears to be the number one mode of weed seed transportation, especially along the San Juan, Animas, and La Plata Rivers. Off of the rivers, the weeds are primarily within one mile of each side of the river.

- **San Juan County:** The BLM oil and gas permittees have established target areas for treatment. There are weeds all over BLM lands, primarily at the well pads, roads and along the pipelines. The permittees provide funding for a variety of restoration/mitigation, with weed treatments included in the list of projects funded.
- **San Juan County:** Russian knapweed is the weed that they have the most acres of, along with musk thistle, and then Canada thistle. Their biggest concern, however, is small "hot spots" of leafy spurge. They also have spotted knapweed in a few spots and they found camelthorn near Upper Fruitland, which is a concern because it has adapted itself to live this far north (previously thought to be out of range) (1900 acres plus).
- **Sandoval County Weed Management Area:** The Cuba Soil and Water Conservation District (SWCD) began a weed control project in 1999. They have primarily been targeting hoary cress and Russian knapweed, along with Canada thistle, musk thistle, and bull thistle. They provide chemical and technical assistance to private landowners to treat the weeds and have used Redeem and Escort brand herbicides. In 2003 they assisted in treating 65 acres total, and in 2002 did 30 acres. The highway department also treated 3 miles of highway right-of-way in 2002. They are very involved in education and awareness activities, writing articles for the local newspaper and showing pictures with their displays (30-65 acres per year, 3 miles of highway).
- The **Taos County Noxious Weed Alternative Management Committee** is a volunteer Noxious Weed/Invasive Plant Management Organization in the northern New Mexico area, based in Taos, NM, which emphasizes nonherbicidal control of weeds. They have been conducting education and awareness activities, demonstration projects, and mapping of existing infestations. In addition, a member has been actively coordinating the timed mowing of highway rights-of-way to insure it is done in a way to limit seed production and spread of weeds. The NMSH&TD entered into an agreement with this committee in 2001 to put the money they would have spent on herbicidal control within Taos County toward the committee's nonherbicidal control efforts.
- **New Mexico Association of Conservation Districts (NMACD):** Coordinating the New Mexico Salt Cedar Control Project along the Pecos and Rio Grande Rivers, including the northern Rio Grande area. The NM State Legislature initially appropriated $5 million for nonnative phreatophyte control. This project will include aerial spraying and ground applications along the northern Rio Grande.
- **Coronado SWCD** has let bids out and plans to treat 25 acres south of 540 in Bernalillo. They also have tentative plans to work on the Sandia Pueblo and, possibly, the Santa Domingo Pueblo on Galisteo River. Additional work may be pursued on Coronado State Park, Jackalope and Coronado Restaurant lands. This could be as much as 25 acres of land.
- **Valencia SWCD** has awarded one contract for stump treatment within its district. This is the first site that is on Middle Rio Grande Conservancy District (MRGCD) lands. The final proposal price was $ 2,672 per acre. They have recently completed 10 acres on the Rio Grande in Valencia County. (This project also has an education component. A local school works in cooperation with the UNM Bosque Ecosystem Monitoring Project (BEMP) to do various types of monitoring in this area.) They are monitoring vegetation, wildlife and elevation in the water wells. Valencia has signed up additional acreage located on lands owned by two pueblos for aerial application. Isleta Pueblo has 1,300 acres signed up plus another 355 acres that the pueblo will pay for. (This would amount to a match of approximately $65,000-80,000.) These acres are located in the Coyote and

Comanche drainages that flow into the Rio Puerco. Laguna Pueblo has a total of 1,830 acres spanning approximately 70 miles with about 805 acres of wetland areas that need treatment. The total of the 2 pueblos is approximately 6,000 acres. Valencia is planning on doing demonstration tracks of about 5-10 acres using different kinds of mechanical methods including mechanized mulchers, sheers, and dozers. The district is hoping to be able to evaluate the efficacy of different labor saving machinery. The goal is to reduce the per acre cost of treating phreatophytes and removing the excess fuel loads they create.

- **Ciudad SWCD** is in the process of awarding bids for work. They will be treating approximately 100 acres within the Rio Grande Nature Center. They have best and final offers for 40 acres and inmate work crews will do the remaining 60 acres of the nature center. On the west side of the river in Rio Rancho, 22 acres will be awarded to another local company. This is north of Corrales, east of Highway 3. This site is within the City of Rio Rancho. About $6,000 worth of in-kind services including labor, legal assistance, and environmental planning assistance and traffic control has been received on the project from the city. One city councilor is highly involved with the project. Another site is at the National Hispanic Cultural Center. This site is only about 2 acres and will be done by inmate crews. However, this site will also offer some unique opportunities for public awareness about bosque health and management.
- **Santa Fe-Pojoaque SWCD** issued RFPs in February and a contract was awarded to the Deveg Group in March. The bid ranged from $ 1,894/acre for cut and pile to $ 2,294/acre for cut and chip. They have five sites. Santa Fe Pojoaque has 2 sites done on Simons in the La Cienega area and the Los Golondrinas area. On La Cienega, there are 41 acres that have been treated. There are another 12-15 acres waiting for treatment. The district has also been in communication with Pojoaque Pueblo and the Pojoaque Irrigation District. There are approximately 20 acres on the pueblo and the acreage has not yet been estimated for the irrigation district. Two additional groups that the Santa Fe-Pojoaque SWCD is working with are the La Cienega Watershed Group and El Rancho de los Golondrinas. These two participants provide public education about riparian restoration and outdoor learning experiences, respectively.
- **East Rio Arriba SWCD** has landowner agreements with 23 landowners, totaling approximately 60 acres. There is a possibility that some will be treated aerially along the Ojo Caliente River. The site identified for aerial treatment is approximately 2 miles by 100 feet wide along the riparian corridor. The landowner is working to secure neighbor’s support to possibly extend the project to10 miles in length, but this will also depend on what the native composition is in the area; there are some areas with dense cottonwood and willow that would not lend themselves to an aerial application. East Rio Arriba SWCD will let RFPs in July and work will begin in September. They are working with the Abiquiu land grant watershed that directly feeds the Rio Chama.
- **Northern Rio Grande Salt Cedar Control Project** aims to eliminate the nonnative phreatophyte with money appropriated by the NM State Legislature. This project will offer to eliminate salt cedar on voluntary cooperators’ lands (private, pueblo, and Middle Rio Grande Conservation District). All herbicide applications are done by licensed applicators. From Bernalillo north, the predominant species treated is Russian olive, with the exception of a stretch of salt cedar in the Galisteo basin. From Bernalillo south, the predominant species treated is salt cedar. In 2003, acres treated as part of this project were:

  - East Rio Arriba SWCD, 93 acres with Garlon 4
  - Santa Fe-Pojoaque SWCD, 94 acres with Garlon 4
  - Coronado SWCD, 20 acres w/Garlon 4 and 670 acres w/Arsenal
  - Ciudad SWCD, 70 acres w/Garlon 4
  - Valencia SWCD, 30 acres w/Garlon 4 and 1,044 acres w/Arsenal

  Foreseeable future treatments include using large cutter machines, which chip the woody above ground material, then leave the chips on the ground. Very preliminary observations seem to show that it inhibits weeds but allows the grasses to become established. Goats are also a viable option for handling the treatment of resprouts (woody species). One organic farmer has requested this option down near Socorro.

- **Mora and San Miguel Counties:** The only weed work is being done by the NM State Highway & Transportation Department. The railroad may be doing a little work along the railroad tracks. The BLM gave the Adelante RC&D funds to establish a native plant seed source for reclamation projects. They are trying to produce mountain muhly and pine drop seed, plus a couple of native forbs. He noted that there is purple starthistle in Mora County, which has been present since the 1950s, possibly brought in at a sheep camp. It has remained fairly small, but it has begun to spread in the past few years. The counties are currently mapping weeds.

  There was one cost share in 2003; it was for control of 10-20 acres of Canada thistle. The private landowner most likely used Roundup for this project. They used goats in 2002 on Carabajal Rd./Fred Baca Park. The goats grazed 10 acres in 5 days. There was a mixture of Canada thistle, musk thistle, bull thistle, and whitetop.

- **Tierra y Montes SWCD:** in the planning process to treat approximately 6 acres of salt cedar along the Pecos River. It is a cut stump treatment (Garlon). They are working with private landowners on this project.
- **Upper Chama SWCD: NRCS** has a cost-share program. Their cooperators have been concentrating on big sage control (native – 1000s of acres, Jicarilla Apache Reservation, private landowners, with Spike) and chicory control (nonnative but not yet listed as noxious in NM – 40-60 acres over the past couple of years, Cebolla area, with Picloram). Hoary cress (white top) is of high concern to them; there is a lot of it on the Jicarilla Reservation. Of lesser concern, is dalmation toadflax, which is coming in on hay, and about 5 species of thistles. The SWCD has equipment (backpack sprayer) that they loan out to individuals who need it and that they participated in an outdoor classroom-type outreach several years ago.
- **Rio Arriba County Extension Service** has proposed work in El Rito for perennial pepperweed, hoary cress, Russian knapweed, and chickweed. Along Hwy. 285, dalmation toadflax has expanded to about 10 acres in the Tusas area. Several years ago Sam Martinez released biological controls on leafy spurge in the Tusas area. (The leafy spurge infestation started with some hay on his property….) Now that population of biological control is an "insectary" where you can collect from it in July to release in other patches of leafy spurge. There is no fee, just the time it takes to collect.
- **New Mexico State Highway and Transportation Department** (NMSHTD): The NMSHTD Vegetation Management page on the Department's Web site listed the weed spraying schedule for the State by route number and mile post information. The schedule

for 2003 included the following areas in the general vicinity of the two forests. Portions of NMSHTD Districts 3, 4, 5, and 6 are near the Forests.

- **District 3:** On Interstate 25, Roundup and Velpar were scheduled to be applied on 6/19-6/20/2003 from mileposts: 248-264 (Algodones to Santa Fe County Line).
- **District 4:** The spraying within District 4 was all very distant from the forest boundaries, in the eastern part of the state, south of Interstate 40.
- **District 5:** The areas near the Forests include the following, and were all scheduled for application during the week of July 21-25, 2003.
  - NM 106 from the junction with 84/285 and the junction with NM 76, mileposts 0-0.7: .7 miles Roundup and Sahara. Espanola area - spraying medians. (Near Espanola RD, Santa Fe National Forest.)
  - NM 112: from Junction 64/112 to El Vado State Park, mileposts 30.2-44.6: approximately 14 miles guardrails and signs of 2,4-D Amine, Garlon 3A, Roundup, Sahara, Tordon. (North of the Cuba RD, Santa Fe National Forest and between the Jicarilla and Tres Piedras RDs, Carson National Forest).
  - N 41: From junction of U.S. 285 to the Junction with I40, mileposts 62.09-28.2: approximately 34 miles spot spraying guardrails with Roundup and Sahara. (South and west of the Santa Fe National Forest.)
  - U.S. 285: From the patrol yard to junction with NM 41, mileposts 249-283: approximately 24 miles spot spraying guardrails with Rodeo and Sahara. (South and west of the Santa Fe National Forest.)
  - U.S. 64: From Jct. 84/64 to the end of the patrol yard, mileposts 171.7-198.5: approximately 27 miles spot spraying guardrails and shoulders with 2,3-D Amine, Garlon 3A, Roundup, Sahara, Tordon. (Tierra Amarilla.)
  - U.S. 84: Junction 84/NM 96-Junction 84/U.S. 64, mileposts 218.3-255: approximately 37 miles spot spraying guardrails and shoulders with 2,4-D Amine, 3A, Roundup, Sahara, Tordon (Tierra Amarilla – Abiquiu Dam.)
  - U.S. 84: From NM 584 to Northwest Frontage Road, mileposts 190.6-194.3: approximately 4 miles spraying medians with Roundup and Sahara. (Espanola area.)
  - U.S. 84: From entrance to patrol yard to Junction of NM 30/84, mileposts 177.6-189.2: spraying median and sidewalk with Roundup and Sahara. (Espanola area.)
- **District 6:** The spraying within District 6 was all very distant from the forest boundaries, in the western and northwestern part of the State.

- **Santa Fe Watershed Association/City of Santa Fe:** used a cut stump herbicide treatment. Aquamaster (Round Up® with nearly 50 percent glyphosate) painted directly onto cut Siberian elm stumps The cut stump treatment of Siberian elm along the Santa Fe River was done along a stretch from Galisteo Street to St. Francis Drive (less than one mile) within Santa Fe city limits. The project was done in October/November 2003, so they don’t have any information on the effectiveness yet. This was not a comprehensive treatment designed to remove all of the Siberian elm; rather, it was designed to reduce the elms enough to give the native species a chance to more effectively compete against the elm and get established. Reduce the amount of seed source, as well as the density of trees along the river. He noted that they had also treated a 300- to 500-foot stretch of the Santa Fe River just below Adam Armijo Park early this spring, again at the request of citizens (the Canyon Road Association and Audubon Society), using the same cut stump treatment with Aquamaster. He noted that they had tried a nonherbicide control using a backhoe and an inmate crew a few years ago along a 100-yard stretch near St. Francis. At the end of the project, they decided the damage to the streambank outweighed the benefits.

- **Nature Conservancy:** a weed control project on their Santa Fe Canyon Preserve in 2001. It was a cut stump treatment of Russian olive and Siberian elm using Garlon 4 along an approximate quarter- to half-mile stretch of the Santa Fe River. There may also have been a little salt cedar in there. This project is sandwiched in between the work the City of Santa Fe did on city property and the project the Audubon Society did on private land.
- **Audubon Society and Canyon Road Association:** Aquamaster was used in the treatment in the east canyon where it crosses the Santa Fe River, and on private properties along a 2-mile stretch of the Santa Fe River, with the goal of removing exotic Siberian elm and Russian olives. They are also conducting inventory and identification of wildlife habitat.
- **Earthworks Institute:** coordinating the Galisteo Watershed Project. They have done work in enhancing the riparian conditions (induced meandering, etc.) in the watershed in favor of native species. They have used some prescribed grazing with goats in the grasslands within the project to remove dead material and weeds, including juniper. Due to the drought, the results are inconclusive at this time.
- **Rio Grande Restoration:** working on several projects over the past several years. Salt cedar control in this Chama Canyon project involved a small amount of mechanical control. They were trying to protect a spring by removing the salt cedar sprouting there. Mostly they have small emergent plants which can be hand dug. They also have a site they are working on along the Rio Grande: The Taos-Rio Arriba County Line Site. They have a more aggressive salt cedar control project there. Chain saw work with followup hand digging with cutter hoes by numerous youth groups from around the country doing service projects in conjunction with river trips.
- **Bureau of Indian Affairs:** Eight Northern Pueblos Agency has not done any herbicide treatments on tribal lands in the past several years. The last time they did any herbicide treatment was on the Taos Pueblo approximately 10 years ago on a sagebrush control project.
- **Valles Caldera National Preserve:** approved a noxious weed control and eradication project on September 5, 2003. This project proposes to treat three species of thistles (bull, Canada, and musk) along 70 miles of roads using clopyralid. The project was scheduled to begin September 2003, and they hope to complete it by November 2006. They currently only have an estimated 5 acres of these species within the VCNP.
- National Park Service: **Bandelier National Monument** has not done any herbicide treatment for weed control for about 3-4 years. Then it was limited to about 10 individual stumps using Pathfinder. He noted that they have a lot of Russian olive, Siberian elm, and salt cedar along a 6-mile stretch of river corridor (Rio Grande) (maybe 10 years down the road). He is seeing the worst weed problems in the Cochiti Reservoir area, where they just located Russian knapweed last year. He said they treated Ailanthus (tree of heaven) about 6 years ago, but it wasn’t successful.

- **Chaco National Historical Park:** the park uses a prevention and early detection strategy to control their weeds. Cheat grass is the species they have the most acres of. They treat small isolated patches of salt cedar away from the wash with a cut stump treatment using Tordol in the fall. They estimate having treated no more than 10 acres with this method over the past 2 years.
- **Pecos National Historical Park** has been working on controlling Scotch thistle, Siberian elm, Russian olive, and salt cedar on the approximately 6,600-acre park for 3 years, using a Garlon 4a cut stump treatment on the woody species. Since initial treatment 3 years ago, it has been a minimal retreatment process on resprouts. Roundup is also used on scotch thistle early in the growing season, usually May and June, but sometimes as early as April, so that a minimal amount of Roundup will control the relatively small rosettes. About 5-10 gallons of Roundup is needed each year.
- **Bureau of Land Management:** There are three field offices (FO) with BLM lands near the Forests: Albuquerque FO, Farmington FO, and Taos FO. The totals of acres inventoried for weeds for each FO and the total weed acres treated for each FO, for the fiscal years 2000-2003 are shown in Table 55.

Table 55. Acres Inventoried and Treated for Weeds on Nearby BLM Lands by Fiscal Year

Field Office	FY 2000	FY 2001	FY 2002	FY 2003
Acres Inventoried (total acres surveyed)				
Albuquerque FO	4,800	26,700	5,500	4,000
Taos FO	500	1,080	12	204
Farmington FO	4,000	3,500	5,500	11,400
Acres of Invasive Weeds Treated				
Albuquerque FO	60	303	96	857
Taos FO	10	0	1	0
Farmington FO	250	1,400	120	17

- **Farmington FO:** 11,400 acres surveyed in 2003 were part of a fairly systematic survey of San Juan County. Some acres were done in conjunction with general work activities. They have more acres of Russian knapweed than any other weed, but it is so widespread that their primary control strategy is “containment,” to reduce additional spread from known infestations. Their priority species for “rapid response” include: Scotch thistle, leafy spurge, toadflaxes and camel thorn. They work in conjunction with the highway department to notify each other of new infestations they find so they can be treated quickly. Oil and gas leases are responsible for treating well pads and pipeline rights-of-way. Some of the offsite mitigation funds go for weed control.
  - The acres treated in 2003 were: 20 acres of Russian knapweed - 15 with Grazeon P+D, scattered populations in eastern San Juan County (Middle Mesa and Jarosa areas); and 5 with Redeem; 3 acres of leafy spurge with Grazeon P+D in the same general area as the Russian knapweed; 2 acres of Scotch thistle – hand grubbed; and 15 acres of buffalo bur (an invasive plant from the Midwest) with Grazeon P+D, 4 miles east of Aztec. These were done from spring to early fall in 2003. These acres

don't match the 17 acres reported for 2003, due to the fiscal reporting year ending September 30.

- **Albuquerque FO:** weed inventories were conducted in conjunction with general work, as well as with permit lease renewal health assessments. In conjunction with the Cuba SWCD (BLM funded in part), they treated 2.5 acres of hoary cress, 60 acres of Russian knapweed, one-half acre of Canada thistle, and 4.5 acres of musk thistle in 2003. Of these acres, 64.5 were done with Redeem and Escort. The remainder was hand digging. The same acres reported under the Cuba SWCD were done on private lands within Sandoval County. In addition, they treated 110 acres of musk thistle and 5 acres of halogeton with Roundup in 2003 on BLM lands within Sandoval County. They also treated 300 acres of salt cedar in the Chico Drainage with an aerial application of Arsenol and Roundup in 2003.
- **Taos FO:** limited time/funds to concentrate on weeds. Treated acres for the Taos FO are: 2001 (0 acres), 2002 (1 acre), and 2003 (0 acres). The one acre of treatment in 2002 included hand digging of black henbane in their north unit, and hand digging of hoary cress along the Orilla Verde Recreation Area along the Rio Grande. They did not use any herbicidal control.
- **Southwest Strategy:** USFS Riparian Invasive Species Interagency Plan that numerous agencies in the State are working on.

Table 56. Methods of Addressing Weeds in 2003

Agency or Organization	Education and Awareness	Manual Control (hand pulling, grazing, and mowing) and Biological Control	Herbicide Treatment
Carson National Forest	Yes	150 acres	0 acres
Santa Fe National Forest	Yes	88 acres	0 acres
Colfax County Weed Management Area	Yes		
San Juan County Weed Management Area	Yes		1,872 acres (over the past 3 years)
Sandoval County Weed Management Area	Yes	3 acres hand digging	65 acres (Redeem and Escort brand herbicides)
Taos County Noxious Weed Alternative Management Committee	Yes	Coordinated timed mowing with the NMSH&TD	
Northern Rio Grande Salt Cedar Control Project			
East Rio Arriba SWCD	Yes		93 acres (Garlon 4)
Santa Fe-Pojoaque SWCD	Yes		94 acres (Garlon 4)
Coronado SWCD	Yes		20 acres (Garlon 4) 670 acres (Arsenal)
Ciudad SWCD	Yes		70 acres (Garlon 4)

Agency or Organization	Education and Awareness	Manual Control (hand pulling, grazing, and mowing) and Biological Control	Herbicide Treatment
Valencia SWCD	Yes		30 acres (Garlon 4) 1,044 acres (Arsenal)
NM Soil & Water Conservation District in the vicinity of the Carson and SF National Forests (separate work from the Northern Rio Grande Salt Cedar Control Project above)			
Colfax SWCD	Yes		
Cuba SWCD	Yes		Coordinating Sandoval County WMA work described above
East Rio Arriba SWCD	Yes		
Mora-Wagon Mound SWCD	Yes		
Western Mora SWCD	Yes		
Santa Fe-Pojoaque SWCD	Yes		
Taos SWCD	Yes		10-20 acres (probably Roundup)
Tierra y Montes SWCD	Yes		
Upper Chama SWCD	Yes		1000s of acres treating weeds on private and Jicarilla Apache lands (Spike) 40-60 acres over past 2 years (Picloram)
New Mexico State Highway and Transportation Department			
District 3			Along 16 miles of I-25 (broadcast-Roundup and Velpar)
District 5			Along .7 mile of NM 106 (spot spraying medians Roundup and Sahara)
			Along 14 miles of NM 112 (2,4-D Amine, Garlon 3A, Roundup, Sahara, Tordon - spot spraying guard rails and signs)
			Along 34 miles of NM 41 (spot spraying guardrails - Roundup and Sahara)
			Along 24 miles of U.S. 285 (spot spraying guardrails - Rodeo and Sahara)

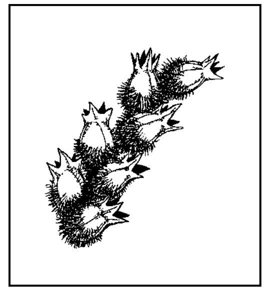
Agency or Organization	Education and Awareness	Manual Control (hand pulling, grazing, and mowing) and Biological Control	Herbicide Treatment
			Along 27 miles of U.S. 64 (spot spraying guard rails and shoulders - 2,4-D Amine, Garlon 3A, Roundup, Sahara, Tordon)
			Along 37 miles of U.S. 84 (spot spraying guardrails and shoulders - 2,4-D Amine, Garlon 3a, Roundup, Sahara, Tordon)
			Along 4 miles of U.S. 84 (spot spraying medians - Roundup and Sahara)
			Along 12 miles of U.S. 84 (spot spraying medians and sidewalks - Roundup and Sahara)
Other Organizations and Agencies			
Santa Fe Watershed Association/City of Santa Fe			Along a less than 1-mile stretch of the Santa Fe River within Santa Fe (cut stump treatment - Aquamaster).
Nature Conservancy	Yes		None in 2003
Audubon Society and Canyon Road Association	Yes		Along 2 miles of the Santa Fe River on private land (cut stump treatment - Aquamaster); 300- to 500-foot stretch on City land
Bureau of Indian Affairs	Yes		
Valles Caldera National Preserve	Yes		Plan to treat 5 acres with Clopyralid
Southwest Strategy	Yes		
Earthworks Institute (Galisteo Watershed Project)	Yes	Prescribed grazing with goats	
Rio Grande Restoration	Yes	5 acre chain saw work with followup hand digging	

Agency or Organization	Education and Awareness	Manual Control (hand pulling, grazing, and mowing) and Biological Control	Herbicide Treatment
Rio Arriba County Extension Service	Yes	Leafy spurge “insectary” – biological control source	
Bureau of Land Management			
Albuquerque Field Office	Yes		Sandoval County: 115 acres (Roundup) 300 acres (Arsenol and Roundup)
Taos Field Office	Yes		0 acres
Farmington Field Office	Yes	2 acres	23 acres (Grazeon P+D), 5 acres (Redeem), in eastern San Juan County. 15 acres (Grazeon P+D) just east of Aztec.
National Park Service			
Bandelier National Monument	Yes		None in 2003
Chaco National Historical Park	Yes	Early hand pulling.	10 acres over past 2 years (Tordol-cut stump treatment)
Pecos National Historical Park	Yes		7,000 individual Scotch thistle plants (5-10 gallons of Roundup total in a backpack sprayer-spot treatment); Minimal retreatment with Garlon 4a (cut stump treatment)

Appendix 2 • Weed Species Ecology and Impacts

This appendix provides a brief overview of the weeds known to exist on the Forests. The "References Cited" chapter provides sources for further information about these species.

