CHAPTER 4

EFFECTS OF VEGETATION TREATMENTS

TABLE OF CONTENTS

Page

List of Tables

CHAPTER 4

EFFECTS OF VEGETATION TREATMENTS

Introduction

This chapter examines how vegetation treatment activities could affect natural, cultural, and socioeconomic resources on public lands. The focus of the effects assessment is on non-herbicide treatment methods. A summary of effects associated with the use of herbicides has also been included based on information provided in the *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States PEIS* (USDI BLM 2007a). Within each resource area, applicable direct and indirect effects are evaluated. Cumulative effects, unavoidable adverse effects, and those resource commitments that cannot be reversed or are lost are identified for all treatment activities in the PEIS. These effects are defined as follows:

- Direct effects – Those effects that occur at the same time and in the same general location as the activity causing the effects.
- Indirect effects – Those effects that occur at a different time or in a different location than the activity to which the effects are related.
- Cumulative effects – Those effects that result from the incremental impact of the action when it is added to other past, present, and reasonably foreseeable future actions (see Chapter 4 of PEIS).
- Unavoidable adverse commitments – Those effects that could occur as a result of implementing any of the action alternatives. Some of these effects would be short term, while others could be long term (see Chapter 4 of PEIS).
- Irreversible commitments – Those commitments that cannot be reversed, except perhaps in the extreme long term (see Chapter 4 of PEIS).
- Irretrievable commitments – Those commitments that are lost for a period of time (see Chapter 4 of PEIS).

This chapter should be read together with Chapter 2 (Vegetation Treatment Programs, Policies and Methods), which explains the methods the BLM typically uses for treating vegetation, and Chapter 3 (Public Land Resources), which describes the important resources and their occurrence and condition on public lands. The descriptions of environmental effects in this chapter build upon and relate to information presented in these earlier chapters to identify the types and distribution of resources that could be affected by vegetation treatments and how these effects might occur.

This report addresses large, regional-scale trends and issues that require integrated management across broad landscapes. It also addresses regional-scale trends and changes in the social and economic needs of people. This report does not identify site-specific effects, in part because of the level of specificity in broad-scale management direction, and because site-specific information is not essential for determining broad-scale management direction. As discussed in Chapter 1, Purpose of the Environmental Report, site-specific issues would be addressed through subsequent NEPA analysis for resource management and other land use, activity, or project plans prepared at the state, district, or field office level.

The description of effects assumes that SOPs would be followed by the BLM to ensure that risks to human health and the environment from different vegetation treatments methods were kept to a minimum (see Table 2-5).

General SOPs that would be followed for all resources include the following:

Fire Use

- Prepare fire management plans.
- Use trained personnel with adequate equipment.
- Minimize frequent burning in arid environments.
- Minimize burning herbicide-treated vegetation for at least 6 months.

Mechanical Treatments

- Ensure that power cutting tools have approved spark arresters.
- Ensure that crews have proper fire-suppression tools during the fire season.
- Wash vehicles and equipment before leaving weed infested areas to avoid infecting weed-free areas.
- Keep equipment in good operating condition.

Manual Treatments

- Ensure that crews have proper fire-suppression tools during fire season.
- Minimize soil disturbance, which may encourage new weeds to develop.

Biological Treatments

- Use only biological control agents that have been tested and approved to ensure they are host specific.
- If using domestic animals, select sites with weeds that are palatable and non-toxic to the animals.
- Manage the intensity and duration of containment by domestic animals to minimize overutilization of desirable plant species.
- Utilize domestic animals to contain the target species in the treatment areas prior to weed seed set. Or if seed set has occurred, do not move the domestic animals to uninfested areas for a period of 7 days.

Herbicide Treatments

- Prepare a spill contingency plan in advance of treatment.
- Select herbicides that are the least dangerous to environment while providing the desired results.
- Minimize the size of the application area, where feasible.
- Use the least amount of herbicide necessary to achieve the desired result.
- Follow the product label for use and storage.
- Have licensed applicators apply herbicides.
- Keep records of each application, including the active ingredient, formulation, application rate, date, time, and location.
- Dispose of unwanted herbicides promptly and correctly.

Additional SOPs are presented, by resource, under the appropriate resource subheadings, as well as in Table 2-5.

This report assumes that the BLM would comply with federal, state, tribal, and local regulations that govern activities on public lands. In addition, mitigation measures have been identified for most resources to further reduce effects associated with non-herbicide and herbicide vegetation treatments.

Subsequent Analysis before Projects are Initiated

At the national level, this PER and the PEIS identify broad management direction in context with resource issues of national interest. This PER assumes that vegetation treatments would occur on approximately 6 million acres annually, that treatments would focus on areas with high levels of hazardous fuels and unwanted vegetation, that allowable land uses would comply with the intent of Congress as stated in the FLPMA (43 U.S.C. 1701 *et seq.)*, and that future land uses would be similar to those that currently occur on public lands. Modifications to existing land uses could occur at a lower level, primarily the field office level, based on information in the PER and analysis in the PEIS.

Before site-specific actions are implemented and an irreversible commitment of resources made, information essential to those fine-scale decisions will be obtained by the local land managers. Localized data and information will be used to supplement or refine regional-level data and identify methods and procedures best suited to local conditions. Further NEPA analysis may be necessary to address site-specific conditions and processes. For example, mitigation measures identified in the PEIS would be appropriate under the wide range of conditions that must be considered at the programmatic level. However, by considering more site-specific parameters, such as soil and vegetation type and amount of rainfall, the BLM may be able to implement less restrictive mitigation measures while still ensuring adequate protection of the resource. This subsequent NEPA analysis will be used to bridge the gap between broad-scale direction and site-specific decisions. This "step-down" analysis process is described in Chapter 1 of the PEIS and shown in Figure 1-1 of that document.

Program Goals by Ecoregion

The goals of chemical vegetation treatments, by ecoregion, are discussed below. Because chemical treatments are not planned for the Tundra and Subarctic ecoregions, they have been excluded from this discussion.

Temperate Desert Ecoregion

Over 70% of herbicide treatments would occur on public land in the Temperate Desert Ecoregion. Most of these treatments would be used to meet vegetation and integrated weed management (IWM) objectives (33% of treatments), reduce hazardous fuels (25%), conduct ES and BAR activities (19%), and improve rangeland health (12%). Improvements of wildlife habitat and watershed health are objectives of lesser importance (6% and 5% of treatments, respectively) in this ecoregion.

Temperate Steppe Ecoregion

In the Temperate Steppe Ecoregion, most herbicide treatments would be conducted to meet IVM and/or IWM objectives (62% of treatments). Other important objectives include hazardous fuels reduction (25%) and improvement of rangeland health (11%).

Subtropical Steppe Ecoregion

On public lands in the Subtropical Steppe Ecoregion, herbicide treatments would be used to improve habitat (38% of treatments), improve rangeland health (21%), reduce hazardous fuels (17%), and meet IVM and/or IWM objectives (11%).

Mediterranean Ecoregion

In the Mediterranean Ecoregion, chemical treatments would be conducted primarily to improve forest health (35% of treatments), and to meet maintenance-related (28%) and IVM and/or IWM (20%) objectives. Improvement of rangeland health (9%) and recreation areas (6%) would also be important objectives.

Marine Ecoregion

On BLM lands in the Marine Ecoregion, the majority of herbicide treatments would be conducted to meet IVM and/or IWM (69%) and maintenance-related (22%) objectives. Some less important treatment objectives include maintaining ROW (3%), improving forest health (3%), and improving habitat for native vegetation (3%).

Land Use

As discussed in Chapter 1, several federal laws, regulations, and policies guide BLM management activities on public lands. These include the *Federal Land Policy and Management Act of 1976* that directs the BLM to manage public lands "in a manner that will protect the quality of scientific, scenic, historic, ecological, environmental, air and atmospheric, water resources and archeological values" and to develop resource management plans consistent with those of state and local governments to the extent that BLM programs also comply with federal laws and regulations. Management actions on public lands are guided by land use plans. Land use plan decisions establish goals and objectives for resource management, the measures needed to achieve these goals and objectives, and parameters for using public lands (USDI BLM 2000c). The *Taylor Grazing Act of 1934* introduced federal protection and management of public lands by regulating grazing on public lands. The *Oregon and California Grant Lands Act of 1937* provides for the management of the revested Oregon and California and reconveyed Coos Bay Wagon Road grant lands for permanent forest production under the principle of sustained yield and for leasing of lands for grazing.

As discussed in Chapter 1, NEPA analysis occurs at several levels, which allows the BLM to tailor decisions to specific needs and circumstances. The broadest level, which this PER represents, is a national-level programmatic study. This level of study contains broad regional descriptions of resources, provides a broad assessment of environmental effects, including cumulative effects (see PEIS), focuses on general policies, and provides Bureau-wide direction on herbicide use and other available tools for vegetation management. Additionally, it provides baseline information supporting an umbrella ESA Section 7 consultation for the broad range of activities described in the PER and PEIS.