Black Henbane (*Hyoscymas niger*) (HYNI)



Black henbane is a biennial forb member of the nightshade family. This species can be identified by its brownish-yellow flowers that have a network of purple veins. It has a characteristically foul odor. Black henbane usually emerges in May and flowers from June to September, with peak flowering usually in July. Two rows of pineapple-shaped fruits appear in the fall. Reproduction is by seed (Encylcoweedia 2003, Stevens County Noxious Weed Control Board 2003).

Black henbane is commonly found in pastures, fence rows, roadsides, waste places, and riparian areas. It does well in most soils, and will grow in a variety of environmental conditions. Black henbane is poisonous to livestock. However, because of the foul odor of the plant, livestock will seldom graze it and few cases of livestock poisonings have been reported. Black henbane usually establishes on disturbed or heavily grazed sites where it competes for moisture and nutrients with desirable plants. All parts of the plant are potentially poisonous (Encycloweedia 2003, Stevens County Noxious Weed Control Board 2003).

Black henbane is also known as insane root, stinking nightshade, fetid nightshade, hog's beam (California Department of Food and Agriculture 2003).

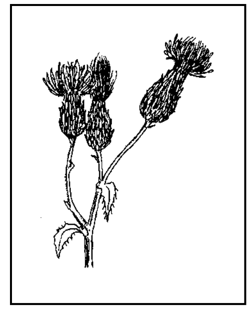
Bull Thistle (*Cirsium vulgare*) (CIVU)

Bull thistle is a coarse biennial, annual, or short-lived perennial to ~ 2 m tall, with stiff-hairy foliage and conspicuous prickly-winged stems. Flowering is from June through October. It can be found in open disturbed sites, roadsides, hillsides, rangeland and forest openings. Thistles typically do not tolerate deep shade or constantly wet soils. Bull thistle grows best on heavy fertile soils. Plants exist as rosettes until flowering stems develop at maturity. Seeds germinate in fall after the first rains or in spring (Encycloweedia 2003, Fire Effects Information System 2003).

Bull thistle is a problem in natural areas because it competes with and decreases desirable forage. Sharp spines deter wildlife from grazing. Bull thistle often dominates recently clearcut forest areas and infestations may limit growth of replanted tree seedlings (Fire Effects Information System 2003).

Bull thistle is also known as spear thistle, plume thistle, bur thistle, roadside thistle, bank thistle, bird thistle, blue thistle, black thistle, button thistle, common thistle and Fuller's thistle. Synonyms are *Carduus lanceolatus L.*, *Carduus vulgaris Savi, Cirsium lanceolatum (L.) Scop., Cirsium lanceolatum (L.) Scop*. var. *hypoleucum* DC., *Cirsium abyssinicum* Sch.Bip.ex A.Rich, *Conicus lanceolatus (L.)* Willd., and *Ascalea lanceolata (L.)* Hill (Encycloweedia 2003).

Canada Thistle (*Cirsium arvense*) (CIAR4)



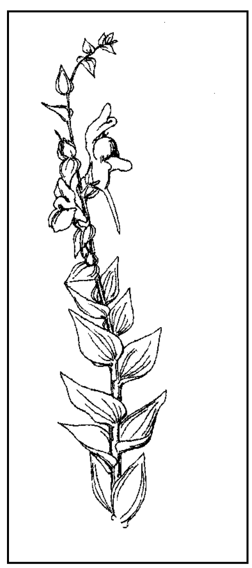
Canada thistle is an erect perennial rhizomatous thistle, usually 0.5 - 1.0 m tall. It can be confused with other thistles, especially bull thistle (*Cirsium vulgare*), and the closely related musk thistles (*Carduus spp.*). Shoots emerge March - May when mean weekly temperatures reach 5 °C. Rosette formation follows, with a period of active vertical growth (about 3 cm/day) in mid- to late-June. Flowering is from June to August. Additional common names include creeping thistle and California thistle (Nuzzo 1997, Encycloweedia 2003).

Canada thistle threatens natural communities by directly competing with and displacing native vegetation, decreasing species diversity, and changing the structure and composition of some habitats. It occurs in nearly every upland herbaceous community within its range. Canada thistle invades natural communities primarily through vegetative expansion, and secondarily through seedling establishment. It invades along riparian areas and irrigation ditches. Canada thistle is shade intolerant. It grows along the edges of woods (both deciduous and coniferous), but is rarely found within forests (Nuzzo 1997).

Dalmation Toadflax (*Linaria dalmatica*) (LIDA) and Yellow Toadflax (*L. vulgaris*) (LIVU2)

Toadflax is a persistent, aggressive invader capable of forming colonies through adventitious buds from creeping root systems that rapidly colonize open sites. These colonies can push out native grasses and other perennials, thereby altering the species composition of natural communities. Toadflax is most commonly found along roadsides, fences, rangelands, croplands, clear cuts, and pastures. Disturbed or cultivated ground is a prime candidate for colonization. This species is capable of adapting growth to a wide range of environmental conditions (Carpenter and Murray 1998 [1], Encycloweedia 2003).

The seedlings of toadflax are considered ineffective competitors for soil moisture with established perennials and winter annuals. However, once established toadflax suppresses other vegetation mainly by intense competition for limited soil water. Mature plants are particularly competitive with winter annuals and shallow-rooted perennials. Mature toadflax plants grow to be between 0.8 to 1.5 m tall. Flowers are bright yellow and typically appear from May to August. Seeds are produced from July to October (Carpenter and Murray 1998 [1]).



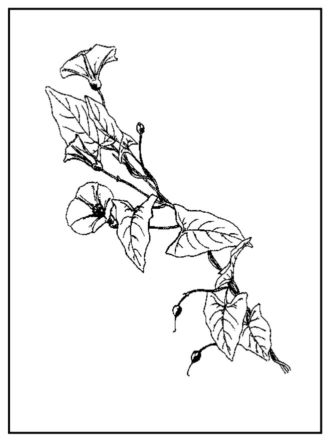
Additional common names include broad-leaved toadflax, butter and eggs, wild snapdragon and common toadflax (Carpenter and Murray 1998 [1], Encycloweedia 2003).

Diffuse Knapweed (*Centaurea diffusa*) (CEDI3)

Diffuse knapweed is a highly competitive and aggressive plant that forms dense colonies in pastures, over-grazed rangelands, croplands, and along riverbanks. It is especially adept at spreading along rights-of-way and farm roads, and can spread rapidly. Disturbed or overgrazed lands are prime candidates for colonization, but diffuse knapweed will also invade undisturbed grasslands, shrublands, and riparian communities (although infestations are typically less dense). The plants first form low rosettes and may remain in this form for one to several years. After they reach a threshold size they will bolt, flower, set seed, and then die. Thus they may behave as annuals, biennials or short-lived perennials, bolting in their first, second, third, or later summer, respectively. Plants of this type are often called semelparous perennials or short-lived monocarpic perennials (Carpenter and Murray 1998 [2], Encycloweedia 2003).

Diffuse knapweed is the most commonly used name in North America. Additional common names include spreading knapweed and tumble knapweed. Acosta diffusa is a synonym for this species (Carpenter and Murray 1998 [2].

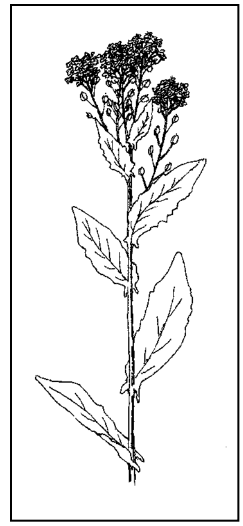
Field Bindweed (*Convolvulus arvensis*) (COAR4)



Field bindweed is a persistent, perennial vine of the morning-glory family which spreads by rhizome and seed. It is a weak-stemmed, prostrate plant that can twine and may form dense tangled mats. Stems can grow to 1.5 m or longer, and its underground rhizomes may range from 5 cm to 2.6 m long. The extensive roots can measure 6.6 m long and penetrate deeply into the soil. Seedlings emerge from the soil erect and ascending. Field bindweed may be confused with *Polygonum convolvulus L.* and with *Calystegia sepium*. Field bindweed begins growing in the late spring or early summer and may persist until the first frost (Lyons 1998 [1], Encycloweedia 2003).

Because of its wide distribution, abundance and economic impact, field bindweed is considered one of the ten “world’s worst weeds.” Field bindweed has deep roots that store carbohydrates and proteins. They help field bindweed spread vegetatively and allow it to resprout repeatedly following removal of above ground growth. Like other weeds, field bindweed takes nutrients and water that would otherwise be available to desirable species. It can reduce the available soil moisture in the top 60 cm of soil to below the wilting point for many species. Field bindweed is primarily a problem in riparian corridors and mountain-mahogany shrubland/grassland, where it can rapidly choke out native grasses and forbs. Field bindweed may be mildly toxic to some grazing animals (Lyons 1998 [1], Encycloweedia 2003).

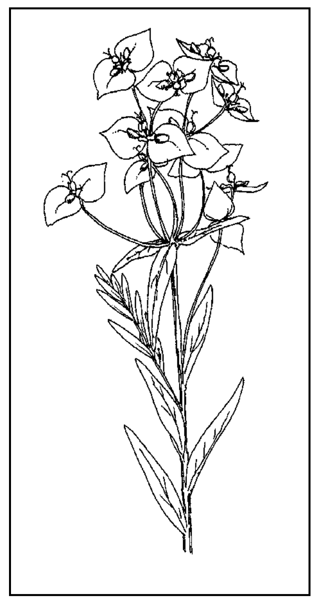
Hoary Cress (*Cardaria draba*) (CADR)



Hoary cress displaces valuable rangeland forage species and is toxic to livestock. It reduces native biodiversity and forage quality. Disturbed sites are the most threatened. This species can grow in a variety of nonshaded, disturbed conditions, including roadsides, waste places, watercourses, and along irrigation ditches. It is found in a variety of upland habitats including open grasslands, the edge of riparian habitats and as a minor component of aspen/willow communities. It is not particular about soil type, and can grow in heavy or light, sandy, or gravelly loams. It is salt-tolerant, but prefers nonacidic soils. It is most aggressive in irrigated conditions or during moist years (Lyons 1998 [2], Encycloweedia 2003).

Hoary cress is also known as white weed, white top, heart-podded hoary cress, perennial peppergrass and Cranson dravier (Lyons 1998 [2], Encycloweedia 2003).

Leafy Spurge (*Euphorbia esula*) (EUES)



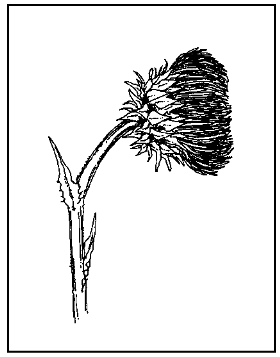
Leafy spurge emerges earlier in spring than most other species and also shows allelopathy toward associated species as evidenced by bare ground and lack of other forbs in dense patches of leafy spurge. One of the most important aspects of leafy spurge biology (in addition to production of large amounts of seed) is its ability to reproduce and spread rapidly via vegetative reproduction. As patches develop, density reaches over 200 shoots/m^2 in light soils, and up to 2000/m^2 in heavy soils (Biesboer 1996, Encycloweedia 2003)

Leafy spurge presents a management problem because it is a long-lived, aggressive perennial weed that tends to displace all other vegetation in pasture, rangeland, and native habitats. It is particularly aggressive in drier sites such as hillsides and prairies. Forbs and grasses in natural areas may be completely displaced by leafy spurge in a few years if the infestation is left unchecked. Rapid re-establishment of dense stands will occur after an apparently successful management effort because of the long-lived root system present in the soil (Biesboer 1996).

Musk Thistle (*Carduus nutans*) (CANU4)

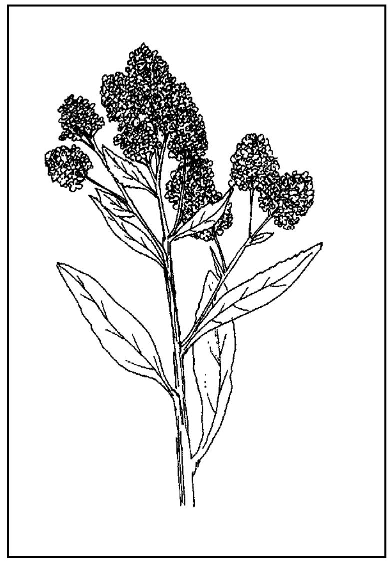
Musk thistle in the United States includes a complex of closely-related species of the *Carduus nutans* group. Under natural conditions, musk thistle most often functions as a spring biennial, fall biennial, or winter annual. Plants of all ages overwinter as rosettes. Seed maturity and dispersal occur within 7 to 10 days of flowering. The bulk of the seeds fall near the parent plant with less than 1 percent being carried further. Seeds have been reported to remain viable in the soil for periods as long as 10 years (Heidel 1987, Encycloweedia 2003).

Musk thistle is most prevalent in disturbed areas such as roadsides and grazed pastures, but can invade deferred pastures and native grasslands. Musk thistle grows best on moist alluvial soils but



tolerates a wide range of conditions, from acidic to saline soils. Plants establish poorly on highly acidic or nutrient deficient soils or soils with extremes in moisture content. Musk thistle seeds appear to possess allelopathic qualities. They can inhibit germination and radicle growth in other pasture species, but stimulate or have no affect on other seeds of their own species. Emerged musk thistle plants can also weaken other pasture species by an allelopathic interaction at the early bolting stage, when the larger rosette leaves are decomposing and releasing soluble inhibitors, and at the stage when bolting plants are dying and releasing insoluble inhibitors (Heidel 1987, Encycloweedia 2003).

Perennial Pepperweed (*Lepidium latifolium*) (LELA2)



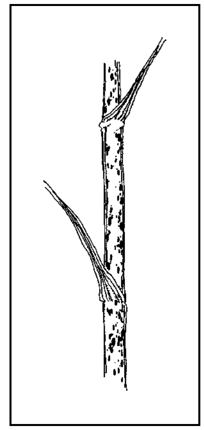
Perennial pepperweed is an herbaceous perennial that produces dense stands with stems reaching up to 1.5 meters in height. These stems originate from large perennial below ground roots and emerge in early spring/late fall. Shoots will remain in the rosette form for several weeks before stems elongate (bolt). Shoots flower and fruit during late spring and continue throughout much of the summer. Plants senesce by mid- to late-summer while fruits remain on the stem (Morisawa 1999, Renz 2000, Encycloweedia 2003).

Perennial pepperweed is a highly invasive herbaceous perennial. It can invade a wide range of habitats including riparian areas, wetlands, marshes, and flood plains. Once established this plant creates large monospecific stands that displace native plants and animals and can be very difficult to remove. These plants can act as “salt pumps” which take salt ions from deep in the soil profile, transport them up through their roots and deposit them near the surface. This can favor halophytes and put other species at a disadvantage, thereby shifting plant composition and diversity (Morisawa 1999, Renz 2000, Encycloweedia 2003).

This plant is most commonly referred to as perennial pepperweed or tall whitetop. Several other common names are used throughout the U.S. such as giant whiteweed, perennial peppergrass, slender perennial peppercress, broadleaf or broadleaved pepperweed, and ironweed (Morisawa 1999, Renz 2000, Encycloweedia 2003).

Poison Hemlock (*Conium maculatum*) (COMA2)

Poison hemlock is a highly toxic weed found in waste places throughout much of the world. Poison hemlock reproduces only from seed, both as a biennial and winter annual, and occasionally as a short-lived perennial. Seeds germinate in autumn and plants develop rapidly throughout the winter and spring. Some produce flowering stems in the first spring and die in the summer. Others remain in the vegetative stage without producing flowering stems until the second spring, thus becoming a biennial. Plants are more likely to be biennial in very moist situations (Pitcher 1989).

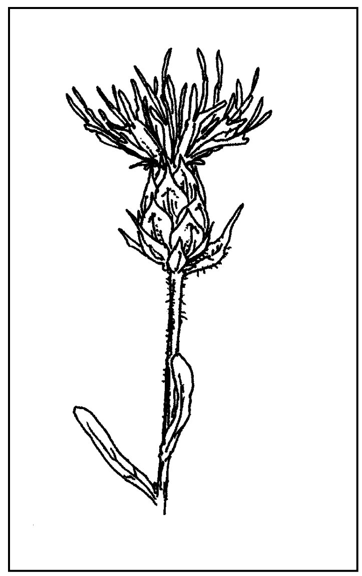


Poison hemlock commonly occurs in sizable stands of dense, rank growth along roadsides, field margins, ditchbanks and in low-lying waste areas. It also invades native plant communities in riparian woodlands and open flood plains of rivers and streams. It can be a tenacious weed particularly in moist habitats and along streams. It may act as a pioneer species quickly colonizing disturbed sites and displacing natives during early successional seres. The presence of poison hemlock degrades habitat quality and could indicate a management problem on an ecological preserve. This species is poisonous to both humans and livestock (Pitcher 1989).

Russian Knapweed (*Acroptilon repens*) (ACRE3)

Russian knapweed is the most commonly used name in North America. Additional common names include Mountain Bluet, Turkestan thistle, and creeping knapweed. A synonym for this species is *Centaurea repens* (Carpenter and Murray Undated, Encycloweedia 2003).

Russian knapweed is a perennial herbaceous plant of the aster (sunflower) family. It is characterized by its extensive root system, low seed production, and persistence. Russian knapweed spreads through creeping horizontal roots and seed. Shoots emerge early in spring shortly after soil temperatures remain above freezing. All shoot development originates from root-borne stem buds. These buds arise adventitiously at irregular intervals along the horizontal roots. Plants form rosettes and bolt in late May to mid-June. Russian knapweed flowers from June to October (Carpenter and Murray Undated).

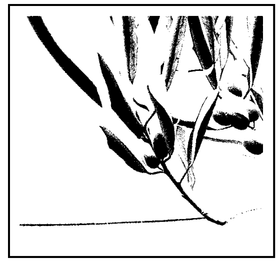


Russian knapweed can commonly be found along roadsides, riverbanks, irrigation ditches, pastures, waste places and clearcuts. Russian knapweed invades many disturbed western grassland and shrubland communities, as well as riparian forests. Once established, it can dominate an area and significantly reduce desirable vegetation (e.g. perennial grasses). It is a strong competitor and can form dense colonies in disturbed areas. Once established, Russian knapweed uses a combination of adventitious shoots and allelopathic chemicals to spread outward into previously undisturbed areas (Carpenter and Murray Undated, Encycloweedia 2003).

Russian Olive (*Elaeagnus angustifolia*) (ELAN)

Russian olive is a shrub or small tree in the Oleaster family (*Elaeagnaceae*). It can grow up to 9 meters (30 feet) in height and is often thorny. Although Russian olive establishes primarily by seed, vegetative propagation can also occur. Russian olive is sometimes confused with the closely related autumn olive, which is also a weed. It is relatively shade tolerant, and once established, can persist throughout seral stages and become the climax dominant species (Tu 2003).

Russian olive can invade both open upland and riparian bottom land (marshland and other wetland) communities, alter the course of plant succession, and ultimately result in lowered levels

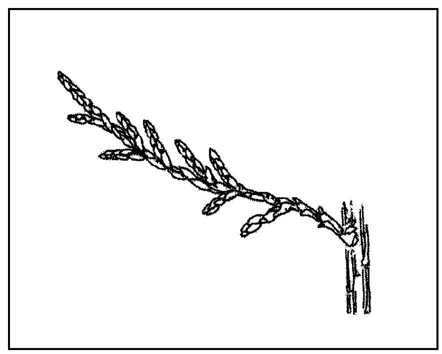


of native plant and animal diversity. It negatively impacts natural areas by creating dense, monotypic stands that out-compete native vegetation, modifying vegetation structure, and displacing native wildlife. Russian olive can also alter nutrient cycling and system hydrology by spreading throughout woodlands, connecting lowland riparian forests with more open, upland areas. This contributes to the stabilization of riverbanks against future flooding, increasing overbank deposition, and limiting the number of suitable sites for native cottonwood regeneration. Russian olive trees have high rates of evapotranspiration, utilizing more water resources than native species, and can eventually change riparian sites into relatively dry uplands with Russian olive as the climax species. Dense thickets of Russian olive can also increase fuel loads that may cause catastrophic wildfire (Tu 2003).

Russian olive is the most common name used for this species. Other names are oleaster and silverberry. Synonymns for this species are *Elaeagnus iliensis* and *Elaeagnus umbellate* (Tu 2003).

Salt Cedar (*Tamarix spp*) (TAMAR2)

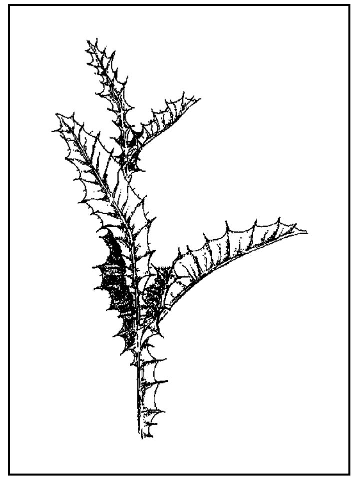
Salt cedar is an aggressive, woody invasive plant species. It is a relatively long-lived plant that can tolerate a wide range of environmental conditions once established. It produces massive quantities of small seeds and can propagate from buried or submerged stems. It can replace or displace native woody species, such as cottonwood, willow and mesquite, which occupy similar habitats, especially when timing and amount of peak water discharge, salinity, temperature, and substrate texture have been altered by human activities. Salt cedar is a facultative phreatophyte, meaning that it can draw water from underground sources but once established it can survive without access to ground water. It consumes large quantities of water, possibly more than woody native plant species that occupy similar habitats (Carpenter 1998).



Salt cedar possesses a number of undesirable attributes, according to a number of authorities. It: (1) crowds out native stands of riparian and wetland vegetation; (2) increases the salinity of surface soil rendering the soil inhospitable to native plant species; (3) provides generally lower wildlife habitat value than native vegetation; (4) dries up springs, wetlands, riparian areas and small streams by lowering surface water tables; (5) widens flood plains by clogging stream channels; (6) increases sediment deposition due to the abundance of salt cedar stems in dense stands; and (7) uses more water than comparable native plant communities. However, data to support these claims by various authors do not always exist (Carpenter 1998).

Scotch Thistle (*Onopordum acanthium*) (ONAC)

Scotch thistle is a vigorous biennial or short-lived perennial with coarse, spiny leaves and conspicuous spiny-winged stems. Plants typically germinate in fall after the first rains and exist as rosettes throughout the first year until flowering stems develop during the second spring/summer season. Severe infestations can form tall (3 m), dense, impenetrable stands, especially in fertile soils. Scotch thistles reduce productivity and strongly compete with native plants for resources. *Onopordum* thistles are distinguishable from other genera of thistles with spiny stern-wings and/or leaves by having receptacles that lack bristly chaff and have deep pits surrounded by membranous extensions (Encycloweedia 2003).



Infestations of Scotch thistle often start in disturbed areas such as roadways, campsites, burned areas and ditchbanks. This species adapts to riparian areas, but can be a serious problem in range areas (Douglas County Cooperative Extension 2003).

Scotch thistle is also known as cotton thistle, woolly thistle, winged thistle, jackass thistle and heraldic thistle (Encycloweedia 2003).

Siberian Elm (*Ulmus pumila*) (ULPU)

Siberian elm is a fast growing, small to medium size tree with an open, round crown of slender, spreading branches. Its spread is equal to three-fourths its height. Its rough bark is gray or brown and shallowly furrowed at maturity. Both the small blunt buds and slender, smooth twigs are nearly hairless. Siberian elm is distinguished from American elm and slippery elm based on its relatively small leaves that are symmetrical or nearly so at the base and are once serrate (Kennay and Fell 1990, Minnesota Department of Natural Resources 2003, Wisconsin Department of Natural Resources 2003).