Air Quality

Air quality would be affected by vegetation treatment activities, primarily smoke from prescribed fire, dust and combustion engine exhaust from mechanical, manual, and biological treatments, and from volatized chemicals associated with herbicide treatments. Except for smoke, effects would be small in scale, temporary, and quickly dispersed throughout the treatment area. Provided SOPs are followed (Table 2-5), and site-specific plans developed and reviewed before a treatment activity occurs, federal, state, and local air quality regulations would not be violated.

Potential air quality effects are assessed before project implementation. The BLM develops land use plans to establish and define resource management objectives for a particular area (USDI BLM 1998). Site-specific plans are reviewed for compliance with applicable federal, state, and local laws and policies. Guidance given in BLM manuals and handbooks is followed in order to minimize potential effects to air quality. Additional mitigation may be incorporated into project proposals to further reduce predicted effects.

The following sections discuss the general types of effects to air quality associated with each treatment method, followed by a discussion of air emission effects predicted to occur in the western U.S. using different vegetation treatment activities.

Scoping Comments and Other Issues Evaluated in Assessment

Respondents suggested that recent historic and projected emissions from prescribed fire and wildland fire should be considered when estimating resource benefits.

Resource Program Goals

The Soil, Water, and Air Management Program is responsible for assisting local field offices in 1) assessing air quality effects and ensuring that air quality conformance requirements are met when implementing federal land management decisions; 2) working proactively with applicable state and local air regulatory agencies to simplify and facilitate future conformity evaluations; and 3) participating in the regional analysis of air quality effects from fire use and other activities on public lands.

Standard Operating Procedures

Practices to Minimize Smoke Production

There are two general strategies for reducing smoke emissions: avoidance (e.g., fire prevention and suppression) and fuel modification. The latter includes techniques for altering either the existing fuel loading, structure, or both. Techniques for fuel modification include utilization (such as thinning or final harvest), mechanical treatment (piling, lopping and scattering, and crushing), and prescribed fire. These strategies can benefit air quality over both the short and long term.

Prescribed fire emissions can be reduced by 1) having clear smoke management objectives; 2) evaluating weather conditions, including wind speed and atmospheric stability, to predict the effects of fires and impacts from smoke; 3) burning when conditions favor rapid combustion and dispersion; 4) burning under favorable moisture conditions; 5) using backfires when applicable; 6) burning small vegetation blocks when appropriate; 7) managing smoke to prevent air quality violations and minimize impacts to smoke-sensitive areas; and 8) coordinating with regional and local air pollution and fire control officials, and obtaining all applicable smoke management permits, to ensure that burn plans comply with federal, state, and local regulations.

Practices to Minimize Emissions Associated with Manual and Mechanical Methods

Practices to minimize emissions associated with the use of manual and mechanical treatment methods include maintaining equipment in optimal working order, conducting treatment activities during the wetter seasons (to minimize fugitive dust production), using heavy equipment under adequate soil moisture conditions to minimize soil erosion, minimizing vehicle speeds on unpaved roads, and minimizing dust impacts to the extent practical. These practices can improve air quality over both the short and long term.

Practices to Minimize Herbicide Treatment Emissions

The BLM has developed several management practices to minimize the potential adverse effects of herbicide use on air quality. These management practices are based on direction in BLM air quality, chemical pest control, and weed management manuals (e.g., manuals 7000 and 9011) and handbooks (e.g., H-9011-1; USDI BLM 1988c). Most of this guidance is related to the effects of spray drift or other forms of wind transport of herbicides. For example, guidance on spray particle size, wind velocity and direction, height of spray boom, herbicide formulation, and drift control spray systems is presented with respect to their effects on spray drift and non-target species. The following SOPs have been developed to guide herbicide applications to minimize the short-term effects on air quality:

- Consider the effects of wind, humidity, temperature inversions, and heavy rainfall on herbicide effectiveness and risks.
- Apply herbicides in favorable weather conditions to minimize drift. For example, do not treat when winds exceed 10 mph (6 mph for aerial applications) or rainfall is imminent.
- Use drift reduction agents, as appropriate, to reduce the drift hazard.
- Select proper application equipment (e.g., spray equipment that produces 200- to 800-micron diameter droplets [spray droplets of 100 microns and less are most prone to drift]).
- Select proper application methods, such as setting maximum spray heights and using appropriate buffer distances between spray sites and non-target resources.

The description of potential effects to air quality assumes that guidance provided in BLM manuals, handbooks, and SOPs would be followed during herbicide treatment activities.

Adverse Effects of Treatments

Effects of Fire Treatments

This section summarizes information on the effects of fire on air quality. Other sources of information that should be consulted before planning a burn include: *Effects of Fire on Air*: *A State-of-knowledge Review* (Sandberg et al. 1979); *Prescribed Fire Smoke Management Guide* (Prescribed Fire and Fire Effects Working Team 1985); *National Strategic Plan: Modeling and Data Systems for Wildland Fire and Air Quality* (Sandberg et al. 1999); *Smoke Management Guide for Prescribed and Wildland Fire* (Hardy et al. 2001); *Fire Effects Guide* (Fire Use Working Team 2001); *Development of Emissions Inventory Methods for Wildland Fire* (Battye and Battye 2002); and *Wildland Fire in Ecosystems: Effects of Fire on Air* (USDA Forest Service 2002b).

The most important atmospheric effect of both prescribed fire and wildfire is smoke. Prior to the 1930s, smoke was a common feature of the western landscape in summer (Barrett and Arno 1982). Since then, land managers have focused on controlling wildfires, and smoke has become increasingly viewed by the public and policymakers as undesirable and often avoidable (Schaaf 1994). In addition to affecting the visual characteristics of an area, smoke can also affect the health of humans, plants, and animals that come into contact with smoke.

The total volume of smoke produced from a fire depends primarily on the amount of fuel consumed and the temperature of the burn. Factors influencing smoke production include fuel type, fire behavior, fuel moisture, particle size, particle arrangement, and fuel weight per unit area (Tables 4-1 and 4-2). In general, emissions per unit of fuel burned are greater at higher fuel moistures and lower temperatures. Fuel beds composed of small particles packed tightly together tend to burn more slowly and produce more smoke than larger particles less tightly packed. Finally, the more fuel available to burn, the greater the smoke production (Prescribed Fire and Fire Effects Working Team 1985, USEPA 1996).

A number of air pollutants are found in smoke emissions, including CO_2, CO, PM_{10} and $PM_{2.5}$, and VOCs. Carbon dioxide and water vapor make up the majority of emissions (about 90%) from prescribed fire and wildfire (Prescribed Fire and Fire Effects Working Team 1985). Lesser quantities of CO, PM_{10}, $PM_{2.5}$, and VOCs are also produced.

Carbon dioxide makes up more than 70% of the total mass emitted from wildfires. This amounts to 2,000 to 3,500 pounds of CO_2 per ton of fuel consumed, depending on the fuel's combustion efficiency (Schaaf 1994). Carbon dioxide emissions from fire have no direct health or visibility effects. It is not generally considered an air pollutant, and therefore is not regulated. But it is a so-called "greenhouse gas" and figures prominently in global climate change assessments.

Carbon monoxide is the most abundant air pollutant emitted during burning, representing nearly 6% of the total mass emitted. This amounts to approximately 20 to 500 pounds of CO per ton of fuel consumed. Carbon monoxide has no effect on visibility, but can present a direct health hazard to fire line workers. Concentrations as high as 200 ppm have been recorded near flames, well above the NAAQS of 35 ppm for a 1-hour averaging period. Because CO dilutes rapidly to levels below the NAAQS, it presents minimal risk to community air quality around prescribed burns.

Particulate matter is the most important air pollutant emitted from fire because of its far-reaching effects. Particulate matter represents approximately 2% of the total mass emitted from wildfires. This amounts to approximately 20 to 180 pounds of PM emitted per ton of fuel consumed. The particles emitted from wildfires vary in size and composition, depending on the intensity of the fire and the characteristics of the fuel bed.

From an air quality standpoint, the two most important size categories of particulate matter are $PM_{2.5}$ and PM_{10}. Fine particles are readily transported by wind, and can affect community air quality at long distances from fires. The Yellowstone National Park wildfires in 1988 affected communities in three states, and concentrations of PM_{10} measured in communities near the fires exceeded the applicable NAAQS (USDA Forest Service 2002b).

Volatile organic compounds are a diverse group of potentially toxic air pollutants containing hydrogen, carbon, and sometimes oxygen and other trace elements. Together, VOCs represent nearly 1% of the total mass emitted in fires. Approximately 20 pounds of VOCs are produced for each ton of fuel consumed (Schaaf 1994). The primary risk from VOCs is adverse effects to human health.

Regional Air Quality Effects. The quantity of emissions from wildfires, and thus the effects on air quality from smoke, varies from fire to fire, depending on several factors. A fire's size, duration, intensity, fuel type, surface fuel loading by size class, and fuel moisture content all affect its total fuel consumption and emission characteristics. The fire's intensity and distance from receptors, as well as current meteorological conditions such as wind speed and atmospheric stability, affect the concentrations that arrive at downwind receptors. Regionally, air quality risks are roughly proportional to the total annual emissions from wildfires. The greater the emissions, the greater the expected effects on human health and visibility.

Other Air Emissions Associated with Fire Use. In addition to pollutants generated by prescribed fire, minor amounts of pollutants would be generated during travel to and from the treatment site by fire crews, and from mechanical treatments (e.g., bulldozing) associated with site preparation before burning (ENSR 2005a). These pollutants would include $PM_{2.5}$, PM_{10}, CO, NO_2, SO_2, and VOCs associated with vehicle exhaust, as well as fugitive dust.

Mechanical, manual, and herbicide treatments conducted prior to, or in support of, prescribed fire can indirectly influence the amount of pollutants generated through removal of fuels or change in the fuel characteristics (Fire Use Working Team 2001). Removal of fuels would reduce the amount of air pollutants produced during burning. Crushing fuels increases the fuel bulk density and can make the rate of burning slower. Lopping, windrowing, and chaining can alter the distribution of fuels and influence fire behavior and smoke production. The use of herbicides can kill vegetation and result in a large amount of standing dead vegetation and amount of fuel available to burn.

Effects of Mechanical and Manual Treatments

Particulate matter associated with operation and use of mechanical and hand-held equipment, as well as driving on unpaved roads to and from the treatment site, would be the primary pollutant associated with mechanical and manual treatments. Power equipment and machinery exhaust would emit CO, SO_2, NO_2, VOCs, and other minor pollutants. However, emissions would generally be small, localized, and temporary.

Effects of Biological Treatments

Biological control organisms would have few direct effects on air quality. Grazing animals would generate odors and dust, but these emissions would be minor, localized, and short term in duration. Emissions associated with vehicle exhaust and dust would occur during transport to treatment sites; these emissions would also be minor, localized, and short term in duration. Practices to minimize transportation emissions would be the same as those identified for mechanical and manual treatments. Odors and dust associated with grazing animals could be reduced by limiting the density of animals confined to an area.

TABLE 4-1
Emission Factors for Particulate Matter as a Function of Fire Behavior

General Fuel Type	Fire Behavior	PM_{10} Emission Factor (pounds/ton of fuel burned)
Grass	Flaming dominates	15
Understory Vegetation Litter	Flaming with light smoldering Flaming with moderate smoldering Flaming with moderate smoldering	25 50 75
Broadcast Slash	Flaming dominates Flaming with smoldering component	20 40
Piled and Windrowed Slash	Flaming dominates Flaming with moderate smoldering Flaming with heavy smoldering	25 50 75
Brush fuels	Flaming dominates Flaming with moderate smoldering	25 50
All fuels	Burning where smoldering dominates	150

Source: Prescribed Fire and Fire Effects Working Team (1985).

Effects of Chemical Treatments

The effects of herbicide use on air quality originate primarily from ground vehicle (truck, ATV, and boat) and aircraft (plane and helicopter) exhaust emissions, as well as fugitive dust (dust created by vehicle travel on unpaved roads) resulting from herbicide transport and application. In addition, spray drift (movement of herbicide in the air to unintended locations) and volatilization (the evaporation of liquid to gas) of applied herbicides temporarily results in herbicide

particles in the air, which can be inhaled and deposited on skin or plant surfaces, with the potential to affect humans, wildlife, and non-target plants. In addition, herbicide particles could be transported long distances from the target location, depending on weather conditions and the herbicide application method. A more detailed assessment of effects associated with the use of herbicides is given in the PEIS.

Air Quality Regulations

Smoke from prescribed fires, and to lesser extent, air pollutants from other vegetation treatment methods, are regulated under the Clean Air Act. As discussed in Chapter 3, states are required to achieve NAAQS through a state implementation plan, approved by the USEPA. Some state regulations pertaining to air quality are administered by more than one state agency, or by local or regional agencies. Thus, the BLM often must coordinate with more than one local, state, or federal agency to ensure that its actions comply with all procedural and substantive requirements.

An overview of state and local laws pertaining to controlled burning is provided in *Prescribed Fire Smoke Management Guide* (Prescribed Fire and Fire Effects Working Team 1985). In addition, a survey of smoke management programs in the western U.S. was conducted for the BLM (Core Environmental Consulting 1998) and for the Western Governors' Association (Battye et al. 2001). In 2002 and 2003, a similar survey was conducted for the PER (ENSR 2003). A total of 121 agencies were contacted in 2002 and 2003, including several tribal governments. The results of the survey can be found on the CD that accompanies the PEIS and on the BLM website at: http://www.blm.gov.

In general, most states have some permitting requirements to regulate smoke from prescribed burns. A number of local municipalities also have jurisdiction in issuing burn permits and enforcing burn permit requirements. Authorization typically depends on the scale of the proposed burn. For a farmer or resident seeking to burn dead vegetation on his or her own property, only a simple burn permit from the local health and fire departments may be required. For prescribed burns anticipated by the BLM, most regulatory agencies require detailed burn permits and often the submission of a detailed smoke management plan (SMP).

Most western state air quality agencies have an operating agreement or memorandum of understanding in place outlining their shared responsibilities and

TABLE 4-2
Emission Factors for Prescribed Burning by Fuel Type (pounds/ton of fuel burned)

Fuel Type	$PM_{2.5}$	PM_{10}	CO
Broadcast-burned slash			
Douglas-fir/western hemlock	21.8	23.2	311
Hardwoods	22.4	25.0	255
Ponderosa/lodgepole pine	21.9	25.0	177
Mixed conifer	18.8	20.6	201
Juniper	18.8	20.4	164
Pile-and-burn slash			
Tractor-piled	10.8	12.4	154
Crane-piled	23.4	25.6	186
Average piles	17.2	19.0	170
Broadcast-burned brush			
Sagebrush	26.8	30.0	206
Chaparral	17.4	20.2	154

Source: Battye and Battye (2002).

expectations with neighboring agencies or jurisdictions regarding SMP requirements. Most SMPs, at the minimum, also require that burn-related personnel be properly trained in a specialized course dedicated to smoke and prescribed fire management techniques. Some states also offer computer modeling training, allowing potential burners to analyze and prepare burning prescriptions that minimize air pollutant emissions.

Another necessary element of a prescribed burn is the evaluation of smoke dispersion conditions. Conditions are typically evaluated by obtaining meteorological information for the burn day, as well as forecasts for the duration of the burn. The main components usually forecast are wind speed, wind direction, ceiling level, mixing depth, atmospheric stability, and presence of inversions. In addition, daytime and nighttime wind paths and down-drainage flow of smoke may be required for areas downwind of the burn site. Also, local dispersion conditions may need to be verified by land managers by utilizing one of the following measurement techniques: release of a pilot balloon at the burn site; establishment of area-representative or actual burn site remote automated weather stations (or the equivalent) to obtain real-time data; or smoke plume measurements using formats supplied by the permitting agency.

Other Treatment Emissions

State and local air quality regulatory agencies do not typically have specific regulations for manual, mechanical, biological, or herbicide treatment methods.

Air Quality Modeling to Assess Effects from BLM Vegetation Treatment Methods

Compliance with National Ambient Air Quality Standards

To estimate the potential effects of vegetation treatment activities on local and regional air quality, example emission scenarios for each of the five treatment methods at six representative locations (Fairbanks, Alaska; Tucson, Arizona; Glasgow, Montana; Winnemucca, Nevada; Medford, Oregon; and Lander, Wyoming) were analyzed using the California Puff (CALPUFF) "lite" air pollutant dispersion model to predict concentrations of total suspended particles (TSP), PM_{10}, and $PM_{2.5}$ (ENSR 2005a). Predicted concentrations were then added to a representative rural background concentration for comparison with NAAQS in order to determine the potential significance of the effect.

As shown in Table 4-3, predicted short-term and annual particulate matter effects at each of the six example locations were extremely small (< 0.1 microgram per cubic meter [$\mu g/m^3$]) for all treatment methods other than prescribed fire. Even for prescribed fire, short-term and annual emissions were less than 1.3 $\mu g/m^3$ for all locations, except for Fairbanks, Alaska, where 24-hour TSP and PM_{10} effects were predicted to be as high as 38 $\mu g/m^3$ (34 $\mu g/m^3$ 24-hour $PM_{2.5}$). Assuming a rural background 24-hour $PM_{2.5}$ concentration of 30 $\mu g/m^3$, the total concentration of 64 $\mu g/m^3$ would approach the applicable $PM_{2.5}$ NAAQS of 65 $\mu g/m^3$. In all instances, particulate matter emissions due to the five treatment methods would not exceed the applicable NAAQS at any of the six locations, based on the assumptions of the analyses (ENSR 2005a).