This tree can invade and dominate disturbed areas in just a few years. Seed germination rate is high and seedlings establish quickly in sparsely vegetated areas. It grows readily in disturbed areas with poor soils and low moisture. This species forms thickets of hundreds of seedlings (Minnesota Department of Natural Resources 2003, Wisconsin Department of Natural Resources 2003).

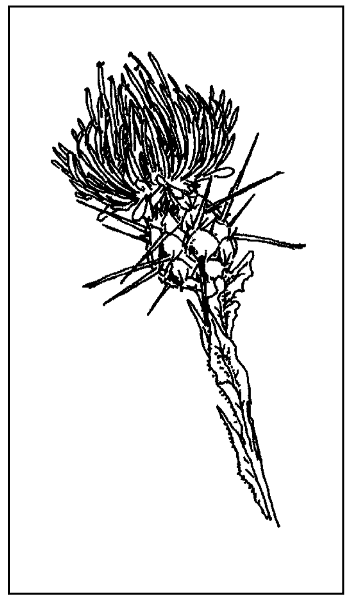
Spotted Knapweed (*Centaurea biebersteinii*) (CEBI2)

Spotted knapweed is a biennial or short-lived perennial composite with a stout taproot. It resembles other species in the genus, including diffuse knapweed, black knapweed, brown knapweed, short-fringed knapweed, and featherhead knapweed. The best way to distinguish spotted knapweed is by the dark tips and fringed margins of its phyllaries. All of these species are capable of becoming serious weed problems (Mauer, Russo and Evans 1987, Encycloweedia 2003).

The competitive superiority of this species suggests preadaptation to disturbance. The initial invasion of spotted knapweed, like other weeds, is correlated highly to disturbed areas. Once a plant or colony is established though, it may invade areas that are relatively undisturbed or in good condition with gradual, broad, frontal expansion. This invasion is associated with a decline in the frequency of some species and a decline in species richness overall. The knapweed is highly adept at capturing available moisture and nutrients, and it quickly spreads, choking out other vegetation. The water storage capacity of the soil decreases, and soil erosion increases as the network root system of the native species is lost, replaced by the taproot of the knapweed (Mauer, Russo and Evans 1987).

Yellow Starthistle (*Centaurea solstitalis*) (CESO3)

Yellow starthistle is an erect winter annual (sometimes biennial) mostly to 1 m tall (occasionally to 2 m tall) with spiny yellow-flowered heads. Taproots grow vigorously early in the season to soil depths of 1 m or more, giving plants access to deep soil moisture during the dry summer and early fall months. Vigorous individuals of yellow starthistle may develop flower heads in branch axils. Plants usually senesce in late summer or fall. Often a dense layer of thatch develops on heavily infested sites (DiTomaso 2001, Encycloweedia 2003).



Yellow starthistle is best adapted to open grasslands with average annual precipitation between 10 and 60 inches (25 to 150 cm) per year. It is generally associated with deep, well-drained soils. Because of its high water usage, yellow starthistle threatens native plant ecosystems. Yellow starthistle infestations can reduce wildlife habitat and forage, displace native plants, and decrease native plant and animal diversity. Dense infestations not only displace native plants and animals, but also threaten natural ecosystems and nature reserves by fragmenting sensitive plant and animal habitat (DiTomaso 2001, Encycloweedia 2003).

When ingested by horses, yellow starthistle causes a neurological disorder of the brain called “chewing disease.” In most cases poisoning destroys the animal’s ability to chew and swallow and death occurs through starvation or dehydration. Other animals, including mules and burros, are not susceptible to the toxic effect of the weed (DiTomaso 2001, Encycloweedia 2003).

Appendix 3 • Herbicides: Characteristics, Effects and Risk Assessments

This appendix provides the DEIS reader with a summary of the available scientific information about the characteristics and effects of herbicides that may be used for this project. More detailed information can be found in literature cited in the DEIS as well as on national and regional Web sites managed by other agencies and organizations including the Environmental Protection Agency (EPA), USDA Forest Service, The Nature Conservancy, and Colorado Department of Agriculture. This information was used during the environmental analysis.

Herbicide Characteristics and Environmental Effects

2,4-D

2,4-D is used to control broadleaf weeds, woody plants, aquatic weeds, and non-flowering plants (Infoventures, 1995b). 2, 4-D is a short-residual herbicide that remains active for 10 to 14 days. It can kill or injure many broadleaf plants depending on site conditions, plant growth stage, and herbicide application rate. However, broadleaf plants that germinate from seed, or that begin to grow more than 10 days following application should remain unaffected. On woody species, vegetative growth may be killed, but plants generally recover in a year or less (USDA FS 2003c).

The half-life of 2,4-D in the environment is relatively short, averaging 10 days in soils and less than 10 days in water and dependent upon other factors (e.g., temperature, soil condition) (Tu et al. 2001). In the environment, most formulations are degraded to the anionic form, which is water-soluble and has the potential to be highly mobile. The formulation proposed for use in this project is the amine salt. It may remain active for up to 6 weeks, though it ultimately metabolizes into harmless products (Infoventures 1995b).

The toxicity of 2,4-D varies by the form of the chemical and affected organism. Ester formulations are toxic to fish and aquatic invertebrates, but salt formulations are registered for use against aquatic weeds *(*Tu et al. 2001*)*. Ester formulations have LC50 values (24 and 96 hour) for several species of fish (flathead minnows, bluegills, and rainbow trout) that ranged between 260 and 358 mg/l, while the same values for amine salt formulations ranged from 250 to greater than 600 mg/l (Alexander et al. 1985). The ester LC50 (24 hour) for *Daphnia Magna* was 100 mg/l and between 25 and 36.5 mg/l (48 hour), while an amine salt formulation had an LC50 of 406 mg/l (24 hour).

In birds, 2,4-D ranges from being virtually nontoxic in its butyl ester form to moderately toxic as an amine salt. Mammals are moderately sensitive to exposure. It is relatively nontoxic to bees. Most LD50 values for 2,4-D range from 300-1,000 mg/kg, though sensitivity varies greatly between animal groups and chemical form (Infoventures 1995b, SERA 1998a, Ecobichon 2001, Tu et al. 2001).

The World Health Organization (1984) concluded that 2,4-D does not accumulate or persist in the environment. The primary degradation mechanism is microbial metabolism, but mineralization and possibly light exposure may also play a role. Degradation rates are determined by the microbial population, environmental pH, soil moisture and temperature *(*Tu et al. 2001*)*. The type of 2,4-D applied does not significantly affect the rate of degradation (Wilson et al. 1997).

2,4-D will change form and function with changes in water pH (Que Hee and Sutherland, 1981). In alkaline waters (pH>7), 2,4-D takes the ionized (negatively charged) form that is water-soluble and remains in the water column. Theoretically, in water of lower pH, 2,4-D will remain in a neutral molecular form, increasing its potential for adsorption to organic particles in water and increasing its persistence (Wang et al. 1994).

2,4-D is considered to be moderately toxic to animals, although LD50 levels vary greatly between formulations and animal species (Ibrahim et al. 1991). 2,4-D can accumulate in organisms. Numerous studies on fish, amphibians and macroinvertebrates are summarized by the Syracuse Environmental Research Institute (SERA 1999a). LC50s (96 hour) for bluegill sunfish and rainbow trout are 263 and 377 mg/L, respectively. Wang et al. (1994), studied bioaccumulation of 2,4-D in carp and tilapia and found that accumulation of up to 18 times the ambient concentration occurred within 2 days of exposure. 2,4-D has been found in oysters and clams in concentrations up to 3.8 ppm and persisted for up to 2 months (Thomas and Duffy 1968). 2,4-D can accumulate in fish exposed to concentrations as low as 0.05 ppm (Wang et al. 1994) and concentrations of 1.5 ppm can kill the eggs of fathead minnows in 48 hours (Thomas and Duffy, 1968). Contrary to this, Cooke (1972) found that concentrations of 2,4-D up to 50 ppm had no visible effect on common frog tadpoles (*Rana temporaria*) after treatment for 48 hours.

Studies in rats suggested 2,4-D was not cancer causing, though liver damage was seen at relatively low dosages. Pregnant rats showed no evidence of birth defects, though fetuses showed evidence of toxic effects. No effect on reproduction or fertility has been demonstrated in rats and 2,4-D did not cause genetic defects in most studies (Infoventures 1995b). While an association between 2,4-D exposure and canine malignant lymphoma has been reported (Hayes et al. 1991), a causal mechanism was not identified. In a recent review of 2,4-D epidemiology and toxicology, Garabrant and Philbert (2002) concluded that the evidence that 2,4-D might be carcinogenic was “scant.” 2,4-D does not bioaccumulate in wildlife (SERA 1998a). Risk to browsing wildlife, however, appears to be low, as do risks to forging raptors. A study in Oregon after aerial spraying found concentrations on forest browse plants to be below those able to cause effects in mammals (Tu et al. 2001). Acid and salt formulations of 2,4-D have been shown in laboratory studies on rabbits to be eye irritants (Infoventures 1995k). In humans, 2,4-D has been found to rapidly distribute within the body with the greatest concentrations appearing in the kidneys and liver (Tu et al. 2001), which may also be the case for wildlife species.

Chlorsulfuron

Chlorsulfuron is used for control of broadleaf weeds and some grasses. It is absorbed through the roots and foliage of plants. It inhibits susceptible plants from producing an essential amino acid, which inhibits cell division in the root tips and shoots. In nonsusceptible plants it is broken down to inactive products. Chlorsulfuron is generally used to combat thistles—including bull, Scotch, and musk thistles—in rangeland and noncrop areas. It is particularly useful in maintaining native perennial grasses (Sheley 1999).

Trade names for chlorsulfuron herbicides are Telar and Glean Weed Killer.

Chlorsulfuron is generally active in soil, and has a greater affinity to adsorb to soils having a higher organic content. It tends to leach in permeable soils, with leaching being reduced in soils having a pH of less than 6. Chlorsulfuron is degraded by soil microbes. The half-life has been reported from 1 to 3 months based on soil acidity (Infoventures 1995f). It does not easily evaporate and is relatively soluble in water.

Chlorsulfuron has a low order of acute toxicity; with oral LD50 levels in the male and female rat, bobwhite quail, and mallard duck reported to be >5,000 mg/kg (Infoventures 1995c). The acute dermal LD50 has been reported to be >3,400 mg/kg. It is considered to be a mild irritant to the skin and a moderate eye irritant. Chlorsulfuron is not considered to be a reproductive, mutagenic, or carcinogenic compound. Infoventures (1995f) reports that rats fed up to 5,000 ppm per day for up to 2 years did not show evidence of carcinogenicity. Teratology studies of rats and rabbits showed no evidence of developmental effects. A 3-generation study in rats show slight decreased fertility at the highest does of 2,500 ppm, but no decrease in fertility was observed at doses up to 500 ppm. In their mutagenic tests, Chlorsulfuron did not cause genetic damage.

Chlorsulfuron is persistent in soils with a half-life of 1 to 3 months based on soil acidity. Low soil pH accelerates the hydrolysis of the chemical into nonherbicidal compounds.

Higher soil temperatures, moisture and levels of oxygen increase the rate of hydrolysis. After hydrolysis, microbial metabolism breaks down the compound further. Photodegradation is minor. The chemical leaches in permeable soils but leaches less in soils with a pH of below 6 (Infoventures, 1995f). The Glean® Weed Killer product is intended for use in soils with a pH of 7.5 or less (PMEP 2001b). Because of its persistence and high mobility, chlorsulfuron has the potential to enter surface waters from runoff. However, due to its very low application rate of 0.25 to 3 ounces formulated product per acre, it has little potential to enter ground water.

The technical grade of chlorsulfuron is practically nontoxic to fish and aquatic invertebrates. The LC50 (96 hr) for rainbow trout is 250 mg/L, for bluegill sunfish and fathead minnows is 300 mg/L and for channel catfish is 40 mg/L (PMEP, 2001b). The 48 hr LC50 for *Daphnia Magna* is 370 mg/L (PMEP, 2001b). There is no potential for bioaccumulation (USDOE, 2000).

Clopyralid methyl

Clopyralid is the most selective herbicide proposed for use. It is effective on spotted knapweed and also affects members of four plant families: *Asteraceae, Fabaceae, Solanaceae* (nightshade) and *Polygonaceae* (Dow AgroSciences 1997). Clopyralid methyl does not affect conifers, including old-growth ponderosa pine or important browse species. The herbicide can be applied near or over conifers and many shrubs and forbs without damaging the native plant community. Clopyralid usually provides one growing season of control.

Weeds such as leafy spurge are not effectively controlled by clopyralid herbicides. If these species occur in a complex with spotted knapweed and infestations are treated only with clopyralid, the spurge would likely expand within the plant community even though spotted knapweed is controlled.

Commercial formulations of clopyralid methyl such as Reclaim®, Stinger®, and Transline® contain approximately 41 percent clopyralid methyl and 59 percent inert ingredients (water, isopropyl alcohol, and a surfactant).

It is chemically similar to picloram, but clopyralid methyl has a shorter half-life, is more water-soluble, and has a lower absorption capacity than picloram. It may be persistent in soils with low microorganism content. The half-life can range from 15 to 287 days depending upon soil type and climatic conditions (Infoventures 1995e). It is degraded almost entirely by microbial metabolism in soils and aquatic sediments. It is not degraded by sunlight or hydrolysis. Its persistence implies that clopyralid methyl has the potential to be highly mobile and a contamination threat to water resources and nontarget species *(*Tu et al. 2001*)*.

Clopyralid is relatively nontoxic to birds, mammals and bees (SERA 1999a). It does not bioaccumulate in animal tissue. The acute oral toxicity in rats was LD50 greater than 4,300 mg/kg (relatively nontoxic). In rabbits, clopyralid had a dermal LD50 of greater than 2,000 mg/kg (relatively nontoxic). Clopyralid caused slight skin irritation and eye irritation in rabbits. Rats showed no adverse effects after 4 hours of exposure to concentrations of 1.3 mg/L in air (Infoventures 1995e). Clopyralid showed no evidence of oncogenicity in a 2-year feeding study in mice or rats at the highest dose tested. It showed no evidence of developmental toxicity in mice and rabbits at the highest dosage tested. No effects on reproduction were observed in study of two generations of rats at the highest dose tested. No evidence of mutagenicity was observed in a number of laboratory studies on mice and rats. Based on the results of these animal studies, clopyralid is not classified as a carcinogen, teratogen, mutagen, or reproductive inhibitor (Infoventures 1995e). Technical grade clopyralid methyl is contaminated with hexachlorobenzene and pentachlorobenzene at average concentrations of < 2.5 ppm and <0.3 ppm, respectively (SERA 1999a). Hexachlorobenzene is potentially carcinogenic. However, because of the small proportion of hexachlorobenzene in clopyralid, the amount released into the environment from USFS programs contributes little to the background levels of hexachlorobenzene in the environment (SERA 1999a).

Clopyralid methyl is of low toxicity to aquatic organisms. It's LC50s (96 hour) for bluegill sunfish and rainbow trout are 125mg/L and 104 mg/L, respectively (Dow Elanco, 1997). Clopyralid methyl is highly water-soluble and will not bind with suspended particles in the water column and as such can be persistent in the aquatic environment. The half-life of Clopyralid methyl in water ranges from 8 to 40 days (DowElanco, 1997). Following aerial application to soils at a rate of 2.5 kilograms (kg) formulated product/hectare (ha) (more than two times the label rate application to soils for noncropland use in California), Leitch and Fagg (1985) recorded peak concentrations of 0.017 mg/L in a nearby stream that drained the area. Similar results were documented from a study in Australia (Dow Agrosciences, 1998). They estimated that a total of 12 grams (g) of Clopyralid methyl (0.01 percent of that applied) leached into the stream during the first significant rainfall (3 days after application). Bergstrom (1991) found a maximum of 0.02 percent of applied Clopyralid methyl was lost to runoff from clay soils in Sweden.

Dicamba

Dicamba is a selective broadleaf herbicide. It is effective on plants in the Asteraceae (composite) and Fabaceae (legume) families. Dicamba is the active ingredient in Banvel® and Vanquish® formulations.

Dicamba is moderately persistent in soil, with a half-life of 1 to 6 weeks. Breakdown is slower with low soil moisture and low temperatures. The main metabolite of dicamba breakdown in soil is 3,6-dichlorosalicylic acid (Infoventures 1995g). Dicamba is soluble in water and microbial degradation is the main route of Dicamba disappearance. Photolysis may also occur. Aquatic hydrolysis, volatilization, adsorption to sediments, and bioconcentration are not expected to be significant (Howard, 1989).

Dicamba is slightly toxic to mammals, nontoxic to birds, nontoxic to bees, and does not bioaccumulate. Based on results of animal studies dicamba does not cause birth defects, cancer, or genetic damage (Infoventures 1995g). Exposure to dicamba has been associated with reproductive and possibly neurotoxic effects in laboratory animals (SERA 1995). However, ecological risk assessment suggests no plausible or substantial effects to terrestrial or aquatic animals (SERA 1995). Concentrated solutions of dicamba have been shown to cause eye irritation in rabbits, which is a common test species for ocular effects. The extent to which actual formulations may cause dermal or ocular irritation during normal use cannot be determined from the available data, however. In addition, moderate dermal sensitization was observed in guinea pigs after contact with a 10 percent solution of dicamba (SERA 1995). The manufacturing process for dicamba has the potential to result in trace amounts of 2,7-dichlorodibenzo-p-dioxin as a contaminant. It may be present in concentrations up to 50 parts per billion (ppb). The dioxin isomer, 2,3,7,8-tetra-chlorodibenzo-p-dioxin has not been found at the limit of detection (2 ppb) and is not expected as an impurity in dicamba (PMEP 1983).

Dicamba is slightly toxic to fish and amphibians. The LC50 (48 hour) for technical Dicamba in rainbow trout and bluegill sunfish is 35 mg/L and 40 mg/L, respectively. The LC50s (48 hour) for other aquatic organisms include 465 mg/L in carp and 110.7 mg/L in *Daphnia*. The LC50 (96 hour) for technical Dicamba in rainbow trout and bluegill sunfish is 135.4 mg/L and 135.3 mg/L, respectively. LC50s (96 hour) for other aquatic organisms include >100mg/L for grass shrimp, and >180mg/L for fiddler crab and sheepshead minnow (EXTOXNET 1996b). Power (1989) identified an LC50 (96 hour) for a tusked frog tadpole (*Adelotus brevis*) of 106 mg/L. Comparable studies on aquatic algae and aquatic animals indicate that some species of algae are much more sensitive to Dicamba compared with fish and aquatic invertebrates (SERA 1995). Dicamba does not accumulate or build up in aquatic organisms. However, its formulations have not been tested for chronic effects in aquatic organisms.

Glyphosate

Glyphosate is a broad spectrum, nonselective herbicide that damages all annual and perennial plants including grasses, broad-leaved weeds and woody plants. It is absorbed through the leaves of plants and is then transported throughout the whole plant. It controls weeds by inhibiting the synthesis of aromatic amino acids necessary for protein formation in susceptible plants, killing the entire plant. At low levels of application it regulates growth. Trade name herbicides that contain Glyphosate include Roundup, Rodeo, Gallop, Ranger, Accord, Vision, Pondmaster, Landmaster and Touchdown. Glyphosate may also be an ingredient in the formulations of other types of herbicides.

Glyphosate itself is an acid, but is commonly used in isopropylamine salt form. When applied to foliage it is quickly absorbed by the leaves and rapidly moves through the plant.

Care should be taken, especially in natural areas, to prevent it from being applied to desirable, native plants because it will likely kill them. In terrestrial systems, glyphosate can be applied to foliage, green stems, and cut stems (cut stumps), but cannot penetrate woody bark. Only certain formulations of glyphosate (e.g., Rodeo®) are registered for aquatic use, as glyphosate by itself is essentially nontoxic to submersed plants, but the adjuvents often sold for use with glyphosate may be toxic to aquatic plants and animals.

Concentrations vary by target species and time of year. For the control of common agricultural weeds during the spring growing season concentrations of about 2 tablespoons per gallon is common, but for control of more persistent weeds such as Himalayan blackberry (*Rubus discolor*) concentrations of up to 4 tablespoons per gallon may be applied during late summer/early fall.

Glyphosate is one of the most commonly used herbicides in natural areas because it provides effective control of many species. Natural area weeds that have been controlled with glyphosate include: bush honeysuckle (*Lonicera maackii*), cogon grass (*Imperata cylindrica*), common buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), Japanese honeysuckle (*Lonicera japonica*), and smooth brome (*Bromus inermis*). In The Nature Conservancy preserves, glyphosate has been used to control dewberries (*Rubus* spp.), bigtooth aspen (*Populus grandidentata*), and black cherry (*Prunus serotina*) at Kitty Todd preserve in Ohio; sweetclover (*Melilotus officinalis*) in Indiana preserves; leafy spurge (*Euphorbia esula*) and St. John's wort/Klamath weed (*Hypericum perforatum*) in Michigan preserves; and bindweed (*Convolvulus arvensis*) and velvetgrass (*Holcus lanatus*) in Oregon and Washington preserves.

In aquatic or wetland systems, glyphosate has successfully controlled common reed (*Phragmites australis*) in Delaware, Michigan, and Massachusetts preserves; purple loosestrife (*Lythrum salicaria*) in Indiana and Michigan preserves; reed canarygrass (*Phalaris arundinacea*) in Illinois preserves; and glossy buckthorn (*Frangula alnus*) and hybrid cattail (*Typha* x *glauca*) in Michigan preserves (Tu, et al. 2001).

Glyphosate is metabolized by some plants, while others do not break it down. Glyphosate would remain in soil unchanged for a varying length of time depending on soil texture and organic matter content. Half-life of glyphosate is reported to be from 3 to 130 days (Infoventures 1995a). Soil microorganisms break down glyphosate and the surfactant used in Roundup to carbon dioxide.

Glyphosate is strongly adsorbed to soil particles, which prevents it from excessive leaching or from being taken up from the soil by nontarget plants. It is degraded primarily by microbial metabolism, but strong adsorption to soil can inhibit microbial metabolism and slow degradation. Photo and chemical degradation are not significant in the dissipation of glyphosate from soils. The half-life of glyphosate ranges from several weeks to years, but averages 2 months. In water, glyphosate is rapidly dissipated through adsorption to suspended and bottom sediments, and has a half-life of 12 days to 10 weeks. Glyphosate by itself is of relatively low toxicity to birds, mammals, and fish, and at least one formulation sold as Rodeo® is registered for aquatic use. Some surfactants that are included in some formulations of glyphosate, however, are highly toxic to aquatic organisms, and these formulations are not registered for aquatic use. Monsanto's patent for glyphosate expired in 2000, and other companies are already selling glyphosate formulations.

Glyphosate is reported to be nontoxic, with a reported oral LD50 of 5,600 mg/kg in the rat, and over 10,000 mg/kg in mice, rabbits, and goats (EXTOXNET 1996b). Toxicity of technical grade acid of glyphosate and Roundup® are nearly the same. The oral LD50 for the trimethylsulfonium salt is reported to be about 750 mg/kg in rats, which indicates moderate toxicity (EXTOXNET 1996b). Acute dermal LD50 for glyphosate and isopropylamine salt are reported to be >5,000 mg/kg, and the dermal LD50 for the trimethlysulfonium salt are reported to be >2,000 mg/kg. Studies of glyphosate lasting up to 2 years have been conducted with rats, mice, dogs, and rabbits, and with few exceptions no effects were observed (EXTOXNET 1996b, Infoventures 1995c, SERA 2002, SERA 2003b). Some tests have shown reproductive effects may occur at high doses (over 150 mg/kg/day), but there have been little to no reports of mutagenic, developmental, or carcinogenic effects. In humans, Glyphosate has been classified as a mild to moderate irritant to the skin and eyes, and there are no data indicating that it causes sensitization in either animals or humans (SERA 2002, SERA 2003b).

Glyphosate has a low acute toxicity (EPA Toxicity Category III for both oral and dermal toxicity). The acute oral LD50 in rats is 4,320 mg/kg (Infoventures 1995c). Its low toxicity can be attributed to it affecting the shikimic pathway that does not exist in animals, although it can disrupt the functions of some enzymes in animals at extremely high doses (several gm/kg body weight). There is little, if any, chronic toxicity. Glyphosate does not appear to cause birth defects, does not affect fertility, reproduction or development of offspring, and is classified as a noncarcinogen. Although Glyphosate itself may have low toxicity, the surfactants used in many of the products can be serious irritants, toxic to fish and can contain carcinogens (Pesticide News, 1996). The most widely used surfactants are ethylated amines, which are significantly more toxic than Glyphosate. A new nonirritant formulation, Roundup Biactive®, has been developed. Rodeo® (Glyphosate 53.5 percent and water 46.5 percent) and Accord® (Glyphosate 41.5 percent and 58.5 percent) are formulations which do not include a surfactant and are best for use in aquatic areas.