Annual Emissions Inventory

Annual emissions were estimated for each treatment method for the following pollutants: CO, CO_2, TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, Pb, and VOCs (Table 4-4; ENSR 2005b.) The emission estimates are directly dependent on the number of acres treated, and thus the estimates given could vary depending on the actual number of acres treated by each method in each state.

Effects to Climate

The combustion of fossil-fuels and the burning of vegetation would release CO_2 (a so-called "greenhouse gas") to the atmosphere. However, a significant adverse

TABLE 4-3
Example Particulate Concentration (μg/m³) Analysis by Treatment Method[1]

Location	Pollutant	Averaging Period	Treatment Method				
			Biological	Chemical	Manual	Mechanical	Prescribed Fire
Fairbanks, Alaska	TSP	24-hour	NA	NA	1.37E-01	4.14E-02	37.8
		Annual	NA	NA	1.12E-03	2.16E-04	4.36E-01
	PM_{10}	24-hour	NA	NA	1.37E-01	5.53E-02	37.8
		Annual	NA	NA	1.12E-03	2.88E-04	4.36E-01
	$PM_{2.5}$	24-hour	NA	NA	1.37E-01	3.08E-02	33.5
		Annual	NA	NA	1.12E-03	1.61E-04	3.87E-01
Tucson, Arizona	TSP	24-hour	1.76E-02	2.79E-04	7.31E-02	2.82E-02	2.81E-01
		Annual	4.94E-05	7.65E-07	2.01E-04	7.74E-05	1.14E-03
	PM_{10}	24-hour	4.31E-02	5.47E-04	7.31E-02	3.40E-02	2.81E-01
		Annual	1.21E-04	1.50E-06	2.01E-04	9.32E-05	1.14E-03
	$PM_{2.5}$	24-hour	6.02E-03	7.21E-05	7.31E-02	2.38E-02	2.56E-01
		Annual	1.68E-05	1.97E-07	2.01E-04	6.54E-05	1.04E-03
Glasgow, Montana	TSP	24-hour	2.96E-03	1.06E-04	5.65E-02	1.63E-02	3.58E-01
		Annual	9.06E-06	2.90E-07	1.72E-04	4.48E-05	1.14E-03
	PM_{10}	24-hour	5.90E-03	2.36E-04	5.80E-02	1.96E-02	3.58E-01
		Annual	1.74E-05	6.48E-07	1.76E-04	5.38E-05	1.14E-03
	$PM_{2.5}$	24-hour	7.78E-04	2.82E-05	5.60E-02	1.46E-02	3.03E-01
		Annual	2.29E-06	7.74E-08	1.70E-04	3.99E-05	9.63E-04
Winnemucca, Nevada	TSP	24-hour	7.65E-04	1.36E-04	3.27E-02	1.15E-02	3.19E-01
		Annual	5.80E-06	3.72E-07	9.00E-05	3.16E-05	8.85E-04
	PM_{10}	24-hour	1.86E-03	2.72E-04	3.32E-02	1.40E-02	3.19E-01
		Annual	1.42E-05	7.44E-07	9.16E-05	3.84E-05	8.86E-04
	$PM_{2.5}$	24-hour	2.59E-04	3.60E-05	3.25E-02	9.68E-03	2.91E-01
		Annual	1.98E-06	9.85E-08	8.92E-05	2.65E-05	8.08E-04
Medford, Oregon	TSP	24-hour	2.09E-02	3.75E-03	1.17E-01	4.89E-02	1.3
		Annual	6.31E-05	1.04E-05	3.52E-04	1.42E-04	6.18E-03
	PM_{10}	24-hour	5.65E-02	8.20E-03	1.18E-01	6.61E-02	1.3
		Annual	1.70E-04	2.28E-05	3.58E-04	1.92E-04	6.18E-03
	$PM_{2.5}$	24-hour	8.17E-03	1.14E-03	1.17E-01	3.90E-02	1.2
		Annual	2.46E-05	3.19E-06	3.50E-04	1.14E-04	5.76E-03
Lander, Wyoming	TSP	24-hour	3.57E-04	6.08E-05	2.82E-03	2.82E-03	2.44E-01
		Annual	1.85E-06	1.67E-07	1.36E-05	1.36E-05	6.77E-04
	PM_{10}	24-hour	9.35E-04	1.37E-04	3.29E-03	3.29E-03	2.44E-01
		Annual	4.84E-06	3.75E-07	1.70E-05	1.70E-05	6.77E-04
	$PM_{2.5}$	24-hour	1.24E-04	1.72E-05	2.51E-03	2.51E-03	2.21E-01
		Annual	6.43E-07	4.70E-08	1.17E-05	1.17E-05	6.13E-04

[1] Results based on use of CALPUFF model. Because of the variation in the number of treatment days for each method, the maximum 24-hour concentrations are listed in lieu of high, second high, or 98th percentile concentrations. Reporting the maximum concentrations also adds a level of conservatism to the modeling results.
NA = Not applicable.
Source: ENSR (2005a).

TABLE 4-4
Emissions Summary for Vegetation Treatments Activities (tons per year)

Pollutant	Prescribed Fire		Manual		Mechanical		Biological Control		Chemical	
	Cur[1]	Prop[2]	Cur	Prop	Cur	Prop	Cur	Prop	Cur	Prop
CO	824,030	2,001,936	829	2,662	109	416	9	12	24	62
CO_2	11,532,114	27,457,364	NA	NA	17,356	66,372	NA	NA	NA	NA
NO_x	21,757	61,325	4	11	468	1,791	1	1	3	7
TSP	101,881	221,044	29	94	26,392	73,032	3	5	7	19
PM_{10}	91,183	211,384	41	132	13,109	36,137	8	11	17	45
$PM_{2.5}$	77,102	186,406	25	80	5,279	14,599	1	2	2	6
Lead	141	365	0	0	0	0	0	0	0	0
SO_2	6,251	14,816	0	0	31	118	0	0	0	0
VOCs	48,545	113,475	139	447	38	147	1	1	2	5

[1] Cur = Current emissions based on current BLM vegetation treatment activities.
[2] Prop = Proposed emissions based on proposed BLM vegetation treatment activities.
NA = Not available.

effect on climate is not likely to be caused by BLM vegetation treatment activities.

Beneficial Effects of Treatments

Carefully planned and implemented prescribed fires result in less smoke effects to air quality than uncontrolled wildfires. The effects of smoke from prescribed fire, unlike those from wildfire, can be managed. Where effects of smoke from prescribed fire are of concern, fuel accumulations can be reduced through manual, mechanical, and chemical treatments prior to, or in place of, prescribed burning. Smoke effects can also be reduced by implementing burns when the wind is blowing away from smoke-sensitive areas and during good dispersion conditions (Hardy et al. 2001). Scheduling prescribed burns before new fuels accumulate can reduce the amount of emissions produced. Fire managers can also reduce the amount of area burned, increase the combustion efficiency of a burn, and increase the plume height in order to reduce smoke effects to air quality.

This PER does not analyze the long-term effects on air quality from implementing an aggressive vegetation treatment management program. However, an analysis of a similar vegetation management program in the Interior Columbia Basin showed that effects from wildfire on air quality and visibility could be significantly greater in magnitude than effects from prescribed burning (USDA Forest Service and USDI BLM 2000b). As discussed in this PER, and shown in the Interior Columbia Basin study, particulate matter emissions associated with prescribed burning and other treatment methods, when considered alone, should not cause widespread regional-scale exceedances of NAAQS. The same would not be true for wildfires. Thus, vegetation treatment actions that improve ecosystem health and reduce hazardous fuels buildup, thereby reducing the risk of wildfire, should provide long-term benefits to local and regional air quality.

Currently, about 645,000 acres are treated annually using prescribed fire and wildland fire for resource benefit, and 580,000 acres are treated using mechanical methods. Despite these efforts, a substantial amount (nearly 55 million acres) of public land is in Fire Regime Condition Class 3. Condition Class 3 lands have fire regimes that have been substantially altered from historical regimes; the risk of losing key ecosystem components to fire or other causes in these areas is high. The composition, structure, and diversity of vegetation, including fuels, have also been substantially altered in these areas. As a result, Condition Class 3 areas are especially susceptible to severe and intense wildland fires. As shown in Figure 3-10, these areas are often in close proximity to populated areas. Thus, wildfires in these areas have the potential to annoy and affect the health of large numbers of people.

The Forest Service and BLM modeled several scenarios to predict the long-term effect of treating vegetation to reduce hazardous fuels and improve ecosystem function on regional air quality and the condition of the land in the western U.S. (Hann et al. 2002). The model assumed that mechanical and hand cutting would be important treatment options in the WUI, in addition to use of fire, because air quality and other considerations could limit the use of fire. This analysis predicted that air quality would generally improve as the number of acres treated annually increased, and that improvement in air quality would be most noticeable when treatments were targeted at high priority western U.S. WUI landscapes. Thus, increasing the number of acres treated annually from current levels (with about half of the treatments occurring in the WUI) should provide greater improvement in ecosystem function and air quality than is projected under current management.

Soil Resources

Vegetation treatments would potentially affect soils by altering their physical, chemical, and/or biological properties. Physical changes could include loss of soil through erosion or changes in soil structure, porosity, or organic matter content. Fire and other treatments would potentially alter nutrient availability and soil pH, and herbicide treatments would involve the addition of chemicals to the soil. Some vegetation treatments might also alter the abundance and types of soil organisms that contribute to overall soil quality, including mycorrhizae. Over the long term, treatments that remove invasive vegetation, reduce fuels, and restore native plants should enhance soil quality on public lands.

Scoping Comments and Other Issues Evaluated in Assessment

There was considerable concern that the BLM address herbicide runoff, overspray, and drift. It was noted that burning often degrades the soil. Other respondents felt that disturbances to cryptogamic crusts must be eliminated, and one respondent suggested that the practice of chaining be prohibited on public lands.

Resource Program Goals

The Soil, Water and Air Management program is responsible for activities involving soil on public lands. One important aspect of the project is reducing soil erosion on degraded lands in the Colorado River Basin, in order to reduce the transport of natural salts to the Colorado River and its tributaries. The program assists with vegetation treatments to improve watershed condition by restoring natural vegetation. As discussed below, treatments that restore degraded lands and native ecosystems benefit soils by reducing erosion and increasing soil productivity.

Standard Operating Procedures

The SOPs listed here would minimize or avoid adverse effects to soil as a result of treatment activities.

- Assess the susceptibility of the treatment site to soil damage and erosion prior to implementing treatment.
- Prescribe broadcast and other burns that are consistent with soil management activities.
- Plan burns so as to minimize damage to soil resources.
- When appropriate, reseed following burning to reintroduce species, or to convert a site to a less flammable plant association, rather than to specifically minimize erosion.
- When appropriate, leave plant debris on site to retain moisture, supply nutrients, and reduce erosion.
- Time treatments to avoid intense rainstorms.
- Use equipment and methods that minimize soil disturbance and compaction.
- Conduct mechanical treatments along topographic contours to minimize runoff and erosion.
- Minimize use of heavy equipment on slopes greater than 20%.
- Conduct treatments when the ground is sufficiently dry to support heavy equipment.
- Implement erosion control measures in areas where heavy equipment use occurs.
- Consider chaining when soils are frozen and plants are brittle to minimize soil disturbance.
- Prevent oil and gas spills to minimize damage to soil.
- Time treatments to encourage rapid recovery of vegetation.
- Further facilitate revegetation by seeding or planting following treatment.
- Avoid grazing on wet soil to minimize compaction and shearing.
- Minimize use of domestic animals if removal of vegetation may cause significant soil erosion or impact biological soil crusts.

- Minimize disturbances to biological soil crusts (e.g., by timing treatments when crusts are moist).
- Re-inoculate biological crust organisms to aid in stimulating their recovery, if possible.
- Closely monitor the timing and intensity of biological control with domestic animals.
- Conduct burns when moisture content of large fuels, surface organic matter, and soil is high to limit the amount of heat penetration into lower soil surfaces and protect surface organic matter.
- Minimize treatments in areas where herbicide runoff is likely, such as steep slopes when heavy rainfall is expected.
- Minimize use of herbicides that have high soil mobility, particularly in areas where soil properties increase the potential for mobility.

Adverse Effects of Treatments

Effects Common to All Treatments

Regardless of the method used to remove vegetation, vegetation treatments would potentially result in increased rates of erosion and reduced water infiltration, leading to reduced soil productivity. The degree of these effects would vary by region depending on differences in climate, landform, hydrology, soil, vegetation, and land use. In the western U.S., the combination of hydrologic characteristics, steep topography, and slow vegetative growth make soil erosion a serious concern in many regions (Kennard and Fowler 2005).

Erosion results when unstable soils are displaced under the forces of gravity, wind, or water. Although erosion is a natural process, it can increase markedly when vegetation is cleared (BPA 2000). Unnaturally high erosion rates could occur as a result of soil disturbance during the vegetation treatment, or from the resultant vegetation removal and associated decrease in soil stability. Vegetative cover and organic layers covering the soil dissipate corrosive energy of raindrops and help to reduce runoff. Plant roots also strengthen and bind the soil together. Vegetation thresholds for soil erosion may exist (Trimble and Mendel 1995). For example, in areas with scarce vegetation (less than 40% cover), minor reductions in plant biomass have been shown to cause significant erosion, whereas areas with more extensive cover experience little change in soil loss under similar conditions. The effects of loss of plant cover and organic matter are most pronounced on steep slopes.

The risks of increased erosion on public lands would depend on the type of treatment and the local site conditions; high risks would be associated with a variety of direct and indirect effects, such as exposure of bare soil to rain and wind energy, loss of soil structure, removal of surface organic matter, and clogging of soil pores. Increased erosion would potentially result in increased dust and sedimentation, and reduced soil quality. Reestablishing vegetation on the site and maintaining organic matter at the soil surface (e.g., plant litter, forest duff, or mulch) would buffer effects and potentially limit erosion rates.

Removal of vegetation on public lands would also contribute to a short-term reduction in water infiltration into soil in some areas. Furthermore, soil compaction associated with some vegetation treatment methods could reduce infiltration and soil productivity by eliminating pore spaces used for water storage and air exchange. Increased erosion and reduced water infiltration have been observed in pinyon-juniper (Roundy et al. 1978), sagebrush (Brown et al. 1985), and creosote bush (Tromble 1980) treatment areas. These effects would typically last until vegetation was able to recover at the treatment site.

Vegetation management can alter the chemistry of the soil. Treatments that reduce organic matter cover can reduce the productivity of soils by reducing carbon and other nutrient inputs, and by reducing the moisture-holding capacity. Erosion can result in the transport of organic matter and nutrients off site (BPA 2000). Soils with little organic matter to begin with (e.g., most aridisols) are more susceptible to losses of organic matter. Removing nitrogen-fixing plants, such as red alder and ceanothus, can reduce soil nitrogen, and removing logs and other plant material can deprive soils of nutrients provided by decaying material. Removing vegetation can also reduce evapotranspiration, allowing more water to leach soluble nutrients from the soil.

Vegetation treatments can harm or kill soil microorganisms. Mechanical and manual treatments can disturb soil, exposing soil organisms to desiccation and predation. Soil organisms found on or near the soil surface are usually killed by fires, but populations of some bacteria and fungus actually increase after a burn (National Wildfire Coordinating Group 2001). As discussed in the PEIS, some herbicides are toxic to soil organisms.

Soil recovery times vary depending on a variety of factors including site conditions and management approaches. Hilty et al. (2003) determined that the benefits of post-fire revegetation and subsequent recovery of soil surfaces conducive to germination and establishment of perennial grass and shrub communities outweighed the initial short-term disturbance associated with drill seeding after fire. However, a recent study in pinyon-juniper in New Mexico by Wilcox et al. (2003) showed that disturbance-related increases in runoff and erosion remain constant with time, and that for low-slope-gradient sites, disturbance leads to accelerated runoff and erosion, which may persist for a decade or longer. The authors postulated the existence of a slope threshold, below which semiarid landscapes will eventually recover following disturbance and above which there will be no recovery without mitigation or remediation.

Vegetation treatments could result in disturbance to biological soil crusts, which could reduce soil quality and ecosystem productivity. The extent of effects to biological soil crusts would be dependent on the intensity and kind of disturbance and the amount of area covered. The duration of the effects would vary, but biological soil crust recovery rates typically are much slower than the recovery of vegetation. Recovery rates are generally species dependent, and can range from 14 to 35 years for cyanobacteria, 45 to 85 years for lichens, and 20 to 250 years for mosses (Belnap et al. 2001).

The removal or destruction of biological soil crusts could adversely affect soils by increasing susceptibility to erosion, encouraging weed establishment, and reducing nitrogen inputs and water infiltration (Evans and Belnap 1999; Belnap et al. 2001). Control of invasive plant species, such as soft brome, can be protective of biological soil crusts by maintaining a natural fire cycle, avoiding excessive shading, and avoiding excessive buildup of a litter layer, which can essentially bury biological crusts.

Effects of Fire Treatments

The BLM proposes to treat approximately 2.1 million acres of public lands annually using fire, twice the number of acres currently treated using this method. Fire affects soil primarily by consuming litter, organic material, dead and down woody fuels, and vegetative cover. Fire treatments would affect physical, chemical, and biological soil processes directly by transferring heat into soil, and indirectly by changing vegetation and altering nutrient and organic matter dynamics. Depending upon the severity of the fire, changes would be beneficial or deleterious (Neary et al. 1999).