Glyphosate is strongly adsorbed to the soil, more so in organic soils where it becomes generally inactive. It is not absorbed from the soil by plant roots. Glyphosate remains unchanged in the soil until it is broken down by microorganisms. Microorganisms also break down the surfactants used in herbicide formulations. The half-life of glyphosate in soil ranges from 1 to 174 days, with an average of 47 days (Wauchope et al. 1992), depending on soil texture and organic matter content. Glyphosate inhibits nitrogen-fixing bacteria (Hendricks 1992). In water, it adsorbs to suspended organic and mineral particles. In water, it is also broken down by microorganisms and has a half-life range from 35 to 63 days (Infoventures 1995c). Its toxicity in water is increased with higher temperatures and pH. Because it adsorbs strongly to soil particles, the potential for leaching is low, but it can be transported to surface waters by eroded soil.

The technical grade of glyphosate is no more than slightly toxic to fish and is practically nontoxic to aquatic invertebrates. The 96-hour LC50 of glyphosate is 120 mg/L for bluegill and is 86mg/L for rainbow trout (EXTOXNET 1996b). The 48-hour LC50 of glyphosate for Daphnia is 780 mg/L (EXTOXNET 1996b). Some formulations are more toxic to fish and aquatic species due to the toxicity of the surfactants. The LC50 for Roundup® (Glyphosate 41 percent, polyethoxylated tallowmine surfactant 15 percent, water 44 percent) is 5-26 mg/L for fish and 4-37 mg/L for invertebrates (Infoventures 1995j). The Rodeo® and Accord® formulations (without a surfactant) have an LC50 of greater than 1,000 mg/L for fish and 930 mg/L for Daphnia (Infoventures 1995c). Water temperature may affect the toxicity of the herbicide; Folmar (1979) found that the toxicity of Glyphosate to bluegill and rainbow trout doubled when the water temperature was increased from 45 to 63 °F.

Hexazinone

Hexazinone is a broad spectrum herbicide used in the control of annual and perennial broadleaf herbaceous plants, some grasses and some woody species. It works by inhibiting photosynthesis in susceptible plants by destroying chloroplast and cell and organelle membranes. In nonsusceptible plants, Hexazinone is broken down to less phytotoxic compounds. Hexazinone is absorbed through the roots and foliage of plants, and best results are obtained for herbaceous species when applied in moist soil conditions, as either a foliage spray or basal soil treatment. Larger woody species are best controlled by injection or hack-and-squirt techniques. Species that have been controlled by hexazinone include: tansy-mustard (*Descurainia pinnata*), cheatgrass (*Bromus tectorum*), filaree (*Erodium* spp.), shepards-purse (*Capsella bursa-pastoris*), false dandelion (*Hypochaeris radicata*), privet (*Ligustrum* spp.), and Chinese tallowtree (*Sapium sebiferum*).

Hexazinone is the active ingredient in the trade name herbicides DPX 3674, Pronone and Velpar. Hexazinone herbicides are available as a water-soluble powder (Velpar®; 90 percent hex, 10 percent inerts), a water dispersible liquid (Velpar® L; 25 percent hex, 40-45 percent ethanol, and 30-35 percent inerts), soluble granules (Velpar® ULW; 75 percent hex, 25 percent inerts) and granules (Pronone®; 10 percent hex, 90 percent inerts).

Hexazinone has an EPA Human Hazards Toxicity Category I rating, due to it being an eye irritant. It causes severe and irreversible corneal opacity and corrosion in rabbits (Infoventures, 1995k). It is slightly toxic via oral ingestion (LD50 of 1,690 mg/kg in rats, Toxicity Category III) and nearly nontoxic via dermal exposure (LD50 of > 5,278 mg/kg in rabbits, Toxicity Category IV) (Infoventures 1995k). Chronic toxicity is not apparent and it does not pose a risk to fertility, reproduction, or growth of offspring (NOEL of 100 mg/kg/day for development in rats, NOEL of 50 mg/kg/day for development in rabbits) (PMEP, 2001a).

Hexazinone is water-soluble and does not bind strongly with soils, and so is of particular concern for ground water contamination. It can persist in soils and aquatic systems for some time (average half-life in soil is 90 days), increasing the likelihood of contamination. (Tu, et al. 2001). Hexazinone can enter aquatic systems through surface and subsurface runoff following application and drift during application. It is degraded by microbial metabolism, but not readily decomposed chemically or by sunlight and can, therefore, persist in aquatic systems. The average half-life of hexazinone in soils is 90 days, but it can sometimes be found in runoff up to 6 months after application.

Although it is of relatively low toxicity to birds and mammals, legal application rates can leave residues that exceed EPA's Level of Concern for aquatic and terrestrial plants and small mammals. It is of relatively low toxicity to fish and aquatic invertebrates but can be highly toxic to some species of algae. Hexazinone contamination has been detected in small water bodies in episodic, low-level pulses that were rapidly diluted in mainstream flows. High concentrations of hexazinone, however, could lead to significant losses of algae and macrophytic biomass, which could produce a ripple effect in the food chain that ultimately could impact fish and wildlife species. Although hexazinone can accumulate in treated crops, concentrations in vegetation are not likely to reach toxic levels for foraging animals when hexazinone is applied properly. Care should be taken in preparing and applying hexazinone as it can cause severe eye damage.

The half-life of hexazinone in soils ranges between 1 and 6 months with an average of 90 days (Tu et al. 2001). The half-life for Velpar® ULW in plants is 26-59 days and in litter is 55 days (Michael et al. 1999). Hexazinone is degraded by microbial metabolism in aerobic soils and may also be broken down by photodegradation. The chemical breakdown of Hexazinone leads to 8 different metabolites, only one of which is known to be toxic to plants and at only 1 percent of the toxicity of Hexazinone (Tu et al. 2001). Hexazinone is stable in water without the presence of sunlight or microbes. In natural conditions, photodecomposition, biodegradation and dilution are methods of loss of activity in water. The half-life of Hexazinone in water can vary between several days (Solomon et al. 1988) to more than 9 months (Thompson et al. 1992).

Hexazinone is a triazine herbicide that acts by inhibiting photosynthesis. It is generally chemically stable, highly soluble in water, and relatively insoluble in various organic solvents. It has been reported that half of the applied dose is lost in soil after 1 to 6 months depending on climate and soil type (EXTOXNET 1996c). Hexazinone is broken down by soil microbes and sunlight. Hexazinone does not evaporate to any appreciable extent, and it can leach through the soil to the root zone. Hexazinone has a low order of acute toxicity; however, it can cause serious and irreversible eye damage. In rats, the LD50 was reported at 1,690 mg/kg (EXTOXNET 1996c). Other LD50 reported for hexazinone are 860 mg/kg for guinea pigs and 3,400 mg/kg for beagle dogs. The LD50 for rabbits is reported to be greater than 5,278 mg/kg.

Studies of chronic toxicity of hexazinone in mammals show it to have a low order of chronic toxicity. Rats given moderate doses of hexazinone in their food for 2 weeks showed no evidence of cumulative toxicity (EXTOXNET 1996c). Rats and dogs fed high doses of the compound for 90 days showed only slight decreased body weights. Very high doses did not appear to effect hamsters, and caused only increased liver weights in mice. It is generally not considered to be a reproductive, mutagenic, or carcinogenic compound based on chronic toxicological studies. Consumption of hexazinone granules by birds immediately after application could lead to reproductive effects or overt toxic effects. However, the plausibility of this risk is questionable, since there are no data indicating birds consume hexazinone granules (SERA 1997).

Hexazinone has low adsorption capacity in soils and sediment and does not volatilize readily. It is, however, highly soluble in water, which makes it very mobile through the soil. Due to its persistence and mobility through soil, there is potential for contamination of ground water and nearby surface water. Sidhu and Feng (1993) observed that after granular formulations were applied during the fall, surface runoff following spring melt contaminated nearby marsh reed grass. Michael et al. (1999) applied Hexazinone at a rate of 6.72 kg/ha (3 times the rate prescribed for the site) to a watershed in Piedmont, Alabama. During application, maximum stream concentration was 422 µg/L for Velpar® ULW and 473 µg/L for Velpar® L, due to direct overspray. During the first 30 days, stream concentrations peaked several times with stormflow (56-70 µg/L Velpar® ULW; 145-230 µg/L Velpar® L), but was diluted 3 to 5 times 1.6 km downstream. In the upper Piedmont in north Georgia, low concentrations of Hexazinone were found in storm runoff 7 months after application (Neary et al. 1986). In a steep watershed in north-central West Virginia, Lavy et al. (1989) found that 4.7 percent of the Hexazinone applied leached into local streams.

The technical grade of hexazinone is only slightly toxic to fish species. The liquid and solid carriers in two commercial hexazinone formulations were found to be of extremely low toxicity to fish (Infoventures, 1995k). The technical grade of hexazinone has an LC50 for rainbow trout of 320 mg/L, 370 mg/L for bluegill sunfish and 274 mg/l for the flathead minnow (WSSA 1994). These levels far exceed residue amounts found in streams in treated watersheds. For freshwater invertebrates Hexazinone is practically nontoxic. The EC50 for *Daphnia magna* is 151 mg/L (WSSA 1994). Mayack et al. (1982) found no significant changes in invertebrate species diversity or composition between treated and untreated sites. Several studies show that Hexazinone is toxic to algae at 0.01 to 0.60 mg/L, and can slow growth after only one day of exposure (WSSA, 1994). Although peak concentrations in streams from stormflow may exceed this threshold, chronic exposure at these levels is unlikely with appropriate application.

Hexazinone does not accumulate in fish. When Rhodes (1980) exposed bluegill sunfish to concentrations of 1 ppm for 28 days, levels in tissue peaked after 1 to 2 weeks of exposure and were completely eliminated 2 weeks after withdrawal. The threat of bioaccumulation is low as it is processed and excreted by animal systems.

Imazapic

Imazapic is a selective herbicide for both pre- and post-emergent control of some annual and perennial grasses and some broadleaf weeds *(*Tu et al. 2001*)*. It works well on species such as leafy spurge. Imazapic also controls annual grasses and can be used for restoration of native bunchgrass sites. The effect of the herbicide on perennial grasses and broadleaf weeds can vary within a plant family. In general, plants in the *Brassicaceae* (mustard) family, leafy spurge, and some cool-season perennial grasses are sensitive to the herbicide. Fall applications increase tolerance of cool season grasses, such as mountain brome, to imazapic. Warm season grasses and plants in the Asteraceae and Fabaceae family are very tolerant. Woody species are generally tolerant due to poor translocation of imazapic to meristem and lack of herbicide uptake through woody stems or roots.

Imazapic has an average half-life of 120 days in soil, is rapidly degraded by sunlight in aqueous solution with a half-life of 1 to 2 days, but is not registered for use in aquatic systems *(*Tu et al. 2001*)*.

Imazapic is essentially nontoxic to terrestrial mammals, birds, amphibians, aquatic invertebrates, and insects. It has a half-life of 7 to 150 days, depending upon soil type and climatic conditions. It is degraded primarily by soil microbial metabolism. It does not bioaccumulate in animals, as it is rapidly excreted in urine and feces (Tu et al. 2001, SERA 2001)). It has a half-life of 7 to 150 days, depending on soil type and climatic conditions.

It is degraded primarily by soil microbial metabolism. The oral LD50 of imazapic is greater than 5,000 mg/kg for rats and 2,150 mg/kg for bobwhite quail, indicating relative nontoxicity by ingestion. The LD50 for honeybees is greater than 100 mg/bee, indicating that imazapic is nontoxic to bees. Imazapic is nonirritating to eyes and skin, even in direct applications. The inhalation toxicity is very low. Chronic consumption in rats for 2 years and in mice for 18 months elicited no adverse effects at the highest doses administered. Chronic consumption by dogs for 1 year caused minimal effects (Tu et al. 2001, SERA 2001). Imazapic may be mixed with other herbicides such as picloram or 2,4-D. Combining imazapic with other herbicides should not increase the toxicological risk over that of either herbicide when used alone (Tu et al. 2001).

It is, therefore, essentially nontoxic to a wide range of nontarget organisms including mammals, birds and insects *(*Tu et al. 2001*)*. However, Imazapic itself is of low toxicity to fish. The LC50 (96 hour) for technical grade Imazapic for bluegill sunfish and rainbow trout are >100 mg/L. American Cyanamid Company (ACC 2000) indicated that degradation in aqueous solution renders Imazapic relatively safe to aquatic animals.

Imazapyr

Imazapyr is strongly adsorbed by soils, found only in the top few inches of the soil. Imazapyr is broken down by exposure to sunlight and soil microorganisms (Infoventures 1995j). As such, it has a low potential for leaching to ground water, but may reach surface water during storm events over recently treated land.

Because imazapyr is a weak acid herbicide, environmental pH will determine its chemical structure, which in turn determines its environmental persistence and mobility. Below pH 5 the adsorption capacity of imazapyr increases and limits its movement in soil. Above pH 5, greater concentrations of imazapyr become negatively charged, fail to bind tightly with soils, and remain mobile in the environment. In soils imazapyr is degraded primarily by microbial metabolism. It is not, however, degraded significantly by photolysis or other chemical reactions. The half-life of imazapyr in soil ranges from 1 to 5 months. In aqueous solutions, imazapyr may undergo photodegradation with a half-life of 2 days. Imazapyr is not highly toxic to birds and mammals, but some formulations can cause severe, irreversible eye damage. Studies indicate imazapyr is excreted by mammalian systems rapidly with no bioaccumulation. It has a low toxicity to fish, but studies on the effects of imazapyr to other aquatic species are lacking. Because imazapyr can be highly mobile, persistent, and can affect a wide range of plants, care must be taken in the application of this herbicide to prevent accidental contact with nontarget species. Additionally, recent studies report that imazapyr can "leak" out of the roots of treated plants and adversely affect the surrounding native vegetation.

Very little is lost by evaporation. Imazapyr is practically nontoxic to mammals and birds (Infoventures 1995j; SERA 1999b). In birds, the LD50 was reported to <2,150 mg/kg and in mammals between 4,800 and 5,000 mg/kg (Infoventures, 1995g). Imazapyr has not been found to be mutagenic and there has been no evidence to support developmental effects. Imazapyr can cause irritant effects in the skin and eyes (SERA 1999b). The EPA has classified imazapyr as a Class E compound, one having evidence of noncarcinogenicity. Under typical and conservative worst-case exposure assumptions, the evidence suggests that no adverse effects would be expected from the application of imazapyr (SERA 1999b).

Imazapyr and its formulations are low in toxicity to invertebrates and practically nontoxic to fish. Acute oral toxicity in rates tested LD_{50} greater than 5,000 mg/kg, dermal toxicity was greater than 2,000 mg/kg in rabbits. Chronic toxicity is not apparent and shows no evidence of developmental effects and there is not enough information available at this time to determine whether it causes cancer or adverse reproductive or fertility effects (Infoventures 1995k).

Metsulfuron methyl

Metsulfuron methyl is a selective herbicide used to control brush and certain unwanted woody plants, annual and perennial broadleaf weeds, and annual grassy weeds. It can control plants in the mustard and borage families including whitetop and houndstongue, respectively.

Commercial formulations of metsulfuron methyl (Escort®, Ally®) contain 60 percent metsulfuron methyl and 40 percent inert ingredients.

Metsulfuron is water-soluble and remains in the soil unchanged for varying lengths of time, depending on soil type and moisture availability. The half-life can range from 120 to 180 days. Soil microorganisms and chemical hydrolysis break it down (SERA 2000, Infoventures 1995d). Metsulfuron methyl is practically nontoxic to birds, mammals, invertebrates, and bees (SERA 2000). Acute oral LD50 was greater than 5,000 mg/kg in rats and 2,000 in mallard ducks; acute dermal LD50 was greater than 2,000 mg/kg in rabbits (Infoventures 1995d). Based upon the results of animal studies, metsulfuron methyl is not classified as a carcinogen, mutagen, teratogen, or reproductive inhibitor (Infoventures 1995d, SERA 2000). The primary adverse effect from exposure to metsulfuron methyl appears to be weight loss (SERA 2000).

The chemical is stable to hydrolysis at neutral and alkaline pHs.

Metsulfuron methyl has very low toxicity to aquatic organisms. LC50 (96 hour) for rainbow trout and bluegill sunfish are both >150 mg/L. A LC50 (48 hour) for *Daphnia* was also >150 mg/L (EXTOXNET 1996c). It appears that compound related mortality after acute exposure is not likely to be observed in fish exposed to concentrations less than or equal to 1000 mg/L (SARA, 2000). Kreamer (1996) conducted a study regarding the toxicity of Metsulfuron methyl to fish, eggs and fry and observed no effects on rainbow trout hatchling, larval survival or larval growth over a 90-day exposure period at a concentration of up to 4.7 mg/L. Concentrations greater that 8 mg/L resulted in small but significant decreases in hatching and survival of fry.

Metsulfuron methyl appears to be relatively nontoxic to aquatic invertebrates based on acute bioassays in *Daphnia* with an acute LC50 value for immobility of 720 mg/L and a NOEL for reproduction of 150 mg/L (SERA 2000). The only effect seen in a 21-day *Daphnia* study was a decrease in growth, which was observed at concentrations as low as 5.1 mg/L (Hutton 1989). At concentrations less than 30 mg/L, the effect was not statistically significant.

Picloram

Picloram generally affects members of the *Asteraceae* (composite), *Fabaceae* (legume), *Polygonaceae* (buckwheat), and *Apiaceae* (parsley) families. Members of the *Brassicaceae* (mustard), *Liliaceae* (lily), and *Scrophulariaceae* (figwort) families are less affected. The selectivity of picloram is rate and season dependent. Spring and fall applications at 1 pint per acre would have a short-term effect on native broadleaf plants (SERA 2003c).

Fall applications would be more selective at rates up to 1½ pints per acre because many nontarget native plants are dormant and herbicide uptake is reduced. Rates under 1 quart per acre generally do not kill woody plants. Impacts to nontarget native plants from picloram would be offset by reduction of weed competition and an increase in vigor and abundance of surviving species. Picloram can control weeds for 2 to 4 growing seasons depending on weed biology and site conditions that would allow plant communities to become more resistant to weed invasion.

Picloram is the active ingredient in a number of herbicide formulations including Tordon®, Grazon®, and Pathway®. Tordon K®, Tordon 22K®, and Grazon PC® are picloram salt formulations and inert ingredients, primarily water and dispersing agents. Tordon RTU® and Grazon P+D® include picloram and 2,4-D salts as well as inert ingredients (Tu et al. 2001, Infoventures 1995a).

Picloram can stay active in soil for relatively long periods of time, maintaining toxicity to plants for up to 3 years. The half-life can vary from 1 month to 3 years (Tu et al. 2001) though long-term buildup in soil generally does not occur. Carbon dioxide is the major end product of breakdown of picloram (Infoventures 1995a).

Picloram does not bind strongly with soil particles and is not degraded rapidly in the environment allowing it to be highly mobile and persistent. However, in soils with high clay content or organic matter, adsorption is increased and its leaching capacity is reduced. In Picloram application, Watson et al. (1989) cited several past studies where 1 to 6 percent of picloram applied mobilized from the treatment areas and reached drainage channels.

Picloram is water-soluble and is readily degraded when exposed to sunlight in water or on the surface of plant foliage and soils (Tu et al. 2001). Photodegradation will occur most rapidly in clear, moving water *(*Tu et al. 2001*)*. Woodburn et al. (1989) found the half-life of Picloram in water was 2 to 3 days. Picloram can move offsite through surface or subsurface runoff and may also “leak” out of the roots of treated plants.

Picloram is almost nontoxic to birds, relatively nontoxic to bees, and low in toxicity to mammals. Mammals excrete most picloram residues unchanged and it does not bioaccumulate in animal tissue. Formulated products are generally less toxic than picloram (Infoventures 1995i). Tu et al. (2001) and Infoventures (1995a) report an acute oral LD50 for rats for picloram of greater than 4,000 milligrams per kilogram (mg/kg). LD50s were reported to be greater than 2,500 and 5,000 mg/kg for mallard ducks and the bobwhite quail, respectively. The acute dermal LD50 in rabbits was reported to be greater than 2,000 mg/kg. In laboratory tests with rabbits, picloram was not shown to be a skin irritant, but was a moderate eye irritant. Weight loss and liver damage in mammals has been reported following long-term exposure to high concentrations of picloram. Picloram is classified as a Class E carcinogen, a compound having evidence of noncarcinogenicity (Felsot 2001). Picloram showed no evidence of birth defects in rats or rabbits, and it was negative in two tests for mutagenicity (Infoventures 1995a). Male mice receiving picloram at dietary doses of 1,000 to 2,000 mg/kg/day over 32 days showed no clinical signs of toxicity or changes in blood chemistry, but females did show decreased body weight and increased liver weights. Liver effects were also seen in rats at very high doses of 3,000 mg/kg/day over an exposure period of 90 days, and above 225 mg/kg/day for 90 days.

Dogs, sheep, and beef cattle fed low levels of picloram for a month experienced no toxic effects. The ester and triisopropanolamine salt showed low toxicity in animal tests (EXTOXNET 1996a). Based on these studies, picloram does not appear to cause genetic damage or birth defects, has little or no effect on fertility and reproduction, and is not carcinogenic (Infoventures 1995a, Felsot 2001). There have been some concerns expressed that picloram acts synergistically with 2,4-D or other ingredients to cause chronic effects on wildlife.

There is some evidence that high concentrations of picloram and 2,4-D esters (fat soluble) (note: 2,4-D proposed for use by the forest is an amine formulation which is water soluble) have an additive, but not synergistic, effect as they can accumulate in the body. Picloram and 2,4-D are both rapidly excreted in an unchanged form by mammals, reducing the risk of their interaction. In one study, a test group of sheep was fed a single dose of picloram (72 mg/kg) and 2,4-D (267 mg/kg) and others were fed a mixture of 7.2 mg/kg of picloram and 27 mg/kg 2,4-D for 30 days. There was no evidence of toxicity in any of these sheep (Dow 2001). No adverse effects on endocrine activity have resulted from numerous studies conducted on mammals and birds to determine picloram toxicity values. The evidence indicates that the endocrine system in birds and mammals is not affected by exposure to picloram at expected environmental concentrations (DOW 2001). One byproduct in the manufacture of picloram is hexachlorobenzene (HCB). As there has been some concern that HCB is carcinogenic, the EPA has required that there be a maximum concentration of 100 ppb (parts per billion) in picloram.

The manufacturer of Tordon has set its own limit at 50 ppb (50 micrograms per liter of formulation). In practice, the formulation is further diluted by a factor of 350 for spraying (Felsot 2001). As a result, residues of picloram after spraying do not contain more HCB than background levels (Felsot 2001).

Toxicity to aquatic species varies depending on the formulation used and the species involved. Some salmonids (such as brook and brown trout) have been found to have a moderate tolerance for Picloram with LC50s (96 hour) of 91 and 52 parts per million (ppm), respectively, (Norris et al. 1991). The LC50 (96 hour) reported for rainbow trout, bluegill sunfish and flathead minnow are 19.3 milligrams per liter (mg/L), 14.5 mg/L and 55 mg/L, respectively (EXTOXNET 1996a, SERA 2003c). Other reports present LC50s (96 hour) for cutthroat, rainbow and lake trout as 1.5, 2.0, and 3.1 ppm, respectively (Woodward 1979). Mayes et al. (1987) evaluated the toxicity of Picloram to rainbow trout and found that the 96-hour LC50 for fry was 16.5 mg/L while the chronic NOEL based on egg hatching and growth was 0.55 mg/L. Growth and survival of fry was reduced at concentrations of 0.88 mg/L and 1.34 mg/L, respectively. Mayes et al. (1987) concluded that Picloram is not an acute or chronic hazard to aquatic species when used as directed. However, Woodward (1976) found even very low concentrations of Picloram (35 micrograms per liter) reduced survivability and growth of lake trout fry after 60 days of exposure. Gersich et al. (1985) evaluated the acute and chronic toxicity of Picloram to the aquatic macroinvertebrate *Daphnia Magna* and found an LC50 (48 hour) of 68.3 mg/L and a chronic NOEL of 11.8 mg/L. The authors concluded that these findings corroborated the low toxicity rating of Picloram to wildlife and aquatic species. Power (1989) identified an LC50 (96 hour) for a tusked frog tadpole (*Adelotus brevis*) of 95 mg/L. Other aquatic macroinvertebrates such as *Pteronarcys spp.* (stonefly) and *Gammarus spp.* (crustacean) had LC50s (96 hour) of 48 and 27 ppm, respectively (Johnson and Finley, 1980).

Sulfometuron methyl

Sulfometuron methyl is more selective than glyphosate and is useful in controlling weedy grasses, in particular cheat grass. Native grass seeding should follow spraying within one year to prevent reestablishment of cheat grass (Sheley 1999).

Sulfometuron methyl herbicides are sold under the trade names Oust® Weed Killer and DPX 5648. It is a general use pesticide used to control annual and perennial broadleaf weeds and grasses and some woody tree species. Sulfometuron methyl inhibits plant growth of the root and shoot by blocking the production of three amino acids needed for growth. It works by blocking cell division in the active growing regions of the stem and root tips. It may also have the same inhibitory effect on many fungi and bacteria, such as the bacteria *Salmonella typhimurium* (Infoventures 1995h).

It is generally active in soil, and is broken down by microbes, hydrolysis, and sunlight. It has been reported that half of the compound degraded within 30 days in silt loam soils. It has a field half-life in the range of 20 to 28 days (EXTOXNET 1996g). It is more strongly adsorbed to acidic soils and soils with a high organic content than to alkaline soils or soils with low organic content. Sulfometuron methyl is practically insoluble in water, and it mainly decomposes to carbon dioxide (Infoventures 1995h). Sulfometuron methyl is a slightly toxic compound. Burnet and Hodgson (1991) found 5 out of 11 typical soil microorganisms were inhibited by Oust®.

The oral toxicity of this compound is very low, reported to have oral LD50 levels in rats of >5,000 mg/kg (EXTOXNET 1996g). Acute toxicity LD50 values for the bobwhite quail and mallard duck were reported to be <5,000 mg/kg, respectively (Infoventures 1995h). The acute dermal LD50 has been reported to be >2,000 mg/kg in female rabbits and >8,000 mg/kg in male rabbits. It is considered to be a mild irritant to the skin and a moderate eye irritant. Some immunological toxic effects have been reported with chronic exposure to sulfometuron methyl in test animals. Dogs have experienced reduced red blood cell counts and increased liver weights at exposures of 25 mg/kg/day for a year (EXTOXNET 1996g). SERA 2000 also reported reduced red blood cell counts and increased liver weights at doses of 50 mg/kg/day.

While there is some concern of reproductive and teratogenic effects from exposure to sulfometuron methyl in laboratory animals, the results of the studies are somewhat unclear (SERA 2000, Infoventures 1995h) and EXTOXNET 1996g reports that sulfometuron methyl is unlikely to pose a mutagenic, carcinogenic or reproductive risk to animals and humans.

Sulfometuron methyl has a half-life in soils of approximately 30 days (Infoventures 1995h). Its adsorption is stronger in acidic soils and soils with high organic matter. It is practically insoluble in water. Oust® is a dispersible granule that can be suspended in water. Sulfometuron methyl's half-life in acidic water is 10 days and in more alkaline water is about 8 months (EXTOXNET 1996g). It is degraded by soil microorganisms, hydrolysis and photodegradation. There is potential for sulfometuron methyl to leach through the soils and be displaced by surface runoff to contaminate surface waters. However, due to its very low application rate (one-quarter to 8 ounces formulated product per acre) and subsequent microbial breakdown, there is little potential for contamination of ground water.

Sulfometuron methyl has an acute oral Toxicity Category IV, no toxicity (EPA Human Hazards Toxicity Category; 40 CFR 162, July 3, 1975). It has an acute dermal toxicity Category II and an eye irritation Toxicity Category III. The sulfometuron methyl compound is slightly toxic to fish with an LC50 of 12.5 mg/L for both the rainbow trout and bluegill sunfish (EXTOXNET 1996g). Although it may not be a threat to adult fish, the compound is highly toxic to the embryo hatch stage of fathead minnow at low concentrations of 0.71 mg/L (EPA 1984). The LC50 for *Daphnia Magna* is 125 mg/L (EXTOXNET 1996g).

There is little potential for bioaccumulation. Bluegill sunfish exposed to 1 mg/L for 28 days had no accumulation of the compound in their muscle or viscera (Environmental Fate and Effects Division 1992). The compound is absorbed by the gastrointestinal tract and is broken down and excreted.

Triclopyr

Triclopyr is a selective systemic herbicide used to control woody and herbaceous broadleaf plants along rights-of-way, in forests, and in grasslands and parklands. It has little or no impact on grasses. Triclopyr controls target weeds by mimicking the plant hormone auxin, causing uncontrolled plant growth. It is absorbed through the roots, foliage and green bark of plants. Within the plant, triclopyr mimics an auxin growth hormone—indoleacetic acid—causing uncontrolled and disorganized growth of the plant and plant cells, leading to withering and death. Grasses are able to quickly convert triclopyr to compounds that do not mimic growth hormones.

Triclopyr herbicides come in one of two formulations, a triethylmine salt (triclopyr amine or salt) or a butoxyethyl ester (triclopyr ester). Trade names for triclopyr herbicides are Access, Crossbow, ET, Garlon, PathFinder, Redeem, Rely, Remedy and Turflon.

Triclopyr is particularly effective at controlling woody species with cut-stump or basal bark treatments. Susceptible species include the brooms (*Cytisus spp.*, *Genista spp.*, and *Spartium spp.*), the gorses (*Ulex spp*.), and fennel (*Foeniculum vulgare*). Triclopyr ester formulations are especially effective against root- or stem-sprouting species such as salt cedar (*Tamarisk spp*.), buckthorns (*Rhamnus spp.*), ash (*Fraxinus spp.*), and black locust (*Robinia pseudoacacia*) because triclopyr remains persistent in plants until they die.

There are two basic formulations of triclopyr—a triethyamine salt and butoxyethyl ester. In soils, both formulations degrade to the parent compound, triclopyr acid. Degradation occurs primarily through microbial metabolism, but photolysis and hydrolysis can be important as well.

The average half-life of triclopyr acid in soils is 30 days. Offsite movement through surface or subsurface runoff is a possibility with triclopyr acid, as it is relatively persistent and has only moderate rates of adsorption to soil particles. In water, the salt formulation is soluble and, with adequate sunlight, may degrade in several hours. The ester is not water-soluble and can take significantly longer to degrade. It can bind with the organic fraction of the water column and be transported to the sediments.

Both the salt and ester formulations are relatively nontoxic to terrestrial vertebrates and invertebrates. The ester formulation, however, can be extremely toxic to fish and aquatic invertebrates. Because the salt cannot readily penetrate plant cuticles, it is best used as part of a cut-stump treatment or with an effective surfactant. The ester can be highly volatile and is best applied at cool temperatures on days with no wind. The salt formulation (Garlon 3A®) can cause severe eye damage.

It is active in soil and rapidly broken down by microbes, particularly in warm climates. The average half-life of the compound in soils is 46 days, with a range of 30 to 90 days (Infoventures, 1995i) in natural soil and aquatic environments, the ester and amine salt formations convert to the acid, which is neutralized to a nontoxic salt.

Even though offsite movement of triclopyr acid through surface or subsurface runoff is a possibility, triclopyr is one of the most commonly used herbicides against woody species in natural areas.

On preserves across the U.S., triclopyr has provided good control of tree-of-heaven (*Ailanthus altissima*), salt cedar (*Tamarix spp*.), glossy buckthorn (*Frangula alnus*), common buckthorn (*Rhamnus cathartica*), sweet fennel (*Foeniculum vulgare*), Brazilian peppertree (*Schinus terebinthifolius*), and Chinese tallow tree (*Sapium sebiferum*). The Nature Conservancy preserves in Hawaii have successfully used triclopyr to control blackwood acacia (*Acacia melanoxylon*), bush honeysuckle (*Lonicera maackii*), Chinese banyan (*Ficus microcarpa*), corkystem passionflower (*Passiflora suberosa*), eucalyptus (*Eucalyptus globulus*), Florida prickly blackberry (*Rubus argutus*), Mexican weeping pine (*Pinus patula*), Monterey pine (*Pinus radiata*), strawberry guava (*Psidium cattleianum*), tropical ash (*Fraxinus uhdei*), and velvet leaf (*Miconia calvescens*). Triclopyr can also be used in forest plantations to control brush without significant impacts to conifers (Kelpsas & White). Spruces (*Picea spp.*) can tolerate triclopyr, but some species of pine (*Pinus spp*.), however, can only tolerate triclopyr during the dormant fall and winter months (Tu, et al. 2001).

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The two formations act very differently in soils and water. The salt formations do not readily adsorb with soil and are water-soluble and, therefore, quite mobile. The ester formations bind readily with organic material in soils and are not water-soluble causing them to be less mobile.

However, both rapidly degrade to the parent compound—triclopyr acid—by photolysis, microbial metabolism and hydrolysis. Triclopyr acid has intermediate soil adsorption capacity and binds with clay particles and organic matter in the soil. Leaching potential into ground water and surface water is moderate. Triclopyr acid is further broken down through photodegradation, microbial degradation and chemical decomposition. The acid can have as short a half-life as 2 hours in soil (McCall and Gavit 1986) and 12 hours in water (Johnson et al. 1995) on a sunny day, due to photolysis and microbial activity.

Other reports of the half-life of the acid in soils vary from 3.7 to 314 days, with an average of 30 days. Its half-life in water may range from 2.8 to 14.1 hours (EXTOXNET 1996e). The degradation time depends on many variables such as moisture, temperature, pH and light intensity. While concentrations of triclopyr acid in soil may degrade, the acid tends to remain in plant tissue until they die or drop their leaves (Newton et al. 1990). This litter adds a new source of triclopyr acid to the soil at time of litter drop. Triclopyr acid itself degrades to several metabolites, the major product being Trichloropyridinol (TCP). TCP further degrades to carbon dioxide and organic matter, and has a half-life of 30-90 days (Infoventures 1995g).

Triclopyr has an acute oral toxicity of slightly toxic (EPA Human Hazards Risk Category III), acute dermal toxicity of slightly toxic (Toxicity Category III), and is a slight to moderate eye irritant (Toxicity Category III to IV) (Infoventures, 1995i). Triclopyr has not been shown to cause birth defects or cancer, and has little or no effect on fertility and reproduction (Infoventures 1995g). The salt formulation (Garlon 3A®) can cause severe eye damage.

Triclopyr acid and the salt formation herbicide are only slightly toxic to fish. The LC50 for the acid is 117 mg/L for rainbow trout and 148 mg/L for bluegill sunfish (Tu et al. 2001). The LC50 for the salt formation is 552 mg/L and 891 mg/L for rainbow trout and bluegill sunfish, respectively (Tu *et al.* 2001). The ester formulation however is highly toxic to fish, with an LC50 of 0.74 mg/L for rainbow trout and 0.87 mg/L in bluegill sunfish (WSSA, 1994). The ester formulation was also found to be toxic to some species of frog tadpoles (LC50 = 1.2 mg/L). Tadpoles exposed to one-half or one-quarter the lethal dose levels exhibited loss of avoidance behavior when prodded, which may affect survival (Berrill et al. 1994). The high toxicity of the ester formulation is compounded by the fact that this form is hydrophobic and, therefore, is readily absorbed into fish tissue where it is degraded to triclopyr acid. This provides a means by which fish can acquire high levels of triclopyr acid that may reach or exceed the LC50. Although the ester formulation degrades rapidly to triclopyr acid, Kreutzweiser et al. (1994) has shown that there is a significant chance that fish may acquire acute lethal doses when exposed to high concentrations of the ester formulation for more than 6 hours. Application procedures of the ester formulation (e.g., overspray) and factors affecting the rate of breakdown of ester formulations (soil type, moisture, temperature, pH and light) determine the risk of lethal exposure for fish. Triclopyr is practically nontoxic to aquatic invertebrates. The triclopyr LC50 for *Daphnia Magna* is 1,140 mg/L (Infoventures 1995i, SERA 2003a). After treating a stream with Grazon®, Maloney (1995) found aquatic invertebrate species composition did not significantly change in treated and control sites.

Triclopyr has little if any potential to bioaccumulate. The bioconcentration factor in whole bluegill sunfish is 1.08 (EXTOXNET 1996e). Petty et al. (2001) found that concentrations of triclopyr and its byproduct, TCP, in fish were cleared from their systems in relation to the concentrations found in the water.

Triclopyr is a slightly toxic compound (SERA 2002, SERA 2003a). The oral LD50 levels in rats have been reported in the range of 630 to 729 mg/kg (EXTOXNET 1996e). Acute toxicity LD50 values for mammals are reported to be 310 to 713 mg/kg, and ducks were reported to have an oral LD50 of 1,698 mg/kg (Infoventures, 1995b). The acute dermal LD50 has been reported to be >2,000 mg/kg in rabbits. Triclopyr is considered to be a slight irritant to the skin and eye. Studies summarized in EXTOXNET (1996e), Infoventures (1995i) and SERA (2002/2003a) indicated that triclopyr does not pose a carcinogenic, mutagenic, reproductive, developmental risk to animals or humans at doses anticipated for this project.

Inert Ingredients

Herbicide manufacturers add inert ingredients (or "other ingredients") to enhance the action of the active ingredient. Inert ingredients may include carriers, surfactants, preservatives, dyes, and antifoaming agents among other chemicals. Inert refers to any ingredient that is not intended to affect the target species and does not convey any information regarding the toxicity of the chemical (EPA 2003a). Many manufacturers consider the inerts in their herbicide formulations to be proprietary and do not list specific chemicals. "The lack of disclosure of specific inert ingredients indicates that none of the inerts present at a concentration of 0.1 percent or greater is classified as hazardous" (SERA 1997b). Listed inert ingredients for the herbicide formulations being considered include water, ethanol, isopropanol, isopropanolamine, kerosene, polyglycol 26-2, and polyoxyethylamine (USFS 1992, USFS 1997, SERA 1995, 1996, 1997a, 1997b, 1998a, 1998b, 1999a, 1999b, 2000, 2001, 2002, 2003a, 2003b, 2003c). None of these chemicals are listed as Level 1 or Level 2 compounds (i.e., "Inert Ingredients of Toxicological Concern" or "Potentially Toxic Inert Ingredients," respectively) (EPA 2003a). Although there is some concern regarding the toxicity of polyoxyethylamine (POEA), a surfactant included in a formulation of glyphosate (Ecobichon 2001; SERA 2003b), there is no anticipated increase in toxicity of the glyphosate formulation as a result of POEA.

A risk analysis for Phase, the only additive/surfactant proposed for use on the forests, has not been performed or is unavailable. A MSDS exists for Phase® which provides a brief overview of the properties and effects of the chemical formulation; however, the information provided references human impacts and not those for fisheries or wildlife. Although there is limited information available about the effects of this chemical formulation, by applying Phase® at the recommended application rate of 1-4 pints per 100 gallons, the Forests assume the toxicity of the formulation will likely be well below levels that could impact fisheries or wildlife.

Human Health Risk Assessment

This discussion reviews the risks to people associated with herbicide application. The following referenced literature was used to analyze potential human health risks associated with herbicide application. Although the risk assessments consider aerial application of herbicides, this project does not propose such a use.

- The Risk Assessment for Herbicide Use in Forest Service Regions 1, 2, 3, 4 and 10 and on Bonneville Power Administration Sites (USDA FS 1992) (referred to as RAHUFS).

This analysis was developed for the Forest Service specifically to address human health issues raised by use of herbicides.

- Assessing the Safety of Herbicides for Vegetation Management in the Missoula Valley Region – A Question and Answer Guide to Human Health Issues, referred to as ASH (Felsot 2001).
- Risk assessments completed by the Forest Service under contract with Syracuse Environmental Research Associates for 2,4-D, picloram, clopyralid, dicamba, hexazinone, sulfometuron methyl, metsulfuron methyl, triclopyr, imazapic, and imazapyr.

Three levels of analyses were used in the risk assessment processes:

- Review of toxicity test data (i.e., acute, chronic, and subchronic) for herbicides proposed for use on the project to determine dosage that could pose a risk to human health. Toxicity test data on laboratory animals is available for herbicides proposed for use in this analysis. Most tests have been conducted under EPA pesticide registration/re-registration requirements for use in the United States. The EPA uses test data to determine conditions for use of herbicides in the United States.
- Estimate of exposure levels to which workers (applicators) and general public may be exposed during treatment operations. These exposure levels tend to be very conservative, with the highest doses expected multiplied by a factor of 100 to provide margins of safety.
- Determine potential health risks by comparing dose levels to toxicological thresholds developed by EPA.

Factors Affecting Hazard of Herbicides

Toxicity of Herbicides

A comparison of toxicity for herbicides proposed for use in this project is shown in Table 57. Toxicological studies using animals typically involve purposeful exposure to dosages (per unit of body weight) required to cause an effect (i.e. tumors, changes in immunity, etc.) or to establish a Lowest Observed Effect Level, known as a (LOEL) or a No-Observed-Effect-Level (NOEL). This often requires administration of relatively high doses of a chemical in order to document an effect or lack thereof.

Acute Toxicity

Acute toxicity is measured by the LD_{50}, defined as the dosage of toxicant expressed in milligrams per kilogram of body weight, which is lethal to 50 percent of animals in a test population within 14 days of administration (USDA FS 1992). Risk assessments for the herbicides proposed for use show that the likelihood of exposure at these acute levels is not plausible, even in an accidental spill scenario (Infoventures 1995a-j; EXTOXNET 1996a-h).

Subchronic and Chronic Toxicity

There is considerable information on subchronic and chronic effects due to exposure to herbicides in controlled animal studies. The information suggests that the herbicides proposed for use by the Forests are not carcinogenic, and there is no evidence to suggest that the herbicides proposed for use would result in carcinogenic, mutagenic, teratogenic, neurological or reproductive effects based on anticipated exposure levels to workers and the public (Arbuckle 1999; Charles et al.

1996; Faustini 1996; Ibrahim, et al. 1991; Mattsson 1997; Mustonen 1986; Infoventures 1995a-j; EXTOXNET 1996a-h; EPA 1990a; EPA 1990b; SERA 1995, 1996, 1997a, 1997b, 1998a, 1998b, 1999a, 1999b, 2000, 2001, 2002, 2003a, 2003b, 2003c).

The Reference Dose (RfD) provides a measure of long-term exposure that could result in chronic toxic effects. Generally, the dose-response assessments used in Forest Service risk assessments adopt RfDs proposed by the EPA as indices of acceptable exposure. An RfD is a level of exposure that will not result in any adverse effects in any individual. The EPA RfDs are used because they generally provide a level of analysis, review, and resources that far exceed those that are or can be conducted in support of most Forest Service risk assessments. In addition, it is desirable for different agencies and organizations within the Federal Government to use concordant risk assessment values. (Infoventures 1995a-j; EXTOXNET 1996a-h, EXTOXNET 2001.)

The Reference Dose comparison is discussed in more detail with the exposure risks discussion later in this section.

Table 57. Herbicide Characteristics

Herbicide	Carcinogenic[1]	Mutagenic and Reproductive[2]	Acute oral LD50 for rats (mg/kg/day)
Glyphosate	E	No	2,000 - 6,000
Picloram	E	No	3,000 - 5,000
Hexazinone	D	No	1,690
Clopyralid	E	No	2,675 - 5,000
2,4-D	D	No	100 - 1,800
Dicamba	D	No	757 - 1,701
Chlorsulfuron	E	No	>5,000
Metsulfuron methyl	E	No to slight	>5,000
Triclopyr	E	No to slight	630 - 729
Sulfometuron methyl	E	No	>5,000
Imazapyr	E	No	>5,000
Imazapic	E	No	5,000

[1] EPA carcinogenicity classification based on daily consumption for a 70-year life span. D = Not Classifiable as to Human Carcinogenicity; E = Evidence of Non-Carcinogenicity

[2] Unlikely that compound is mutagenic or would pose a mutagenic risk to humans at expected exposure levels.

Source: Infoventures 1995a-j; EXTOXNET 1996a-h; EXTOXNET 2001; EPA 1990a; EPA; 1990b; SERA SERA 1995, 1996, 1997a, 1997b, 1998a, 1998b, 1999a, 1999b, 2000, 2001, 2002, 2003a, 2003b, 2003c.

Synergistic Interactions

Concerns are occasionally raised about potential synergistic interactions of herbicides with other herbicides in the environment or when they are mixed during application (tank mixing). Synergism is a special type of interaction in which the combined impact of two or more herbicides is greater than the impact predicted by adding their individual effects. The RAHUFS (USDA FS 1992) addresses the possibility of a variety of such interactions. These include the interaction of the active ingredients in an herbicide formulation with its inert ingredients, the interactions of these herbicides with other herbicides in the environment, and the cumulative impacts of spraying as proposed with other herbicide spraying to which the public might be exposed.

As noted in various risk assessments, no guarantee can be made regarding the effects of a chemical being zero (Infoventures 1995a-j; EXTOXNET 1996a-h, 2001). Similarly, guarantee can be made about the absence of a synergistic interaction between herbicides and/or other chemicals to which workers or the public might be exposed. For example, exposure to benzene, a known carcinogen that comprises 1 to 5 percent of automobile fuel and 2.5 percent of automobile exhaust, followed by exposure to any of these herbicides could result in unexpected biochemical interactions. Analysis of the infinite number of materials a person may ingest or be exposed to in combination with chemicals is not feasible. This being said, there is some indication that the co-exposure to 2,4-D and picloram may induce effects not associated with exposure to 2,4-D or picloram alone (SERA 2003c; Cox 1998; EXTOXNET 1996a). Risk assessments conclude, however, that the additive effect of Forest Service herbicide use lies below the background levels for many of these chemicals (SERA 1995, 1996, 1997a, 1997b, 1998a, 1998b, 1999a, 1999b, 2000, 2001, 2002, 2003a, 2003b, 2003c, EXTOXNET 1996a-h, 2001).

Impurities, Adjuvant and Inert ingredients in Herbicide Formulations

During commercial synthesis of some pesticides, byproducts can be produced and carryover into the product eventually formulated for sale. Occasionally byproducts or impurities are considered toxicologically hazardous, and their concentrations must be limited so that potential exposures do not exceed levels of concern (Felsot 2001).

Technical grade picloram (prior to mixing with other inerts) and clopyralid contains hexachlorobenzene (HCB) as a byproduct of the synthesis of the active ingredients (USDA FS 1999c). HCB is also a byproduct of chlorinated solvents used extensively in industry and occasionally around the home. Because of this chemical’s prevalence in the environment, it has been assigned a background level of 0.00001 (1×10^{-6}) mg/kg/day (picloram risk assessment p. xiv). HCB was registered as a fungicide until banned by EPA over concerns that it may be carcinogenic. As a result, EPA has imposed a limit of 100 parts per million (ppm) HCB in Tordon®. The manufacturer of Tordon® has set its own manufacturing standard even lower and reportedly maintains HCB levels in formulated picloram at 50 ppm or less (i.e. 50 milligrams per liter of formulation). Average concentrations of HCB in picloram have been estimated at 8 ppm (EPA, 1995). Therefore, HCB comprises only 0.000005 (5×10^{-6}) percent of the Tordon® formulation, which is then further diluted when the spray solution is prepared in accordance with the label.

Given the dilution of formulations by water in the final spray solution, estimates of HCB exposure from use of picloram or clopyralid-containing products have shown that resulting residues in the environment and bystander exposure levels do not exceed current background levels. Estimates for worker exposure range from 2×10^{-7} mg/kg/day to 4×10^{-7} mg/kg/day. For the public, the upper range of long-term exposure are about 1×10^{-10} mg/kg/day to as much as 2×10^{-8}, which are below background levels. Longer-term dose estimates for the general public exposed to HCB in clopyralid were also below the general background exposure to HCB in the environment by factors of about 25,000 to several million (SERA 1999a, 2003c).

The estimates of worker exposure to HCB under normal conditions were expected to be lower than the background levels of exposure by factors of about 1,000. Likewise, the exposure assessments based on the use of picloram by the Forest Service have been estimated to result in long-term predictions for the general public that are below background doses of HCB due to environmental contamination by factors of about 1,400 to 7 million (SERA 1999a, 2003c). Thus, for commercially sold products which are more dilute than technical grade products, there appears to be no basis for asserting that the use of clopyralid or picloram in accordance with the label by the Forest Service would result in substantial increases in the general exposure of either workers or members of the general public to HCB.