Fire treatments would potentially alter the physical properties of soil by consuming organic matter, modifying soil structure, and harming soil organisms. Because organic matter contributes to surface soil structure and porosity, burning of organic matter during fire treatments could result in soil structure degradation. Such degradation can persist from a year to decades, depending on the severity of the fire and post-fire ecosystem conditions. Persistent soil structure deterioration following fire would be greatest in cold and arid climates (Neary et al. 1999). Surface runoff and soil erosion would increase after severe fire as a result of these physical changes.

Fires that consume large quantities of surface organic matter can reduce the productivity of soils by reducing moisture-holding capacity. Soils with little organic matter (e.g., many aridisols) would be most susceptible to losses of organic matter through fire treatments, especially from frequent burns. Soils with high organic matter content, such as permafrost soils in Alaska (gelisols) would tend to burn slowly, and it is unlikely that the organic matter would be completely consumed by fire.

Fire treatments could cause long-term changes in soil temperatures, with increases in both hot and cold temperature extremes caused by the loss of shade and insulating organic matter, and by the accumulation of blackened fire residues. Loss of soil insulation can influence the dates of both the first and last frosts and freezes of soil and understory vegetation (Fisher and Binkley 2000). Warmer soils increase the rate of decomposition and nutrient availability to post-fire vegetation, which is especially important in Alaska, where permafrost is present. Soil temperatures usually increase in tundra soils after a fire because the fire removes the overstory vegetation, blackens the surface, and removes organic matter that insulates the soils from summer warmth (Viereck and Schanderlmeier 1980, National Wildfire Coordinating Group 2001). The depth to which the permafrost melts each summer (active layer) can increase several feet after a fire, and it may take many years before the depth of the active layer decreases to its original thickness.

A severe fire could cause water repellency in soil, resulting from the condensation of organic compounds onto soil particles. Water repellency is a common phenomenon in chaparral soils of southern California. Water repellent soil layers eliminate water infiltration, thereby increasing surface runoff and erosion (DeBano 2000). This process is most likely to occur in coarse-textured soils (McNabb and Swanson 1990), and has also been frequently reported in arid soils of the southwest (Salih et al. 1973). Water repellency has not been reported in Alaska (Viereck and Schandelmeier 1980), and would be unlikely to occur on public lands in that state.

Fire treatments would alter soil chemistry by volatilizing organic matter and by changing the form, distribution, and quantity of nutrients. A reduction of incorporated organic matter as a result of fire is especially important in arid, semi-arid, and forested sites because many of the nutrients on these sites are tied up in the organic matter. Burning surface organic matter could also cause the loss of some nutrients (primarily carbon, nitrogen, and sulfur) through volatilization, and could cause soils to become less acidic.

Fire treatments would kill some soil organisms on the site including microorganisms, microarthropods, biological soil crusts, and plant roots. The effects of fire on soil microorganisms would be dependent on fire severity (Neary et al. 1999). Observed effects have ranged from no detectable effect in the case of infrequent, low severity fires, to total sterilization in very severe fires. There have been few scientific studies of the responses of soil macroinvertebrates to fire. It appears that the response is driven by changes in habitat structure or by changes in the amount or the quality of food resources after fire.

Biological soil crusts could be negatively affected by fire, depending on fire severity. Algae are generally the first to recover from fire and can form a protective crust within 5 to 10 years after fire. Lichens and mosses are slower to recover and may take 10 to 20 years to achieve substantial cover (Johansen and Rayburn 1989). In some cases, such as a low severity fire treatment, crust aggregation might persist to some degree even though crust organisms are killed. In a study of soil crusts after a wildfire, a substantial reduction in the diversity and richness of biological soil crust species was observed. The study showed increased cover of short mosses and reduced cover of lichens and tall mosses growing on shrub hummocks (Hilty et al. 2004).

Fire severity would determine the degree of effects to soil, with more severe fires causing more extensive and long-term soil changes. Of the three components of severity (heat, duration, depth), duration would likely contribute most to belowground soil damage (Certini 2005). The adverse effects of concentrated heat have been observed after the burning of pinyon-juniper slash piles, which has resulted in soil sterilization (USDI BLM 1991a). Low to moderate severity fires would have fewer adverse effects on soils, and in some cases might even improve soil nutrient availability. In general, subsurface heating would be greater in forestlands than rangelands, as rangelands generally support lighter fuel loadings and frequently result in fires of shorter duration that produce less subsurface heating. Depth and condition of duff and soil moisture content are important regulators of subsurface heating, with less subsurface heating in wet duff than in dry duff (National Wildfire Coordinating Group 2001). In some cases, subsurface heating could be substantially less in forests with damp soil and little duff, compared to rangelands with dry soil and dense accumulations of duff. Recovery of soil quality after a treatment would depend on the burning intensity and its effects on soil processes, and also on the previous land-use practices (Neary et al. 1999).

Ground equipment associated with burn treatments, such as equipment used to create firelines, could disturb soils, contributing to compaction and an increased risk of erosion. In Alaska and other cold areas with permafrost, the construction of firelines can accelerate thawing in soil to depths beyond those typically reached during the fire itself, potentially resulting in land subsidence, erosion, and gullying (Viereck and Schandelmeier 1980). These effects would be localized in their extent. Most fires, however, would be ignited using aerial methods. Therefore, ground operations would be limited, reducing effects to soil from mechanical pre-treatment activities. Effects of mechanical treatments are discussed further below.

Effects of Mechanical Treatments

Approximately 2.2 million acres would be treated using mechanical methods under the proposed treatment program, which is a 3-fold increase from current levels. Most mechanical treatments would occur on public lands in Nevada, Idaho, Oregon, and Utah. The effects of these treatments on soil would depend on the following: 1) the amount of soil exposed during the treatment; 2) the effect of ground disturbance on soil properties; and 3) the site conditions, especially slope and patterns of precipitation. Mechanical treatments would include methods that do not directly disturb the soil, such as mowing, shredding, mastication, and roller chopping; and methods that do directly disturb the soil, such as plowing, disking, blading, and chaining (USDI BLM 1991a). The *Final EIS Vegetation Treatment on*

BLM Lands in Thirteen Western States (USDI BLM 1991a) provides a detailed discussion of effects to soil from mechanical treatments; much of the following discussion is based on information provided in that document, or in references therein, unless otherwise noted.

Soil Exposure

Mechanical treatments would affect soils by removing vegetation and by disturbing or removing topsoil. Because plant and litter cover protect the soil, and roots hold the soil in place, removal of plant materials exposes soil. Exposed soils are vulnerable to increased erosion and drying out. About two-thirds of treatments would involve the removal of vegetative cover; the remaining one-third would consist of drill seeding. The risk of increased erosion would be reduced where some vegetation or organic matter was left in place.

Soil Disturbance and Compaction

Mechanical treatments would result in soil disturbance and compaction at the treatment site. The specific effects to soils would depend on the type and area of treatment, site soil texture and structure, and soil moisture at the time of treatment. About 15% of mechanical treatments that remove vegetation would involve mowing, which does not disturb soil directly, but which can result in compaction.

Approximately 85% of mechanical treatments would involve cutting, crushing, shredding, and logging and similar treatments. Crushing, shredding, and cutting (followed by chipping or shredding) can result in all or most of the organic material remaining on site. The application of large quantities of fresh, woody organic material to the soil surface can provide protection to the soil in the form of the mulching effect. It is well documented that the mulching effect results in attenuated soil temperatures and increased soil moisture retention (Resh et al. 2005). Other effects such as reduced erosion and runoff, increased infiltration, changes in soil carbon, and reduced compaction are expected. Adding large amounts of organic matter to the soil surface may result in smothering biological soil crusts and in short-term reductions in nutrient availability for plant reestablishment.

Use of certain mechanical treatments would directly disrupt biological soil crusts. Crusts are sensitive to compaction by vehicles and other heavy equipment. The removal or destruction of biological soil crusts could adversely affect soil quality by increasing susceptibility to erosion, reducing nitrogen inputs, infiltration, and potentially encouraging weed establishment (Evans and Belnap 1999; Belnap et al. 2001). The duration of the effect would vary, but recovery of biological soil crusts typically takes much longer than the recovery of vegetation. Recovery rates are generally species dependent, and can range from 14 to 35 years for cyanobacteria, 45 to 85 years for lichens, and 20 to 250 years for mosses (Belnap et al. 2001).

Soils with physical surface crusts (non-living crusts that often form in arid regions on fine textured and low organic matter content soils; not to be confused with soil biological crusts discussed in the preceding paragraph) have low water infiltration rates. Mechanical treatments that disturb the soil, such as disking, blading, and tilling, can improve infiltration by breaking up surface crusts (Wood et al. 1982); however, these areas would then be potentially susceptible to increased rates of erosion. Disking and tilling would comprise about 10% of treatments. If these treatments result in increased surface roughness (e.g., pits or furrows), benefits could occur through the capture of precipitation and potential increased infiltration.