Another concern is potential presence of dioxin in formulations containing chlorinated chemicals. Dioxins are a group of chemicals involving 76 different types of related molecules called congeners, each having from two to eight chlorine atoms. The toxicity of each of the types of dioxin molecules is different. The toxic potency is determined by spatial arrangement of the chlorine atoms in a molecule rather than mere presence of chlorine. Of all of the congeners, one—TCDD (2,3,7,8-tetrachloro-para-dibenzodioxin)—is the most potent. All 2,4-D products manufactured in the U.S. do not contain TCDD and so do not contaminate the environment with the dioxin congener of greatest regulatory concern (EPA 2000, Chapter 8 of the Draft Dioxin Assessment).

The proprietary nature of herbicide formulations limits the understanding of the risks posed by inert ingredients and adjuvant in herbicide formulations. Unless the compound is classified as hazardous by the EPA, the manufacturer is not required to disclose its identity. It could be suggested that the inert ingredients in these herbicides are not toxic, or their toxicity would be reported to the EPA. This would hold true if considerable toxicological testing of inert ingredients has been done. That, however, has not been the case. EPA is increasing the testing requirements for inert ingredients, but in many cases, the inert ingredients currently in use have not been tested rigorously and their toxicity is not well characterized. That being said, studies on the toxicity of technical grade formulations, which often contain the inert ingredients, account for the toxicity of the inert ingredients and, as has been reported here, these studies show that the use of herbicides by the forest would not expose workers or the public to levels of concern.

Literature does report considerable information on types of inert ingredients and adjuvants present in herbicides proposed for use by the forest. As noted in SERA (1997a), Velpar L®, the trade name for hexazinone, contains 40-45 percent ethanol, an eye irritant and a considerable toxin if ingested. It has been reported the most common impurities of technical grade 2,4-D include other phenoxyacetic acids, a variety of chlorinated phenols, and possibly low levels of nitrosamines in amine salts (Ibrahim et al. 1991). Transline, the commercial formulation of clopyralid, contains clopyralid as the monoethanolamine salt and isopropyl alcohol, an approved food additive (SERA 1999a). Both Tordon 22 and 22K contain the potassium salt of picloram (24.4 percent), the remaining consisting of polyglycol 26-2, the DOW name for polyethylene glycol, a widely used family of surfactants considered to have low toxicity and frequently used in the formulation of ointments and cosmetics (MCCHB 2001).

SERA (2003, 2003a) reports that Garlon® formulations of triclopyr contain ethanol and kerosene. Technical formulations of imazapyr contain isopropyl alcohol and isopropanolamine salts of imazapyr (SERA 1999b). Glyphosate has been reported to contain small amounts of nitrosamine, and N-nitroglyphosate (SERA 2003b). Roundup®, a formulation of glyphosate, contains the surfactant polyoxyethyleneamine (POEA) and 1,4-dioxane, classified by the EPA as a probable human carcinogen. However, carcinogenic studies of Roundup® by the EPA have shown the herbicide to be noncarcinogenic (SERA 2003b). The inert ingredients in Escort®, which contains metsulfuron methyl, are confidential. The risk assessment does report, however, the inert ingredients in Escort® are not classified by EPA as toxic (SERA 2000).

Many herbicide formulations contain dyes. The use of dyes can be beneficial in that they can color vegetation, making it less likely for an individual to inadvertently or intentionally consume contaminated vegetation. The presence of a dye in herbicide formulations may also make it easier for workers to see when they have been contaminated and allow for prompt remedial action.

Dyes may also pose risks to humans and wildlife. The most common dyes used with herbicides are Milori blue, Heliogen blue, Lithol rubine, and Sico fast orange (SERA 1997b). Little information is available on the toxicity of the majority of dyes used in the industry. There has been considerable concern over the carcinogenic potential of less used dyes Rhodamine B and Basic Violet 3. Rhodamine B is a colorant used in some commercial herbicide dyes. Basic Violet 3 is the colorant used in Colorfast Purple. Both have been used with glyphosate. The Forest Service completed a risk assessment of Rhodamine B and Basic Violet 3. It estimated the excess cancer risk for Rhodamine B, assuming a lifetime of occupational exposure, within the range of 8×10^{-6} to 8×10^{-8} (SERA 1997b). The excess cancer risk for Basic Violet 3 was estimated to be about twice that of Rhodamine B. Both estimates suggest that use of these dyes does not pose an unacceptable health risk.

Surfactants are also commonly used in herbicide formulations. Surfactants are added to herbicides to improve herbicide mixing and the absorption or permeation of the herbicide into the plant. Like dyes and other inert ingredients, there is often limited information on the types of surfactants used and the toxicity of surfactants, especially since the industry considers the surfactant to play a key role in the effectiveness of the herbicide formulations. Most knowledge of surfactants is kept as proprietary information and not disclosed. This is not always the case. A review that attempted to assess the effects of surfactant formulations on the toxicity of glyphosate (SERA 1997b) reported that the toxicity of glyphosate alone was about the same as the toxicity of the glyphosate and surfactant mixed, and greater than the toxicity of the surfactants alone. Whether this same pattern would hold true of other herbicides having the same or different surfactants is unknown. If so, the toxicological studies performed on herbicide formulations (which contain the inert ingredients and surfactants) may accurately portray the toxicity and risks posed to humans by the surfactant.

Endocrine Disruption

The endocrine system includes tissues and hormones that regulate metabolism, growth, and sexual development. The Food Quality Protection Act (FQPA) requires that EPA develop tests to screen for chemicals with the potential to mimic hormones. Chemicals that do mimic hormones and cause biochemical changes in tissues are called endocrine disrupters or hormonally active agents (HAAs).

The concern over HAAs is due to the fact that the endocrine system is intimately linked with the brain and the immune system. All three systems communicate with one another to affect body development and functioning. Adverse effects on this network have been blamed for a variety of maladies ranging from cancer to infertility to behavioral problems (Felsot 2001).

Chemicals, other than our own hormones, can interact with components of the endocrine system. Scientists have discovered that many kinds of chemicals, including natural food biochemicals as well as industrial chemicals and a few pesticides, can mimic the action of the hormones estrogen or testosterone. Concern has also been expressed about potential effects on the thyroid hormone during early development (Felsot 2001).

Two general types of tests are used to screen chemicals for endocrine disrupting abilities. The most widely used tests are in vitro tests. These tests are conducted in a test tube or dish using cells and, in some cases, the actual protein receptors, enzymes, and genes involved in the biochemistry of the endocrine system. In vitro tests can be used to quickly screen large numbers of chemicals for their ability to interact with different biochemical components of the endocrine system (SERA 2002).

Positive in vitro tests, however, do not necessarily indicate that a substance would actually disrupt hormone functioning in a whole organism. In vitro screening tests are properly used to determine which chemicals should be subjected to a second type of test, the in vivo or “live animal” test. In vivo tests use whole animals that are fed various doses of chemical. In some cases, the chemical is injected beneath the skin or directly into the body cavity. Developmental and reproductive toxicity studies with live animals over several generations are especially useful for determining if a substance adversely affects the endocrine system.

With one exception—the drug DES (diethylstilbesterol)—all chemicals that have been tested in vitro are thousands to millions of times less potent than the natural estrogen hormone (estradiol) (Felsot 2001). Also, as exhibited by estradiol, all chemicals tested in vitro appear to show definitive threshold effects (i.e., NOELs) for estrogenic activity. No pesticides, food biochemicals, or other synthetic chemicals have definitively shown greater and/or different in vitro effects at low doses as compared to higher doses. Although our natural hormones function at very miniscule levels in the body, endocrine disrupter tests have shown that interactions of hormone receptors with natural and synthetic chemicals are still related to dose during exposure. Even chemicals capable of interacting with the endocrine system at sufficiently high doses have not been found biologically active at low doses (EPA 1997a).

In the in vivo (live animal) studies to date, only a handful of chemicals, including natural food biochemicals, a few pesticides, and several industrial chemicals show endocrine disrupting effects (Felsot 2001). The in vivo experiments usually involve feeding pregnant rats or mice one or more doses of a chemical. With one exception, the drug DES, any effects that have been observed were in tests with doses at least thousands of times greater than environmental or dietary concentrations.

In virtually all published cases where a series of doses are tested in vivo, endocrine effects did not occur below some threshold dose (EPA 1997a). The EPA (1997a) concluded with few exceptions (e.g. diethylstilbestrol) a causal relationship between exposure to a specific environmental agent and an adverse effect on human health operating via an endocrine disruption mechanism has not been established.

Potential for Exposure

While the toxicity of a substance is the first part of the risk assessment, the second equally important consideration is the potential for exposure. The dose level that causes an effect in many toxicological studies is exponentially greater than what an applicator might be exposed to while applying herbicides. The method of exposure to herbicides in animal studies is also different than that of a worker or the general public, which also magnifies the chemical effect. In animal studies, herbicides are commonly pumped into stomachs (gavage), put directly into food, or placed directly on shaved skin. Potential exposure levels to workers and the general public associated with use of herbicides on forestlands have been estimated to be at or below EPA RfDs (see Table 58). Therefore, dosages would not exceed acute toxicity dose levels when applying herbicides on forestlands.

Herbicide applicators and the general public are clothed and do not purposely ingest herbicides under the same conditions as animal studies of toxicological significance. Estimates of exposure to workers and the general public of herbicides applied to forestlands have been reported under various conservative exposure scenarios. The most reasonable interpretation of the risks associated with application of most herbicides on forestlands is that, except for accidental exposures or extremely atypical and perhaps implausible exposures scenarios (i.e. acute direct spray entirely covering a naked child), the use of herbicides on forestlands would not pose an identifiable risk to workers or the general public.

Exposures under typical exposure scenarios (those following guidelines on the label) would be below the RfD, a dose level determined to be safe by EPA over a lifetime of daily exposure.

There are exceptions worth noting that may help identify protective measures that could be instituted when applying herbicides.

- USDA Forest Service (1997d) reports that over a range of plausible application rates, workers may be exposed to hexazinone at levels that exceed the RfD.
- Likewise, there is reasonable concern that workers applying triclopyr over a prolonged period of time in the course of a single season and/or several seasons may be at risk of impaired kidney function. (SERA 2003a)
- SERA (1998a) reports that if 2,4-D were applied directly to fruits and vegetables at anticipated application rates, the consumption of vegetables would be undesirable and could lead to health effects. These reports also point out that the likelihood of such an exposure seems remote when applying on forestlands.
- SERA (1998a) also reports that exposure levels for workers involved in ground or aerial application of 2,4-D may exceed the RfD slightly, based on central estimates of exposure, or substantially, based on upper limits of exposure. They go on to indicate that 2,4-D can be applied safely (exposure doses below the RfD) if effective methods are used to protect workers and minimize exposure (personal protective equipment).
- SERA (2003c) also reported that there is no evidence that typical exposures to picloram would lead to a dose level that exceeds the RfD or level of concern with the exception of wearing contaminated gloves for one hour, which results in estimates of absorbed doses that exceed the RfD.

How herbicides are applied can have a direct impact on the potential for human exposure and subsequent adverse health effects. According to risk assessments completed on herbicide usage on forestlands, herbicide applicators are at a higher risk than the general public from herbicide use. The risk assessments compared risks to workers for all types of application, including aerial, backpack, ground-mechanical, and hand applications. Lower risks were estimated for aerial and ground mechanical application as compared to other methods, even though the total amount of herbicide applied in a given day was higher (SERA 1995, 1996, 1997a, 1997b, 1998a, 1998b, 1999a, 1999b, 2000, 2001, 2002, 2003a, 2003b, 2003c).

Risks associated with backpack and hand application of herbicides were estimated to be the highest, due to workers being closer to the nozzle and to the containers from which the herbicides were sprayed. Backpack and hand application was also reported to increase the likelihood of a worker receiving repeated exposures that may remain on the worker's skin for an extended time period. The EPA, in its re-registration of picloram (EPA 1995), also noted that the highest risk for herbicide applicators was for those using the backpack application method, the lowest for aerial and ground-boom applicators.

Route of Exposure

Substances tested for acute toxicity are usually administered by pumping a chemical down a tube into an animal's stomach. From this route of exposure, an oral LD_{50} (lethal dose that kills 50 percent of a test population, measured in one milligram of herbicide per kilogram of animal weight) can be estimated. Exposure during chronic testing usually involves placing the chemical in the animal's food, and then measuring the amount of food eaten during each 24-hour period (EPA 1996a,b).

Test substances are also applied to the shaved skin of an animal to estimate a dermal LD_{50}. About 10 percent of the animal's body surface is exposed to a chemical covered by a patch for 24 hours. In acute exposure studies, whether by oral or dermal routes, animals are monitored for a range of adverse responses for 14 days following dosing (EPA 1996c).

Required personal protective equipment (PPE) used by workers during pesticide application (gloves, waterproof boots, etc.) is designed to reduce exposure to sensitive areas on the body. Use of PPE as required by the Forest Service job hazard analysis would protect worker health.

Skin acts as a protective barrier to limit and slow down movement of a chemical into the body. Studies of pesticides applied to the skin of humans indicate that for many only about 10 percent or less passes into the blood. In contrast, absorption of chemicals from the small intestine is quicker and more complete than from the skin (Ross et al. 2000). For this reason, dermal LD_{50}'s are usually much higher than oral LD_{50}'s. A person can tolerate greater doses of a substance without becoming sick when exposure is through skin contact rather than through ingestion (Hayes 1991).

Test organisms are also administered substances in air to estimate an inhalation LD_{50}. In this case, exposure units are expressed as milligrams of test substance per unit of volume (usually a liter of air which is equivalent to 0.035 cubic feet). The onset of illness can occur more quickly by inhalation exposure than by oral or dermal contact due to rapid entry of the substance into the bloodstream. However, studies with pesticide applicators (who receive higher exposures than the general public) indicate dermal exposures are greater than inhalation exposures (Ross et al. 2000).

Table 58. Exposure Risk of Herbicides

Herbicide	RfD[1] (mg/kg/day)	Estimated Exposure to Public[2]	Estimated Exposure to Worker[2]
Glyphosate	0.1	Less than RfD	Less than RfD
Picloram	0.2	Less than RfD	Less than RfD[3]
Hexazinone	0.03/0.05[5]	Less than RfD	Below to slightly above RfD[4]
Clopyralid	0.5	Less than RfD	Less than RfD
2,4-D	0.01	Less than RfD	Below to slightly above RfD[6]
Dicamba	0.03	Less than RfD	Less than RfD

Herbicide	RfD[1] (mg/kg/day)	Estimated Exposure to Public[2]	Estimated Exposure to Worker[2]
Chlorsulfuron	0.05	Less than RfD	Less than RfD
Metsulfuron methyl	0.25	Less than RfD	Less than RfD
Triclopyr	0.005	Less than RfD	Less than RfD
Sulfometuron methyl	0.02[7]	Less than RfD	Less than RfD
Imazapyr	2.5[7]	Less than RfD	Less than RfD
Imazapic	0.05	Less than RfD	Less than RfD

[1] RfD = Reference Dose. A daily dose expressed as milligrams of herbicide per kilogram of body weight = mg/kg

[2] Exposures under typical exposure scenarios. Accidental and extreme exposure scenarios may exceed the RfD.

[3] SERA 1998a reports that worker wearing contaminated glove may received an absorbed dose greater than the RfD.

[4] SERA 2003c reports that over a range of plausible application rates, workers may be exposed to hexazinone at levels that exceed the RfD.

[5] Two RfDs reported.

[6] SERA 1998a reports that worker involved in ground or aerial application of 2,4-D may be exposed to levels above the RfD if effective methods to protect workers and minimize exposure are not employed.

[7] Provisional RfD, EPA has not derived RfD for this compound.

Source: Infoventures 1995a-j; EXTOXNET 1996a-h, 2001; EPA 1990a; EPA; 1990b; SERA 1995, 1996, 1997a, 1997b, 1998a, 1998b, 1999a, 1999b, 2000, 2001, 2002, 2003a, 2003b, 2003c.

Herbicide Drift

Spray drift is largely a function of droplet particle size, release height, and wind speed (Teske and Thistle 1999). Other factors that control drift to a lesser degree include the type of spray nozzle used, the angle of the spray nozzle, and the length of the boom. The largest particles, being the heaviest, would fall to the ground sooner than smaller sizes upon exiting the sprayer. Medium size particles can be carried beyond the sprayer swath (the fan shape spray under a nozzle), but all particles would deposit within a short distance of the release point. The physics of sprayers dictates that there would always be a small percentage of spray droplets small enough to be carried in wind currents to varying distances beyond the target area. Because the small droplets are a minor proportion of the total spray volume, their significance beyond the field boundary rapidly declines as they are diluted in increasing volumes of air (Felsot 2001).

Drift characteristics differ between pesticides. With herbicides proposed in this analysis, it is not critical to coat the entire leaf since some of the products can be absorbed by the plant roots and good efficacy can be achieved by larger droplets on leaves to the target plant. Therefore, herbicide drift can be intentionally reduced by generating larger droplets without reducing efficacy.

Spray nozzle diameter, pressure, amount of water in the tank mixture, and release height of the spray are important controllable determinants of drift potential by virtue of their effect on the spectrum of droplet sizes emitted from the nozzles (Felsot 2001; Teske and Thistle 1999). Meteorological conditions such as wind speed and direction, air mass stability, temperature and humidity and herbicide volatility also affect drift.

Commercial drift reduction agents are available that are designed to reduce drift beyond the capabilities of the determinants previously described. These products create larger and more cohesive droplets that are less apt to break into smaller particles as they fall through the air. They reduce the percentage of smaller, lighter particles that are the size most apt to drift off the treatment area.

Wind speed increases the concentration of drifting droplets leaving the treated area if the wind is adverse (blowing away from the release point in the treatment area). If the wind is favorable (blowing into the treatment area) drift can be reduced. Numerous studies have shown that over 90 percent of spray droplets land on the target area, and about 10 percent or less move offtarget, and that the droplets that move offtarget most typically deposit within 100 feet of the target area (Felsot 2001; Yates et al. 1978; Robinson and Fox 1978; Teske and Thistle 1999).

RAHUFS Drift Estimations

The 1992 Risk Assessment for Herbicide Use in Forest Service Regions 1, 2, 3, 4 and 10 and on Bonneville Power Administration Sites (USDA FS 1992, referred to as RAHUFS), determined spray drift distances downwind of an application site for aerial, backpack, and ground-mechanical application equipment. The results of the RAHUFS spray drift analysis indicates "low" health risk to the public from ground and aerial (aerial application is not a consideration in this project) applied herbicides (USDA FS 1992). "Low risk" was defined in the study as drift from the herbicides that presents a less than one in a million systemic, reproductive or cancer risk. Spray drift from hand application equipment was found to be negligible.

AGDRIFT/Felsot Drift Estimations

Felsot (2001) used the EPA/USDA FS AGDRIFT model to simulate herbicide sprays for several application scenarios, including a truck mounted spray boom set at two heights and a helicopter (aerial application is not a consideration in this project) at two heights. These simulations included crosswinds blowing at 10 and 6 mph. The model output was an estimated amount (percent of that applied) that deposited a defined distance from the edge of a spray swath. A spray deposition curve was developed to calculate a dose that a bystander could potentially receive if standing within the drift zone of an application. The whole body surface area was assumed exposed to a drifting spray (highly conservative), and the bystanders were assumed to be an adult weighing 70 kg and a child weighing 10 kg. Absorption of the depositing dose was assumed to be 10 percent. Calculations were made to determine the percentage of the depositing spray that a child could be exposed to on a daily basis over a 70-year lifespan and be within the EPA safety guidelines as defined by the RfD (i.e., the "safe dose").

The study estimated that for aerial application, the equivalent safe deposits corresponded to distances from the edge of the spray field of 0, 0, and about 60 feet respectively, for clopyralid, picloram, and 2,4-D. For a ground application, the theoretical child would receive a safe dose of 2,4-D at 27 feet from the sprayed field edge.

Other Means of Exposure

The risk assessments note that any number of exposure scenarios can be constructed for the general public, depending on various assumptions regarding application rates, dispersion, canopy interception, and human activity. Several highly conservative scenarios are developed for use in the risk assessments (SERA 1995, 1996, 1997a, 1997b, 1998a, 1998b, 1999a, 1999b, 2000, 2001, 2002, 2003a, 2003b, 2003c).

The two types of exposure scenarios developed for the general public include acute exposure and longer-term or chronic exposure. All of the acute exposure scenarios are primarily accidental. They assume that an individual is exposed to the compound either during or shortly after its application. Specific scenarios are developed for direct spray, dermal contact with contaminated vegetation, as well as the consumption of contaminated fruit, water, and fish.

Most of these scenarios should be regarded as extreme, some to the point of limited plausibility. The longer-term or chronic exposure scenarios parallel the acute exposure scenarios for the consumption of contaminated fruit, water, and fish but are based on estimated levels of exposure for longer periods after application. Most acute, accidental exposure scenarios for members of the general public are less than or similar to the general exposure scenarios in workers.

The major exception is the scenario for an accidental spill of 200 gallons of a field solution into a small pond. This leads to modeled estimates of exposure in the range of 0.3 to about 4 mg/kg/day. This is an extraordinarily extreme and conservative scenario that is used in all Forest Service risk assessments. Mitigation measures are designed to insure that the possibility of this scenario occurring is extremely low.

Most longer term estimates of exposure for members of the general public are much lower than exposure estimates for workers. The one exception involves the longer term consumption of contaminated fruit (see risk assessment for glyphosate). In all the scenarios for herbicides considered in this project, the risk to health are below the levels of concern identified for each herbicide (SERA 1995, 1996, 1997a, 1997b, 1998a, 1998b, 1999a, 1999b, 2000, 2001, 2002, 2003a, 2003b, 2003c).

Length of Exposure

The magnitude of a dose that is hazardous to health depends on whether a single dose is given all at once (acute exposure); multiple doses are given over longer periods (chronic exposure); or, regularly repeated doses or exposures over periods ranging from several days to months (sub-chronic). The EPA develops Reference Doses (RfDs), which are an estimate of a daily dose over a 70-year lifespan that a human can receive without an appreciable risk of deleterious effects (EPA 1989). RfDs include a “safety factor” where the No Observable Effect Level (NOEL) is divided by a factor, usually 100, to account for uncertainty and hypersensitive individuals. The 100 value is derived by including a safety margin of 10 for extrapolating study results from mammals to humans, and an additional safety factor of 10 for variation in population response to a particular compound.

The RfD is a conservative toxicological threshold in relation to this analysis because it assumes daily exposure over a 70-year lifespan, and because the RfD is calculated from the No-Observed-Effect-Level (NOEL), assuming humans are 100 times more sensitive than animals (uncertainty factor of 100). Actual environmental exposures for herbicide treatments in this project would typically be a few days each year for substantially less than 70 years.

Potential doses to workers or the public from application of herbicides would be transitory. Lifetime RfDs are used here as a convenient and conservative comparison for determining significance of human doses. Lifetime RfD values are based on daily feeding studies, whereas workers and the general public would not be exposed daily over a lifetime. Maximum duration of exposure for workers on a yearly basis was estimated in the range of 10 to 40 days for commercial applicators (EPA 1995).

Uncertainty

With the exception of accidental exposures or exposures under very conservative and somewhat implausible exposure scenarios, workers and the general public should not be exposed to a herbicide at concentrations that result in adverse health effects, either by short-term acute toxic effects or long-term exposure to low dosage levels.

This conclusion is predicated on Forest Service employees wearing appropriate personal protection, applying herbicides in accordance with the label, and implementing the job hazard analysis program to be used on this project. By doing so, possible exposure by contact or through drift would result in a potential dose below that determined to be safe by the EPA over a lifetime of daily exposure. It is also predicated on the findings, backed by toxicological studies, that a person can be exposed to some amount of a contaminant and not have an adverse effect (i.e. the dose determines the effect).

All of the herbicides proposed for use by the forest must be registered for use by the EPA and the New Mexico Department of Agriculture. Registration of these herbicides and Federal regulations adopted to protect workers and the general public has required more scientific information and justification for use of herbicides.