In general, use of heavy equipment on treatment sites would be expected to result in increased soil compaction, and heavy equipment can shear and rut wet soils. Compaction by vehicles and other heavy machinery can reduce soil pores and limit water infiltration, soil aeration, and root penetration. Wet, fine-textured soils would be the most susceptible to compaction, while coarse, sandy soils would be the least susceptible. The magnitude of soil compaction would also be dependent on the type and weight of equipment used. Using tracked or low-pressure tires distributes vehicle weight over a larger area, thus reducing the pressure on soil as compared to conventional tires. Compaction can also be avoided by covering the area with mulch or other material that serves to protect the soil surface.

Mechanical treatments such as blading, tilling, plowing, chaining, or soil disking that may disturb several feet of soil would likely kill or harm organisms found near the surface and destroy underground tunnels and dens used by animals for shelter. Blading and chaining can result in complete disruption and permanent displacement of the topsoil with dramatic loss in soil quality and function. Extensive studies on soil quality under tillage have shown that the fungal component of the soil community decreases or even disappears, while other microorganisms remain, but are less abundant overall.

Site Conditions

Soil texture and morphology, site topography, and rainfall affect a soil's response to mechanical treatments. On sites that support coarse-textured soils with high infiltration rates, or clayey soils with low infiltration rates, some mechanical treatments could result in little change in infiltration rates. For most other soils, mechanical treatments that break up the soil surface and create furrows and ruts would increase water infiltration. Avoidance of mechanical treatments in windy areas with poorly structured soils would help to reduce loss of soil to wind erosion.

Erosion can be prevalent on slopes greater than 20%. Thus, mechanical methods that disturb the soil, such as disking, tilling, and blading, should be avoided on steep hillslopes. Slopes of 12% to 15% allow chaining on the contour, and slopes of 30% are recommended as a maximum. Orienting furrows parallel to the hillslope during any type of mechanical treatments would help reduce water runoff and erosion.

Soil Orders

Over half the mechanical treatments would occur in Nevada, which is dominated by aridisols. These soils are characterized by an extreme water deficiency, have low organic matter content, support limited vegetative cover, and are prone to developing hardpans that limit depth of water infiltration. Plowing (36% of treated acres in Nevada), chaining (7%), and disking (5%) would reduce soil structure and could lead to increased erosion, especially if revegetation did not occur. Loss of soil structure can also lead to decreased infiltration. Disking of sagebrush followed by drill seeding of beardless bluebunch and bluebunch wheatgrass have been used successfully to increase herbaceous cover and water infiltration.

Tundra and boreal forest soils are susceptible to soil disturbance and increased erosion from heavy equipment, although the BLM does not propose to conduct mechanical treatments in Alaska at this time. Use of specialized equipment that minimizes the amount of surface disturbance and equipment weight placed upon the ground; limiting heavy equipment travel to the winter months when the tundra is covered by a protective layer of snow and ice; and use of ice roads during winter have greatly minimized the amount of damage that occurs on tundra and other soils in Alaska (USDI BLM 2005c).

Mollisols, which occur on 15% of public lands, typically have a well-developed organic layer and are common in grasslands. Most treatments in grasslands would consist of seeding and revegetation of treatment sites. Mechanical treatments of grasslands are done to reduce less desirable warm-season species and to increase production of cool-season species. Because treated slopes are gentle and plant cover recovers rapidly after disturbance, erosion potential is low. These soils can be prone to wind erosion unless tilling and ripping are done between strips of vegetation, or stubble is left on the ground.

Entisols, which are found on 9% of public lands, are mineral soils that lack significant profile development. Grasses, desert shrubs, and pinyon-juniper are common vegetative types. Mechanical treatments are generally not recommended for desert shrubland. Replacing perennial plant cover by revegetation is usually necessary after treatment, and revegetation is rarely successful. Mechanical methods used to control pinyon-juniper include chaining, blading, chipping, shredding, and handslashing.

Alfisols are found on 2% of public lands, primarily in the forested mountains of Oregon and California. Mechanical restoration treatments in forest vegetation types consist primarily of removing small diameter trees, removing excessive amounts of downed woody debris, and increasing tree canopy spacing (reducing crown bulk density) by thinning dominant and codominant trees. Excess residue from these treatments is either removed from the site using harvesting equipment, burned in place, or piled and burned on site. Residue piling typically consists of either dozer piling or hand piling. Soil disturbances from mechanical treatments may cause soil compaction and loss of soil productivity. Construction of slash piles may also remove some duff, increasing the potential for erosion, especially on steeper slopes. Using equipment that minimizes damage to the soil, traveling on existing roadways, limiting activities to the drier months, maintaining duff, and retaining organic material through mulching are all practices that would protect forest soils and minimize erosion.

Equipment

Treatments such as blading, tilling, plowing, chaining, or soil disking drastically disturb the top 8 to 12 inches of the soil profile, while ripping may go as deep as 36 inches. Under the proposed treatment program, these activities would comprise about 15% of all mechanical treatments. Other types of mechanical treatment, such as roller chopping, maceration, and mowing, directly disturb only the top few inches of topsoil and organic matter. During mechanical thinning to reduce fuel loads, cutting, skidding, and decking all can result in disturbance to soils. Plowing, tilling, or disking would primarily be used in areas with little vegetation, where soil disturbance would help prepare the seedbed for revegetation. Their use in wildland management is largely limited to restoration sites where soils are already badly disturbed. Roller chopping, maceration, and mowing result in minimal soil disturbance, reduce the aboveground biomass, and can provide a layer of mulched organic material to protect the soil from erosion and other effects. With some systems, mowing and mulching occurs in front of the machine, leaving a cushion of mulch to travel over, thereby reducing surface disturbance.

The effects of chaining on soil and vegetation have been an issue of concern in recent years. Chaining may cause soil disturbance, but the plant debris can be left in place to minimize runoff and erosion, shade the soil surface, and maintain soil moisture and nutrient recycling. Alternatively, the debris can be burned to facilitate seeding, improve scenic values, and eliminate potential rodent habitat. Under the proposed action, about 6% of mechanical treatments would involve chaining, which is twice the current level. Chaining treatments would be evenly split between treatments involving evergreen woodland—most likely pinyon-juniper—and evergreen shrubland, including sagebrush and other desert shrubs. Over half of the proposed chaining treatments would occur in Utah.

There is some potential for contamination of the soil by oils and fuels associated with mechanical equipment. The release of these substances into soil could result in a localized area of reduced water infiltration and reduce plant growth. The use of SOPs when treating vegetation, such as using sorbents under vehicles when fueling and servicing in the field, cleaning up spills immediately, and fueling equipment away from water bodies and sensitive soils, would reduce the likelihood of effects to soil caused by petroleum products.

Effects of Manual Treatments

Under the proposed treatment program, manual treatments would be used on about 5% of public lands. Nearly all manual treatments would involve pulling or cutting vegetation with non-motorized hand equipment or chainsaws. Manual treatments would have less direct effect on soil than the other proposed treatments. Laborers and vehicles accessing the site could disturb topsoil and/or surface organic matter, providing prime conditions for re-invasion by weedy species; however, the extent of this disturbance should be limited. Coarse-textured soils and steep slopes would be the most fragile, and extensive areas of disturbance could result in increased erosion rates. There is the potential for some contamination of the soil from petroleum products used in hand-held power equipment, but these effects would be extremely localized.

Leaving vegetation residues on the soil surface, or mulching and spreading them after a manual treatment, would help protect the soil surface. Pulling weeds out of the ground slowly and carefully, and replacing soil in disturbed areas where possible, would further minimize effects to soil at manual treatment sites. Furthermore, limiting the number of people and the amount of time spent in each site would help minimize trampling (Tu et al. 2001).

Although manual treatments would help reduce fuel loads and populations of invasive species, the associated benefits to soil on public lands would be limited. Since manual labor is slower and more expensive than other forms of treatment, the amount of area treated using this method is generally limited.

Effects of Biological Treatments

Approximately 8% of public lands would be treated using biological control methods, with half of these treatments occurring in Idaho, Montana, and Wyoming. Nearly two-thirds of all biological treatments would involve containment by domestic animals (such as livestock), as compared to 75% of biological treatments using domestic animals at present. Most of the remaining biological treatments would utilize insects. Pathogens would be used on less than 100 acres annually. Biological control of vegetation using domestic animals would result in some effects to soil on public lands. The effects would be dependent on the type of animal used and the intensity and duration of the treatment in a particular area. Goats and other browsing animals are used more frequently than cattle. When containment by domestic animals is used specifically to control unwanted vegetation, the BLM closely monitors animal stocking rates, activities, and time of use.