Nevertheless, there are many reports in the scientific literature and sections of this report that document associations between herbicide exposure and alterations of the immune system, autoimmune disorders, and increases in the probability of carcinogenesis. MCCHB (2001), Citron (1995), EPA (1995), Glover-Kerkvliet (1995) are just a few references that provide information on such effects. The body of literature on herbicide effects raises concerns about additive and synergistic effects of exposure to more than one herbicide, unstudied or unknown consequences of low-level chronic exposures, toxicity of inert ingredients, byproducts or contaminants of herbicides, and uncertainties about the health effects of sensitive populations. There is also the realization that it is difficult, if not impossible, for government or any scientific agency to fully evaluate a chemical and all the potential combinations of them to ensure that there would not be an adverse effect (SERA 1995, 1996, 1997a, 1997b, 1998a, 1998b, 1999a, 1999b, 2000, 2001, 2002, 2003a, 2003b, 2003c).

Use of herbicides presents some level of risk to workers and the general public. Yet, the weight of the scientific evidence presented in the risk assessments indicates that there is no route of exposure or exposure scenario suggesting that the general public will be at risk from longer-term exposure to herbicides. There are too many variables (receptor sensitivity, dose received, use of personal protection, etc.) for accurate predictions of the potential health risk of herbicide use and exposure. Given this uncertainty, the risk of adverse health effects is managed as follows:

- Through a process of continual review of toxicological data on herbicides, the EPA, using very conservative assumptions, has determined a dose they believe would not result in an adverse health effect for herbicides proposed for use on this project.
- Risk assessments have been completed to determine the estimated dose a worker or person of the general public might be exposed to under varying exposure scenarios.
- A comparison of EPA established safe doses and estimated exposures concludes that the estimated dose that a worker or person of the general public may be exposed to through use of a herbicide on this project would be below that determined to be safe by the EPA for a lifetime of daily exposure.

Wildlife Risk Assessment

Some studies on effects of herbicides to terrestrial and aquatic organisms were discussed in the previous section with respect to specific herbicides. Results from other risk assessment studies add to those effects described. Risk assessment studies indicate the potential for certain herbicides to cause a number of impacts including impaired kidney function, reproductive problems, eye irritation, and nontarget plant impacts. Establishing effects thresholds is usually performed on rabbits and rats, and then potential impacts on various other species are inferred. The problem with this type of analysis is that specific thresholds for a particular species are never truly quantified. Therefore, any data compiled that states exact toxicities of a given herbicide on a group of animals must be weighed in relation to the physiological similarities of the species in question and the species used in the testing.

In addition, the concentrations used in testing are typically at least 50 percent chemical. When actually implementing an herbicide application plan, concentrations come nowhere near these levels. Formulations of the proposed herbicides would likely be anywhere from tens to thousands of times below those resulting in impacts on animals and, often, concentrations would be similar to those experienced as background levels.

To determine the degree of impact on wildlife from herbicides, several factors need to be considered. There are twelve herbicides being considered for use. Each may have a different impact on different species or groups of species dependent upon:

- The proposed application rate of herbicide applied to an area;
- The persistence of the herbicide in the environment; and,
- The geographic extent of the proposed application.

Although there has been some concern regarding the synergistic effects associated with interactions between various chemicals (including herbicides), no evidence of synergistic effects with other chemicals has been demonstrated for any of these herbicides. No chronic effects analyses on terrestrial animals had been performed for glyphosate or triclopyr (Infoventures 1995a and b), nor have any recent studies involving chronic toxicity to wildlife been conducted.

Various herbicide formulations have the potential to cause eye and skin irritation in the context of splash or spill scenario. The potential for eye and skin irritation to wildlife from normal application, while still possible, is expected to be less than that described because of the reduced concentration of herbicide in a spray scenario when compared to a spill or splash scenario. Mitigation measures aimed at controlling spills are found in Chapter 2.

A risk analysis of various herbicides to terrestrial wildlife species prepared for the Forest Service (USDA FS 1992) considered toxicity, potential dosage through various routes (ingestion, inhalation, dermal), and length of exposure to a number of vertebrate wildlife species and concluded that potential risks for most wildlife species are low for most herbicides and surfactants using recommended application rates. Risk was moderate to high for only a few species and a few herbicides under extreme situations that would not occur under typical application scenarios. Most of the proposed herbicides are either nontoxic or of low toxicity to birds, mammals, and insects. None of those tested have been shown to cause cancer, birth defects, genetic defects, or problems with fertility or reproduction. There is no evidence of synergistic effects or hormone disruption from any of these chemicals (EXTOXNET 1996a-h, SERA 2002).

Considering that the dosages after dilution with water are far below (often thousands of times below) concentrations of these chemicals that have demonstrated any level of acute or chronic toxicity in tests performed, it is very unlikely that any birds, mammals, or insects would be affected by herbicide use following recommended application rate procedures (Infoventures 1995a-k). Triclopyr, while considered a moderately toxic compound does not pose a carcinogenic, mutagenic, reproductive, developmental risk to animals or humans at doses anticipated for this project (SERA 2003a).

Table 59. Effects of Each Herbicide

Herbicide	Carcinogen (Cancer)	Teratogen (Birth Defects)	Mutagen (Genetic Damage)	Reproductive Inhibitor	Skin Irritant	Eye Irritant	Bio-Accumulate	Toxicity To Birds	Toxicity To Bees	Toxicity To Mammals	Target Plants
Picloram	No	No	No	No	Mild	Moderate	No	Almost nontoxic	Relatively nontoxic	Low	Broadleaf plants, brush, conifers and broadleaf trees
2,4-D	Not tumor causing; kidney damage at low doses	No	No	No	Mild to Moderate	Corrosive	No	Non to moderate based on form	Relatively nontoxic	Moderate	Broadleaf weeds, grasses and other monocots, woody plants, aquatic weeds, and non-flowering plants
Dicamba	No	No	No	Little to No	Mild	Corrosive	No	Nontoxic	Nontoxic	Slight	Broadleaf weeds, brush and vines
Metsulfuron methyl	No	No	No	No	Moderate	Moderate	No	Nontoxic	Nontoxic	Nontoxic	Brush and woody plants, annual and perennial broadleaf weeds, and annual grassy weeds
Glyphosate	Not enough information to determine	No	No	No	Mild	Mild to Moderate	No	Nontoxic	Nontoxic	Nontoxic	Grasses, herbaceous plants, brush, some broadleaf trees and shrubs, and some conifers.
Hexazinone	No	No	No	No	Mild	Corrosive	No	Nontoxic	Relatively nontoxic	Nontoxic	Broadleaf weeds, grasses, and woody plants
Sulfometuron methyl	No	No	No	Observed at maternally toxic doses	Mild	Moderate	No	Slight	No Info Available	Slight	Grasses and broadleaf weeds
Triclopyr	No	No	Not enough information to determine	No	Mild to Moderate	Mild to Moderate	No	Very Low	Nontoxic	Slight	Woody plants and broadleaf weeds
Clopyralid methyl	No	No	No	No	Mild	Moderate	No	Low	Nontoxic	Low	Brush and weed species, broadleaf plants, thistle
Chlorsulfuron	No	No	No	No	Mild	Moderate	No	Nontoxic	Nontoxic	Nontoxic	Broadleaf weeds and some annual grass weeds
Imazapic	No	No	No	No	Nonirritating	Nonirritating	No	Nontoxic	Nontoxic	Nontoxic	Annual and perennial broadleaves and grasses
Imazapyr	Not enough information to determine	No	No	Not enough information to determine	Moderate	Moderate	No	Nontoxic	Low	Nontoxic	Grass and broadleaved weeds, brush, vines, many deciduous trees

Aquatic Risk Assessments

One of the primary means by which toxicological effects of specific contaminants on aquatic life are determined includes use of standardized laboratory bioassays. Sutter (1995) identified several shortcomings of bioassays; in particular, their applicability to expected field conditions. However, bioassays remain a useful tool in quantifying toxicological effects of specific contaminants on aquatic life in a consistent, relatively reproducible manner (Munn and Gilliom 2001). The way the bioassay information is used, is to develop a “threshold level” at which it is unlikely a species will suffer any effects—this is called the “No Observable Effect Level” or NOEL.

The most frequently used tool to assist in determining acceptable level of risk is a risk assessment. Risk assessments evaluate the various avenues by which a species can be affected. Examples include effects on the animal in any life stage from possible toxic effects of a specific herbicide and effects on other nontarget organisms that might be important to some portion of the life history or habitat.

The maximum acceptable toxicant concentration (MATC) (Mayer and Ellersieck 1986) protocol was developed by the U.S. Fish and Wildlife Service to estimate the chemical concentrations in aquatic habitats. The Environmental Protection Agency (EPA) uses a safety factor of 1/20 the LC_{50}, which they believe should not result in an unacceptable risk to endangered aquatic species (USFS 2001c). Therefore, this safety factor has been selected for delivery modeling.

Other important elements that come into play during a risk assessment include: how much chemical can reach the water; if it reaches the water, what would the concentration of the chemical be and how long would that concentration be maintained? There have been various approaches used to gauge this type of risk. Some models focus on the worst-case scenario for how much chemical can get into a water body.

In 2001, the Nez Perce National Forest prepared a biological assessment (USFS 2001b) for herbicide treatment of invasive weeds. As part of the aquatic analysis for herbicide application, a risk quotient was calculated for each herbicide proposed for use. This risk quotient was calculated from a no observable effect level (NOEL) divided by an expected environmental concentration (EEC). The risk quotient provides a reference from which a worst-case scenario can be viewed. If the risk quotient is greater than 10, the level of concern is categorized as “low.” If the risk quotient is between one and 10, the level of concern is “moderate.” If the risk quotient is less than 1, then the level of concern is “high.”

The level of concern (risk) analysis is based on direct application of the active ingredient of a chemical product to a pond containing 1-acre-foot of water. This illustrates an extreme case, which should not occur during implementation. The risk of a direct application is mitigated by selecting appropriate application techniques (hand application vs. aerial spray), applying buffers adjacent to water, taking into account such factors as chemical volatility, wind speed and direction, temperature, precipitation, ground slope or use of chemicals that are approved for direct application to water. In some cases it may be appropriate to limit how much chemical is applied in any given drainage if it is a high risk chemical for aquatic species. Table 60 shows the risk analysis using the risk quotient method as identified in the Nez Perce National Forest Biological Assessment (USFS 2001b). Risk can be assessed based on the level of chemical considered to be reaching a stream as well as incorporating the chemical’s toxicological effects. Using the approach described for the Nez Perce National Forest to assess the high risk chemicals, the

Carson National Forest and Santa Fe National Forest identified Picloram as falling into this category.

Table 60. Level of Concern for Chemical Use Using the Risk Quotient Method

Chemical	1/20 Of LC_{50} (ppm)[1]	EEC[2] (ppm)	Risk Quotient	Level of Concern
Chlorsulfuron (Telar)	12.5	0.0690	181.27	Low
Clopyralid	5.2	0.1398	37.21	Low
2,4-D	12.5	0.3677	33.99	Low
Dicamba (Banvel)	50	0.2758	181.27	Low
Dicamba (Vanquish)	6.75	0.2758	24.47	Low
Triclopyr (Garlon)	26.1	1.8389	14.19	Low
Hexazinone (Velpar)	16	1.4711	10.88	Low
Metsulfuron methyl	7.5	0.0114	657.84	Low
Imazapic	5	0.0919	539.40	Low
Imazapyr	5	0.0919	539.40	Low
Picloram	0.075	0.0919	0.82	High
Triclopyr (Redeem)	26.1	1.2872	20.28	Low
Sulfometuron (Oust)	0.625	0.0172	36.34	Low
Glyphosate	4.3	1.4711	2.92	Moderate

Note: 1LC_{50} = Lethal Concentration where 50% mortality occurs ; 2EEC = expected environmental concentration; ppm = parts per million.

Although there remains considerable uncertainty relative to potential herbicide effects, aquatic organisms, including eggs and larvae of amphibians, could be directly exposed to herbicide formulations in water as well and could be impacted. The degree of exposure, however, would be extremely low based on recommended application rates already far below levels where impacts begin to surface. In addition, further dilution of the formulation by the water it enters would result in concentrations several hundred or thousand times below scientifically established tolerance levels. Mitigation measures, such as avoiding boom spraying of herbicides near open water and other restrictions on use (no direct application of herbicide to water, restrictions on herbicide loading and handling), means that the likelihood of aquatic impacts caused by herbicide use are not likely to be detectible.

Appendix 4 • Effects of Nonherbicide Weed Control Methods

Biological Control

Biological control agents are extensively tested to ensure that they have a very narrow host range and would not pose a serious threat to nontarget plants. The testing process for a biological control agent is typically 3 to 4 years and involves 50 to 75 test plant species. Final approval is granted by USDA, Animal Plant Health Inspection Service. Although extensive screening and testing reduces the potential for injury to native plants, biological control is not risk free. Agents may attack plants closely related to the host weed.

Biological control is the use of animals, fungi, or other microbes to feed upon, parasitize or otherwise interfere with a targeted pest species. Successful biological control programs usually significantly reduce the abundance of the pest, but in some cases, they simply prevent the damage caused by the pest (e.g. by preventing it from feeding on valued crops) without reducing pest abundance. Biological control is often viewed as a progressive and environmentally friendly way to control pest organisms because it leaves behind no chemical residues that might have harmful impacts on humans or other organisms, and when successful, it can provide essentially permanent, widespread control with a very favorable cost-benefit ratio. However, some biological control programs have resulted in significant, irreversible harm to untargeted (nonpest) organisms and to ecological processes. Of course, all pest control methods have the potential to harm nontarget native species, and the pests themselves can cause harm to nontarget species if they are left uncontrolled. Therefore, before releasing a biological control agent (or using other methods), it is important to balance its potential to benefit conservation targets and management goals against its potential to cause harm.

It is hypothesized that some nonnative plants become invasive, superabundant and damaging, at least in part because they have escaped the control of their "natural enemies," the herbivores and pathogens that checked their abundance in their native ranges. Biological control addresses this by locating one or more herbivore and/or pathogen species from the weed's native range and introducing them so they can control the pest in its new range. These herbivores and pathogens are carefully selected and screened to determine if they will attack crops or other nontarget plant species. Successful classical biological control programs result in permanent establishment of the control agent(s) and consequent permanent reduction in the abundance or at least the damaging impacts of the weed over all or part of its introduced range. Biological control is not expected to eliminate the pest species completely, and it often takes years or even decades after the initial release of control agents before their effects are obvious. Biological control programs may fail for a variety of reasons. Some biological control agents never establish, or it may take repeated releases to establish viable populations.

Some of biological control's greatest strengths are that once an agent is established, it will persist forever and it may spread on its own to cover most or all of the area where the pest is present, generally with little or no additional cost. On the other hand, these strengths can become great liabilities if the agent also begins to attack desirable species. Because of this, weed biological control researchers take pains to locate and use agents that are specific to the targeted weed and will not attack other important plant species. This screening process contributes to the high cost and long time required for the discovery, testing, and approval of new biological control agents (Tu, et al. 2001).

Manual

Hand pulling and digging can be selective in terms of plants removed. Mowing and hand pulling activities may disturb soil and provide sites for continued weed invasion. Hand pulling may inadvertently destroy native or sensitive species growing in close proximity to invasive weeds because of trampling by pulling crews.

Mechanical

Mechanical treatments would reduce weed seed production for the season they were treated. Most weed species are prolific seed producers and have the ability to regenerate and produce seed following removal of top growth. Residual seed in soil can also germinate and allow populations to maintain or expand. Mechanical treatments would be combined with reseeding or other restoration efforts.

Controlled Grazing

Controlled grazing is often employed in small areas that are intensely infested with weeds. Goats in particular are employed in such circumstances, but depending on the weed present, other livestock can prove effective. Repeated treatment with livestock or livestock treatments in conjunction with other methods such as biological controls, manual eradication, and herbicides is usually necessary. With the use of grazing, the need for other eradication resources (herbicides, manual labor, etc.) is usually reduced. Nontarget species are often impacted, and materials to prevent erosion (weed free seed mixes and mulches) may be needed if the eradication area is large or near an area sensitive to erosion. Revegetation can prevent reinvasion (of weeds) and can lead to the extinction of remnant weed populations (Sheley 1999).

Grazing can either promote or reduce weed abundance at a particular site. By itself, grazing will rarely, if ever, completely eradicate invasive plants. However, when grazing treatments are combined with other control techniques, such as herbicides or biological control, severe infestations can be reduced and small infestations may be eliminated. Grazing animals may be particularly useful in areas where herbicides cannot be applied (e.g., near water) or are prohibitively expensive (e.g., large infestations). Animals can also be used as part of a restoration program by breaking up the soil and incorporating in seeds of desirable native plants.

When not properly controlled, however, grazing or other actions of grazing animals (wallowing, pawing up soil) can cause significant damage to a system and promote the spread and survival of invasive weeds. Overgrazing can reduce native plant cover, disturb soils, weaken native communities, and allow exotic weeds to invade. In addition, animals that are moved from pasture to pasture can spread invasive plant seeds.

In general, the specific weed and desirable native plants will determine the number and species of animal grazers and the duration and frequency of grazing.

Cattle, goats, sheep, and even geese may be used to control weeds. Cattle will graze invasive grasses, can trample inedible weed species, and can incorporate native seeds into the soil. Horses can also be used to control invasive grasses, but horses tend to be more selective than cattle. Geese are also useful for the control of invasive grasses, but are more subject to predation than other animals. Predation problems in many areas may dictate the type of grazing animals that can be used.

Sheep and goats prefer broadleaf herbs and have been used to control leafy spurge (*Euphorbia esula*), Russian knapweed (*Acroptilon repens*), and toadflax (*Linaria spp.*). These animals appear to be able to neutralize the phytochemicals toxic to other animals that are present in these and other forbs. Goats can control woody species because they can climb and stand on their hind legs, and will browse on vegetation other animals cannot reach. Goats, additionally, tend to eat a greater variety of plants than sheep (Tu, et al. 2001).

Prescribed Burning

Prescribed burning is sometimes necessary to prompt the germination of some plants, including a number of rare and endangered species. On the other hand, fire can also sharply reduce the abundance of some species. The weather, topography, and available fuel will determine the temperature and intensity of the prescribed burn and this, along with the timing of the treatment, largely determines how the burn impacts the vegetation and the abundance of particular species.

The most effective fires for controlling invasive plant species are typically those administered just before flower or seed set, or at the young seedling/sapling stage. Sometimes prescribed burns that were not originally designed to suppress weeds have that happy side effect. But in some cases, prescribed burns can unexpectedly promote an invasive, such as when their seeds are specially adapted to fire, or when they resprout vigorously. These prescriptions must be modified or other management actions taken to undo or reverse the promotion of the invader.

Most successful weed control efforts that result from burning are due to the restoration of historical (natural) fire regimes, which had been disrupted by land use changes, urban development, firebreaks, or fire suppression practices. Many prescribed burn programs are, in fact, designed to reduce the abundance of certain native woody species that spread into unburned pine lands, savannas, bogs, prairies, and other grasslands (Tu, et al. 2001). Prescribed burning is often used where it will allow other treatments to be more effective. Persistent shrubby species such as salt cedar are effectively killed by the use of herbicides on small plants or ones that resprout from overstory removal from cutting or burning. Burning is also used in situations to reduce the seed crop of a generation of weeds. This is effective for example in yellow starthistle (*Centaurea solstitialis*) infestations in annual grasslands. Burning annual grasslands after they are dry, but before the yellow starthistle has set seed kills the year’s crop and reduces the seedbank. The following year’s infestations of yellow starthistle are reduced and allow mechanical or herbicide treatments to be more effective. The potential erosion effects from prescribed fire can be similar to grazing, and erosion control materials (weed free seed mixes and mulches) may be needed to reduce the effects from erosion.

Appendix 5 • Herbicide Model for Watershed Analysis

This appendix describes the herbicide mixing calculations that were performed to simulate the potential concentrations of herbicide in a stream draining a watershed subject to weed treatment. Values used to calculate flow in each of 11 representative watersheds are presented in this appendix. Also included in the appendix are resultant flow rates for two time periods (May and September) used to calculate dilution of herbicides in primary streams for each representative watershed. Input data and calculation results are summarized in Table 61.

Picloram was used in the simulation as the target herbicide because it is the only chemical that has a “high risk quotient” for fisheries. The model assumes a “worst case” condition where all acres within each proposed treatment polygon would be treated by picloram for weeds at an application rate of one-half pound per acre per year. This would not be the case for Alternative B (Proposed Integrated Strategy), however, because approximately 3,000 acres (of the 7,345) would be treated using other nonchemical methods.

Representative Watershed Selection

Delivery rates of herbicides to surface water depend on each component chemical’s interaction with soil properties and resulting attenuation or lack of attenuation of that component. Consequently, selection of watersheds for modeling herbicide delivery to surface waters requires consideration of the widest possible range of soil properties.

Major factors in soil formation include type of parent material, climate, overlying vegetation, topography or slope, and time. Type of parent material influences the soil pH, structure, color, etc. High rainfall climates tend to have less fertile soils, due to leaching of nutrients to lower levels of the soil profile, and have more acidic soils. Low rainfall climates tend to accumulate salts near the surface and have generally higher soil pH. Soils that form under coniferous forests tend to be more acidic than those under deciduous forests, and root action is also critical in soil formation. Soils generally have a harder time forming on steep slopes, due to runoff of soil particles during rain events. The longer a soil has to form, the deeper its profile is going to be. Therefore, selection of representative watersheds to include in the watershed sensitivity analysis considered the following factors and data sources:

- Soil Taxonomy - Carson and Santa Fe National Forests GIS databases
- Geologic Parent Material – Data From New Mexico Bureau of Mines & Mineral Resources STATEMAP & EDMAP Programs, including watersheds influenced by:
    - Volcanic Geology – lava flows and ash deposits
    - Coarsely Crystalline Igneous and Metamorphic Geology
    - Sedimentary Rocks
    - Unconsolidated Sediments
- Vegetative Basal Area - Carson and Santa Fe National Forests GIS databases
- Vegetative Canopy Cover - Carson and Santa Fe National Forests GIS databases
- Soil Reaction Class - interpreted data element from the soil taxonomic description and forest specific field data sheets

For the purpose of the herbicide mixing analysis, each of these factors was integrated into an interpreted data element provided specifically for modeling herbicide interaction with soil characteristics and resultant runoff. The interpretation groups soils in the representative watershed into three classes (minimal, intermediate and well developed) describing the "degree of soil development," representing the tendency of herbicide to attenuate (high attenuation for well developed soils and low attenuation for minimally developed soils).

Modeling Assumptions

For modeling purposes, the following assumptions were made based on discussions with Santa Fe and Carson watershed/soils representatives:

- Picloram is the only herbicide modeled for a "worst case" analysis.
- Delivery rate to surface water from soils determined to have a high potential for runoff (i.e., those with little vegetative cover, poor soil development, on steep slopes, or alkaline pH's) equals 2 percent of chemical applied over a period of 6 hours.
- Delivery rate for all other treatment areas equals 1 percent of chemical applied over a period of 24 hours.
- Flow during two treatment periods was evaluated:
    - Spring flows were calculated by using mean monthly discharge in May that was exceeded 20 percent of the time (Q.20). (Note: These calculations are based on data available from USGS gaging stations located downstream of the forest boundary in each of the representative 5th level HUC watersheds modeled. Flows were normalized by multiplying flow at the gaging station by the percentage of the area occupied by the modeled watershed relative to the total area drained by flow at the gaging station.)
    - Fall flows were calculated by using mean monthly discharge in September that was exceeded 20 percent of the time (Q.20). (Note: These calculations are based on data available from USGS gaging stations located downstream of the forest boundary in each of the representative 5th level HUC watersheds modeled. Flows were normalized by multiplying flow at the gaging station by the percentage of the area occupied by the modeled watershed relative to the total area drained by flow at the gaging station.)
- The model assumes that all acres within weed treatment polygons will be treated at a rate of one-half pound of picloram per acre. (Note: This likely overestimates the amount of herbicide to be used, especially in ground-based treatment. Where weeds are scattered, spot-spraying may result in treatment of a very small percentage of the acres in the polygon. Weed density is highly variable within an infestation and, therefore, difficult to measure or to portray on a map or in a database.)

Modeling Calculations

Calculations to determine maximum probable concentrations of picloram in surface water included the following steps:

- Determine P, the total amount of herbicide to be applied in a watershed. P (lbs) = R (lbs/ac) x A (ac) where R is the application rate of active ingredient and A is the total acreage treated.
- Determine if the soil properties of the site would facilitate attenuation of herbicide or allow runoff, based on the "degree of soil development." Well developed soil acres are

assigned to a 1 percent herbicide concentration and runoff acres assigned a 2 percent herbicide concentration. Half of intermediate acres were assigned a 2 percent herbicide concentration and half a 1 percent herbicide concentration.

- Determine Y, the maximum yield in pounds of herbicide that could potentially reach surface waters. Y (lbs) = P (lbs) x D (%) where D is the delivery ratio or the maximum fraction of the applied herbicide reaching surface waters. On sites producing overland flow, D is expected to be 2 percent or less. The delivery ratio of 2 percent was assumed to be representative of Carson and Santa Fe National Forest conditions. On sites likely to allow infiltration, D is not expected to exceed 1 percent and in fact is zero for most sites, but a delivery ratio of 1 percent is used to provide a safety factor.
- Determine the worst case (minimum capacity (C) for dilution in pounds of water of the surface water system in the watershed where the application is to occur).
- C (lbs) = F (cfs) x 62.43 lbs/cfs x T (sec) where F, the flow rate of the stream is expressed in cubic feet per second, and T denotes the time period in seconds over which the flow discharge yielding herbicide is being estimated. Flow can be estimated by multiplying: width x average depth x average velocity in feet per second. A cubic foot of water weighs 62.43 pounds. The minimum delivery time for overland flow dominated systems is assumed to be 6 hours (21,600 sec), and 24 hours (86,400 sec) for infiltration-dominated sites.
- Estimate M the maximum possible concentration in parts per million: M (ppm) = [Y(lbs)/C(lbs)] x 1,000,000.

The resulting value can then be compared to known toxicity levels for aquatic organisms.

The results of this analysis for the 11 representative watersheds is shown in Table 61. In two watersheds (Ponil Creek and Upper Jemez), if all the acres proposed for treatment were spayed with picloram in one year, each watershed would exceed the recommended threshold and some effect to the water and aquatic resources would be expected (e.g. loss of fish or aquatic insects).

Table 61. Herbicide Mixing Model Results

Forest/Stream Name	Acres in Soil 1	Acres in Soil 2	Runoff Threshold	Infiltration Threshold
Carson National Forest				
CanjilonCreek-Rio Chama (Fall)	1	1	113	902
Canjilon Creek-Rio Chama (Spring)	1	500	2,425	19,397
Ponil Creek (Fall)	584	682	43	NA
Ponil Creek (Spring)	584	682	1,398	9,377
Red River-Rio Grande (Fall)	24	55	1,181	9,167
Red River-Rio Grande (Spring)	24	55	3,899	30,911
Rio Grande del Rancho (Fall)	54	73	263	1,901
Rio Grande del Rancho (Spring)	73	500	4,401	35,009
Rio Hondo-Rio Grande (Fall)	4	9	107	818
Rio Hondo-Rio Grande (Spring)	4	9	543	4,303
Rio Tusas-Rio Vallencitos (Fall)	0	0	296	2,369
Rio Tusas-Rio Vallencitos (Spring)	0	0	1,827	14,612

Forest/Stream Name	Acres in Soil 1	Acres in Soil 2	Runoff Threshold	Infiltration Threshold
Santa Fe National Forest				
Pecos River Headwaters (Fall)	68	47	1,462	11,603
Pecos River Headwaters (Spring)	68	87	7,849	62,697
Pojoaque River-Rio Grande (Fall)	1	3	146	1,157
Pojoaque River-Rio Grande (Spring)	1	3	5,382	43,045
Santa Cruz-Rio Grande (Fall)	8	0	1,490	11,927
Santa Cruz-Rio Grande (Spring)	8	0	4,518	36,149
Upper Gallinas River (Fall)	0	0	239	1,909
Upper Gallinas River (Spring)	0	0	92	738
Upper Jemez River (Fall)	584	317	192	NA
Upper Jemez River (Spring)	584	317	1,267	4,099

Similar thresholds would be developed for other watersheds in order to establish annual treatment amounts that would be permitted while assuring water quality is not impacted, even in a worst-case event.

Appendix 6 • Chemical Spill Prevention and Cleanup Plan

The following equipment will be available with vehicles or pack animals that are used to transport herbicides and in the immediate vicinity of all sites where herbicides are applied: shovel, broom, ten pounds of absorbent material, box of large plastic garbage bags, safety goggles, rubber gloves, protective overalls and rubber boots. All personnel involved in the handling of pesticides will review relevant material safety data sheets.

Information in the following section of this appendix are derived from the EPA document, “Applying Pesticides Correctly: A Guide for Private and Commercial Applicators.” This information will be reviewed by all workers that handle herbicides.

Herbicide Cleanup

Minor Spills

Areas where chemicals are spilled will be roped off and flagged to warn people and restrict their entry. Someone should always be on the site to confine the spill and warn of danger until it is cleaned up. Herbicides which have spilled on someone should be washed off immediately.
The spill should be confined. It should be diked with sand or soil if it starts to spread. The spill should be soaked up with absorbent material such as sawdust, soil, or clay. Contaminated material should be shoveled into a leak proof container for disposal. Contaminated material should be disposed of using the same method as for herbicides. The spill area should not be hosed down.

Major Spills

People should be kept away from the spill and the spill should be confined. Then the local fire department and State pesticide authorities should be called. Call the Chemical Transportation Emergency Center (Chemtrec). This is a public service of the Manufacturing Chemicals Association. It provides immediate advice for emergencies. Chemtrec operates 24 hours per day, 7 days a week, to respond to emergency calls. Chemtrec can be reached at 1-800-424-9300.
If the spill occurs on a highway, then call the highway patrol or sheriff. Someone should remain at the site until help arrives. Emergency phone numbers should be carried by the herbicide applicators.

Response Action Guide

A Forest Service employee’s primary responsibility when encountering a hazardous materials emergency such as a chemical spill is to report accurately and completely to the appropriate authorities in a timely manner.

An incident command role for a hazardous materials emergency is not assumed by the Forest Service employee but rather by a State or local authorized authority, or Federal On-Scene Coordinator. Forest Service employees may take actions to include:

- Public warning and crowd control
- Retrieval of information for reporting the emergency
- Rescue anyone in danger
- Take measured actions to mitigate the emergency

Precautions

- Approach the incidents from an upwind direction
- Move people and keep them away from the incident scene
- Do not touch or move or walk across the spilled material
- Do not inhale fumes, vapor, and smoke
- Do not assume that odorless gases or vapors are harmless
- Do not smoke tobacco; remove all ignition sources

Reporting

The following lists information needed for chemical spill incident reports. Incidents should be reported even if there is doubt as to whether it is an emergency or whether someone else has reported it.

- Date
- Time of Release
- Time Discovered
- Time Reported
- Duration of Release
- Location (State, county, route, milepost)
- Chemical name
- Chemical identification number:
- Chemical data
- Known health risks
- Precautions to be taken
- Cause and source of release
- Estimated quantity released
- Quantity which has reached water
- Name of affected watercourse:
- Number and type of injuries
- Potential threats to environment or health
- Your name
- Telephone numbers
- Address
- Name and address of the carrier
- Truck or vehicle number

Appendix 7 • Weed Populations and Treatments

This appendix provides details regarding the weed populations that are the basis for the analysis. Approximately 1,080 separate weed populations have been mapped on the Forests. For this appendix, weed populations have been grouped into potential treatment units that have common treatment methods and locations that make their being treated together likely.

Unit numbers shown in Table 62 reflect the watershed locations (the first three characters of unit numbers align with the map numbers shown with Figure 9 for watershed locations).

Each unit displays the species present, estimated acres of the area, and the proposed treatment by each alternative.

Abbreviation keys:

Weed Name	Abbreviation
Black henbane	BH
Bull thistle	BT
Canada thistle	CT
Diffuse knapweed	DK
Dalmation toadflax	DT
Field bindweed	FB
Hoary cress (white top)	HC
Leafy spurge	LS
Musk thistle	MT
Poison hemlock	PH
Perennial pepperweed	PP
Russian knapweed	RK
Russian olive	RO
Salt cedar	SC
Siberian elm	SE
Spotted knapweed	SK
Complex of elm, salt cedar, Russian olive	SSR
Complex of elm, salt cedar, Russian olive, bull thistle	SSRBT
Scotch thistle	SC
Yellow Starthistle	YS
Yellow toadflax	YT

Treatment Method	Abbreviation
Manual	MA
Mechanical	ME
Herbicides	HE
Grazing	GR
Prescribed fire	FR
Biological	BI or BIO
Biological at Jemez Ranger District	BIO2

Table 62. Weed Populations and Proposed Treatments

Unit	Weed species	Alt. B	Alt. C	Alt. D	Acres
A03.01a	BT	MA	MA	HE	0.3
A03.01a	YS	MA	MA	HE	0.6
A03.01b	BT	MA-HE	MA	HE	1256.2
A03.01b	CTBT	MA-HE	MA	HE	0.1
A03.01b	MT	MA-HE	MA	HE	1.0
A03.01c	CTBT	ME-HE	MA-ME	HE	3.3
A03.09a	BH	MA	MA	HE	0.3
A03.09a	BT	MA	MA	HE	0.3
A03.09c	CT	ME-HE	MA-ME	HE	1.2
A03.09c	CTBT	ME-HE	MA-ME	HE	1.7
A03.09d	BT	MA-HE	MA	HE	0.2
A05.02	BT	HE	ME	HE	17.5
A05.03	BT	HE	ME	HE	258.1
A07.03	BT	HE	ME	HE	119.9
B02.02a	BH	MA	MA	HE	0.1
B02.02a	BT	MA	MA	HE	0.1
B02.02a	CT	MA	MA	HE	0.0
B02.02b	CT	ME-HE	MA	HE	1.1
B02.02c	HC	MA-GR	MA	HE	0.2
B02.02d	CT	ME-HE	MA	HE	0.1
B02.02e	HC	MA-HE	MA	HE	0.2
B02.02f	MT	MA	MA	HE	0.2
B02.02g	PP	HE	MA	HE	0.1
B03.09b	CTBT	ME-HE	MA	HE	39.2
B03.09c	CTBT	ME-HE	MA-ME	HE	13.0
B04.02	CTBT	ME-HE	MA	HE	2.0
B04.02	CTBT	ME-HE	MA-ME	HE	1.4
B04.03	CTBT	ME-HE	MA	HE	1.8
B04.11	BH	MA	MA	HE	0.2
B05.03	BT	ME-HE	MA	HE	0.1
B05.03	CTBT	ME-HE	MA	HE	1.5
B05.04a	BT	HE	ME	HE	43.9
B05.04b	BT	MA	MA	HE	1.8
B05.04c	BT	ME-HE	MA-ME	HE	0.1
B05.04c	CT	ME-HE	MA-ME	HE	0.1
B05.04c	CTBT	ME-HE	MA-ME	HE	13.7
B05.05	BT	ME-HE	MA-ME	HE	7.4
B05.05	CTBT	ME-HE	MA-ME	HE	6.0
B05.06	CTBT	ME-HE	MA-ME	HE	2.7
B05.07a	CTBT	ME-HE	MA-ME	HE	2.1
B05.07a	YT	MA-HE	MA	HE	1.2

Unit	Weed species	Alt. B	Alt. C	Alt. D	Acres
B05.07b	CTBT	ME-HE	MA	HE	2.6
B05.15b	BT	ME-HE	MA	HE	0.1
B05.15b	CTBT	ME-HE	MA	HE	3.0
B05.15b	CTBT	ME-HE	MA-ME	HE	3.6
B05.19	CTBT	ME-HE	MA	HE	0.5
B05.19b	CTBT	ME-HE	MA	HE	2.2
B06.07a	CTBT	ME-HE	MA	HE	2.0
B06.07b	CTBT	ME-HE	MA	HE	1.1
B06.15a	BT	MA	MA	HE	0.3
B06.15a	CTBT	MA	MA	HE	0.5
B06.15b	CTBT	ME-HE	MA	HE	5.0
B06.15b	CTBT	ME-HE	MA-ME	HE	6.6
B07.12	MT	MA	MA	HE	0.2
B07.12a	CTBT	ME-HE	MA	HE	1.0
B07.13	CT	FR	FR-ME	HE	20.6
B07.14a	CT	ME-HE	MA	HE	1.1
B07.14b	HC	GR-HE	GR-MA	HE	16.1
B07.14b	MT	MA	MA	HE	0.1
B07.14c	MT	MA-GR	MA-GR	HE	26.3
B07.14c	ST	MA-GR	MA-GR	HE	53.6
B07.14d	ST	MA	MA	HE	2.0
B08.01a	CT	FR	FR-ME	HE	62.8
B08.01b	CT	MA-GR	MA	HE	0.1
B08.01b	YT	MA-GR	MA	HE	0.6
B08.01c	MT	MA-GR	MA-GR	HE	6.0
B08.02c	CT	ME-HE	MA	HE	2.0
B09.02a	BT	MA	MA	HE	0.2
B09.02b	CT	ME-HE	MA	HE	0.2
B09.02c	HC	MA-GR	MA	HE	0.2
B09.02c	RK	MA-GR	MA	HE	0.2
B09.02d	CT	ME-HE	MA	HE	0.1
B09.02e	HC	MA-HE	MA	HE	0.5
B09.04a	RK	MA	MA	HE	0.1
B09.04b	HC	MA-HE	MA	HE	0.2
B09.04b	YT	MA-HE	MA	HE	0.1
B09.04c	YT	ME-BI	ME-BI	HE	6.0
B09.04d	HC	GR-HE	GR-MA	HE	20.6
B09.06b	HC	MA-GR	MA	HE	0.2
B09.06b	HC	MA-HE	MA	HE	0.3
B09.06c	HC	MA-HE	MA	HE	1.1
B09.06d	MT	MA	MA	HE	0.2
B09.06e	RK	ME	ME	HE	23.9

Unit	Weed species	Alt. B	Alt. C	Alt. D	Acres
B09.06f	YT	MA-HE	MA	HE	0.2
B09.06g	YT	ME-BI	ME-BI	HE	0.2
B10.02a	BT	MA	MA	HE	1.5
B10.02a	RO	MA	MA	HE	0.1
B10.02b	BT	HE	ME	HE	5.9
B10.02b	RK	HE	MA	HE	0.5
B11.01a	BT	MA	MA	HE	0.2
B11.01b	CT	HE	FR	HE	4.7
b12.02a	CT	MA	MA	HE	0.0
b12.02f	MT	MA	MA	HE	0.0
B14.08a	CT	ME-HE	MA	HE	0.1
B14.08b	CT	ME-HE	MA	HE	0.4
B14.08c	CT	HE	FR	HE	16.6
B14.08c	MT	HE	FR	HE	1.6
B14.08d	MT	MA	MA	HE	0.2
B15.02a	CT	HE	FR	HE	23.0
B15.08a	BT	HE	ME	HE	15.0
B15.08c	CT	HE	FR	HE	8.9
B15.08c	DK	HE	FR	HE	5.4
B15.08c	SK	HE	FR	HE	9.5
B15.08e	SC	MA-HE	BIO	HE	13.0
B15.10a	CTMT	HE	FR	HE	426.9
B15.10a	DT	HE	FR	HE	2.7
B15.10a	MT	HE	FR	HE	61.3
B16.01b	CTMT	HE	FR	HE	62.0
B16.01d	BT	HE	ME	HE	17.4
B16.12	CT	HE	FR	HE	49.7
B16.12	CTMT	HE	FR	HE	621.9
B16.12	MT	HE	FR	HE	36.5
B17.01b	CT	HE	FR	HE	6.9
B17.07a	MT	MA	MA	HE	0.8
B17.07b	CT	ME-HE	MA	HE	0.5
B17.07c	CT	ME-HE	MA-ME	HE	0.2
B17.10a	CTMT	HE	FR	HE	262.5
B17.10d	SK	HE	FR	HE	13.2
B17.12	CT	HE	FR	HE	44.8
B17.12	CTMT	HE	FR	HE	201.5
B17.13b	SC	MA-HE	BIO	HE	0.2
B18.07a	BT	MA	MA	HE	0.1
B18.07c	MT	ME-HE	MA-ME	HE	0.1
B19.01a	HC	MA-HE	MA	HE	0.1
B19.01a	YT	MA-HE	MA	HE	0.7

Unit	Weed species	Alt. B	Alt. C	Alt. D	Acres
B19.01b	YT	BI-GR	BI-GR	HE	34.5
B19.02b	CT	ME-HE	MA	HE	0.5
B19.02f	MT	MA	MA	HE	0.3
B19.04b	HC	MA-HE	MA	HE	0.4
B19.04c	YT	ME-BI	ME-BI	HE	7.9
B19.05a	CT	ME-HE	MA	HE	0.1
B19.05b	LS	BIO	BIO	HE	43.0
B19.05c	MT	MA	MA	HE	1.0
B19.06a	CT	ME-HE	MA	HE	0.2
B19.06g	YT	ME-BI	ME-BI	HE	0.1
B21.07c	CT	ME-HE	MA-ME	HE	0.2
B21.07c	MT	ME-HE	MA-ME	HE	0.1
B21.13a	SCRK	MA-HE	BIO	HE	21.1
B21.13a	SE	MA	MA	HE	15.9
B21.13c	SC	BIO	BIO	HE	91.9
C01.03	CT	HE	FR	HE	2.5
C01.03	MT	HE	FR	HE	0.5
C04.05a	BT	MA	MA	HE	0.2
C04.05b	BT	HE	ME	HE	343.2
C08.01b	CT	HE	FR	HE	27.5
C08.01b	CTMT	HE	FR	HE	33.6
C08.01b	MT	HE	FR	HE	37.4
C08.01c	DT	HE	MA	HE	9.6
C08.01c	RK	HE	MA	HE	15.3
C08.01c	ST	HE	MA	HE	1.7
C08.01d	BT	HE	ME	HE	38.2
C08.04a	CT	HE	FR	HE	14.9
C08.04a	MT	HE	FR	HE	8.8
C08.04b	RK	HE	MA	HE	18.2
C08.04c	BT	HE	ME	HE	5.1
C08.04c	MTBT	HE	ME	HE	45.8
C08.04c	PH	HE	ME	HE	22.3
C08.05a	MT	HE	FR	HE	3.3
C08.05b	SE	BIO2	BIO2	NT	8.1
C08.05b	SSR	BIO2	BIO2	NT	140.6
C08.05c	SE	MA	MA	HE	80.5
C09.01b	CT	HE	FR	HE	12.5
C09.05a	CT	HE	FR	HE	4.8
C09.05a	HC	HE	MA	HE	5.4
C09.05a	HCFB	HE	MA	HE	4.2
C09.05a	MTBT	HE	ME	HE	35.4
C09.05b	SE	BIO2	BIO2	NT	495.7

Unit	Weed species	Alt. B	Alt. C	Alt. D	Acres
C09.05b	SSRBT	BIO2	BIO2	NT	1035.1
C10.05b	SE	BIO2	BIO2	NT	10.0
C13.01a	DK	HE	BIO	HE	100.1
C13.01b	DK	HE	FR	HE	3.4
C13.01b	MT	HE	FR	HE	10.8
C13.01c	DK	HE	MA	HE	0.2
C13.01d	BT	HE	ME	HE	18.6
C13.02a	CT	HE	FR	HE	0.1
C13.03a	MT	HE	FR	HE	21.4
C13.03b	RK	HE	MA	HE	14.3
C14.01d	BT	HE	ME	HE	21.7
D01.04a	BT	HE	ME	HE	33.5
D01.04a	BTST	HE	ME	HE	77.9
D01.04b	ST	MA	MA	HE	3.7
D02.01b	BT	HE	ME	HE	23.2
D05.01a	BTST	HE	MA	HE	1.9
D05.01b	BT	HE	ME	HE	239.5
D05.12	MTST	MA-GR	MA	HE	0.4
E01.02	BT	MA-GR	MA	HE	0.2
E01.02	MTST	MA-GR	MA	HE	4.7
E01.02	ST	MA-GR	MA	HE	0.2
E01.05	MTST	MA-GR	MA	HE	1.6
E01.18	MTST	MA-GR	MA	HE	0.3
E02.02	MT	MA-GR	MA	HE	0.5
E02.02	MTST	MA-GR	MA	HE	1.0
E02.02	ST	MA-GR	MA	HE	0.2
E02.03	MTST	MA-GR	MA	HE	1.0
E02.04	MTST	MA-GR	MA	HE	2.7
E02.04	RK	MA-GR	MA	HE	0.4
E02.06a	SC	MA-HE	BIO	HE	37.4
E02.06b	MTST	MA-GR	MA	HE	0.7
E02.07	MTST	MA-GR	MA	HE	0.6
E02.07a	SC	MA-HE	BIO	HE	22.8
E02.07b	MTST	MA-GR	MA	HE	0.2
E02.13	ST	MA-GR	MA	HE	0.1
E02.18	MTST	MA-GR	MA	HE	1.9
E03.01a	FB	HE	MA	HE	0.2
E03.01b	MTST	MA-GR	MA	HE	1.3
E03.09a	SC	MA-HE	BIO	HE	30.5
E03.09b	CT	MA-GR	MA	HE	0.3
E03.09b	MTST	MA-GR	MA	HE	0.6
E03.09b	RK	MA-GR	MA	HE	0.2

Unit	Weed species	Alt. B	Alt. C	Alt. D	Acres
E03.10	CT	MA-GR	MA	HE	0.2
E03.10	MT	MA-GR	MA	HE	0.8
E03.10	MTST	MA-GR	MA	HE	0.4
E03.10	RK	MA-GR	MA	HE	0.6
E03.13	FB	HE	MA	HE	0.1
E03.13	MTST	MA-GR	MA	HE	1.5
E06.01a	FB	HE	MA	HE	0.2
E06.01b	MTST	MA-GR	MA	HE	0.7
E06.10	MTST	MA-GR	MA	HE	1.9
E06.10	ST	MA-GR	MA	HE	0.1
E06.11	MTST	MA-GR	MA	HE	0.3
E06.11a	SC	MA-HE	BIO	HE	37.5
E06.11b	MTST	MA-GR	MA	HE	0.7
E06.12	CT	HE	MA	HE	0.2
E06.12	FB	HE	MA	HE	0.1
E06.12	MTST	MA-GR	MA	HE	1.1
E06.12	RK	HE	MA	HE	0.2
E06.12	SC	MA-HE	BIO	HE	0.6
E06.12	ST	HE	MA	HE	0.3

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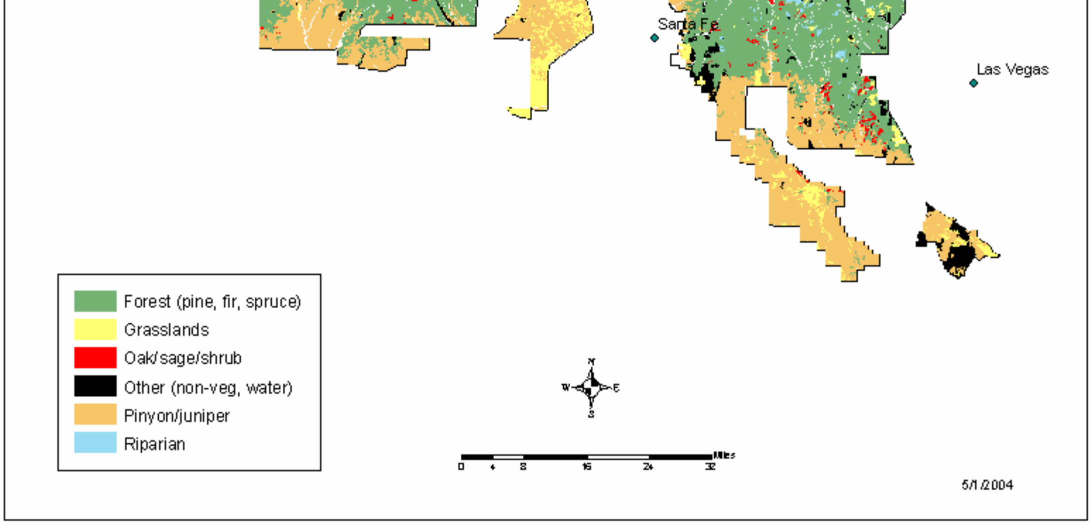
Santa Fe
Las Vegas
Forest (pine, fir, spruce)
Grasslands
Oak/sage/shrub
Other (non-veg, water)
Pinyon/juniper
Riparian
5/1/2004