The action of animal hooves would cause some disturbance, shearing, and compaction of soil, increasing its susceptibility to both water and wind erosion. These effects can be severe in heavily grazed areas, but may be less so under light and moderate grazing intensities (Trimble and Mendel 1995). Severe compaction often reduces the availability of water and air to the roots, sometimes reducing plant vitality. Grazing disturbance can be extensive enough to transform the runoff regime from variable source areas to overland flow, facilitating increased rates of erosion. Soil organisms can be negatively affected by the loss of surface organic matter, soil compaction, and other alterations to habitat. Recovery from grazing-induced compaction is site-dependent, with recovery observed within 1 year at a site with frequent freeze-thaw events and high soil organic matter content (Wheeler et al. 2002).

Domestic animals could alter nutrient cycling processes in soil by depositing organic nitrogen in urine and feces. Many years of grazing on a site can result in increased soil nitrogen (Dormar and Willms 1998), which could increase productivity in nitrogen-limited ecosystems of the arid west. In some instances, the formation of soil nitrogen hotspots could increase localized productivity to such a degree that weeds would be favored over native plants adapted to low nitrogen conditions (Evans and Ehleringer 1993).

Domestic animals could damage biological soil crusts at treatment sites through physical disruption, resulting in reduced species richness and lichen/moss cover (Belnap et al. 2001). Resistance to disturbance generally decreases as the organisms become more morphologically complex, with cyanobacteria the most resistant to disturbance. In addition, soil compaction alone can lead to changes in crust species composition, with potential loss of diversity. Recovery from these effects could take many years. In one study, the percent cover of crust organisms increased from 4% to 15% during the first 18 years after grazing exclusion, and then increased only an additional 1% during the next 20 years (Anderson et al. 1982).

The effects of containment by domestic animals can be minimized by following a planned vegetation management program that limits the number and amount of time livestock remain on any one site, and that uses fencing and salt/nutrition blocks to restrict livestock to treatment areas and keep livestock away from riparian and other sensitive areas.

Effects of Chemical Treatments

Herbicides may affect soil through plant removal resulting in changes in physical and biological soil parameters. As vegetation is removed, there is less plant material to intercept rainfall and less to contribute organic material to the soil. Loss of plant material and soil organic matter can increase the risk of soil susceptibility to wind and water erosion. The risk for increased erosion would be temporary until vegetation was reestablished. If herbicide treatments lead to revegetation with native plants, soil stability may be improved relative to sites dominated by invasive plants.

There are few studies on herbicide effects on biological soil crusts. Therefore, caution should be used when applying these chemicals to soils supporting biological soil crusts (Belnap et al. 2001) or to areas where management goals include crust recovery. Herbicides may also adversely affect soil micoorganisms and macroorganisms, leading to poorer soil productivity. A more detailed discussion of the effects of herbicides on soil is in Chapter 4 of the PEIS.

Beneficial Effects of Treatments

Benefits of Improving Ecosystems and Restoring Natural Fire Regimes

Findings and comparisons of studies in forested and rangeland environments concluded that forest and range landscapes that resemble conditions within historical ranges of variability (i.e., they contain native plant communities in natural mosaic patterns and have relatively uninterrupted disturbance regimes) provide favorable conditions for soil functions and processes that contribute to long-term sustainability of soil productivity (Hole and Nielsen 1970; Munn et al. 1978; Cannon and Nielsen 1984).

Substantial changes in disturbance regimes, especially changes resulting from fire suppression, timber management practices, and livestock grazing over the past 100 years, have resulted in moderately to highly altered plant composition and structure and landscape mosaic patterns, compared to historical conditions. Restoration activities that move forests and rangelands toward historical ranges of variability would provide favorable conditions for soil functions and processes that contribute to long-term soil productivity at a broad scale (USDA Forest Service and USDI BLM 2000b).

Although treatments would have short-term effects on soil condition and productivity, it is predicted that disturbance effects resulting from restoration activities would be less severe than fire effects and erosion caused by traditional management activities. Furthermore, monitoring and evaluation, integrated with an adaptive management approach, would result in adjustment of treatment design and implementation to reduce soil disturbance to levels similar to historical conditions.

In some instances, fire treatments could potentially have beneficial effects on soil (National Wildfire Coordinating Group 2001). Fire raises the pH of soil, especially soils that are naturally acidic. Since nutrient availability is related to soil acidity, elements critical for plant growth, such as phosphorus and nitrogen, become more available to plants as the soil pH increases. However, availability may decrease for some nutrients, such as phosphorus above a pH of 7. Fire also helps to release nutrients that may be tied up in forms that are unavailable to plants, such as woody material. The burning of surface organic matter releases some nutrients onto the soil in the form of ash, resulting in an increase in available calcium, phosphorus, and potassium. These available nutrients would be used by new vegetative growth or could be leached by precipitation (DeBano et al. 1998). In some cases, prescribed burning may reduce erosion by releasing existing understory plants and establishing new plants on sites that may have had little vegetative cover before burning (USDI BLM 1991a).

Benefits of Removing Invasive Species

Vegetation treatments that reduce or eliminate invasive species could be beneficial to soil quality. If these treatments were to result in increased native plant cover on sites degraded by weedy vegetation, soil quality would begin to rebound. For example, watershed-level treatments that remove the invasive mesquite tree have been shown to increase the productivity of perennial grasses, with resulting soil erosion losses five times less than those observed in nearby untreated watersheds (Martin and Morton 1993).

Sites with a large component of invasive plants may be at a higher risk for erosion than sites that support native vegetation. Invasive plants can increase the potential for wind or water erosion by altering fire frequency or producing chemicals that directly affect soil quality or organisms. These negative effects include increased sediment deposition and erosion, and alterations in soil nutrient cycling. For example, millions of acres of grassland in the Great Basin have been taken over by downy brome. A study that compared soil organisms in native grasslands to those at a site invaded by soft brome found that the soft brome caused negative changes in most levels of the soil food web (Belnap and Phillips 2001). Soft brome invasion also appears to change soil physical characteristics and alter the cycling of carbon and nitrogen (Norton et al. 2004).

Benefits of Reducing Risk of Wildfire

Vegetation treatments may benefit soil quality by reducing the risk of wildfire. Wildfires generally occur when soils are driest, resulting in hot soil temperatures, loss of nutrients, and consumption of soil organic matter. Catastrophic, stand-replacing fires in pinyon-juniper woodlands and ponderosa pine forests of Arizona, for example, caused loss of 75% to 100% of the soil organic matter (Neary et al. 1999). Given the ability of an unplanned, uncontrolled, severe wildfire to cover a large geographic area, the detrimental effects of wildfire on soil quality have the potential to be high. Thus, vegetation management that reduces this risk would be beneficial to soil resources on public lands.

Benefits of Mechanical and Biological Treatments

Mechanical treatments that ultimately result in improved plant cover and diversity can improve habitat for soil organisms. Chaining is a common and relatively inexpensive mechanical method of converting woodlands to grasslands. It is effective at uprooting and killing trees, such as pinyon and juniper, in preparing sites for seeding, and in adding litter to the soil surface (Grahame and Sisk 2002).

The Utah Department of Wildlife (2005) indicated that percent cover of perennial vegetation can be increased with chaining and planting, and advocates evaluation of site suitability prior to this type of vegetation treatment. The agency found that chaining was effective in treating pinyon-juniper sites on steep and rocky hillslopes that could not be treated using other methods. Chaining reduced the cover provided by pinyon-juniper trees and scattered debris over the site, holding soils in place until herbaceous plants became established. Chaining also efficiently thins and opens dense stands of sagebrush, while covering seeds of herbaceous species, which allows establishment of perennial herbs or development of suppressed understory herbs while retaining sagebrush in the midstory.

Benefits of Chemical Treatments

Herbicide treatments would benefit soil by removing invasive species and other unwanted vegetation and allowing restoration of native vegetation and return of natural fire regimes. In many situations, herbicides are the only, or the most effective, method for controlling invasive vegetation. For example, mechanical and manual methods are not appropriate for large-scale treatments (hundreds to thousands of acres), or for treatments in remote areas that are difficult to access.

Water Quality and Quantity

Introduction

Invasive plants can create or exacerbate conditions that modify water quantity and quality. Directly or indirectly, invasive plants can affect streambank stability, sediment, turbidity, shade and stream temperature, dissolved oxygen, and pH. Invasive plants can also reduce water quantity. For example, tamarisk and giant reed can alter stream form and can use more water than native vegetation (USDA Forest Service 2005).

Vegetation treatments could affect both surface water and groundwater quality and quantity. Removal of vegetation could affect surface water by increasing surface runoff, promoting erosion and sedimentation, reducing shading and increasing water temperature, and limiting the amount of organic debris entering water bodies (BPA 2000). Potential groundwater effects would vary relative to type of treatment and herbicide applied at a specific location. These effects could be short-lived, recovering with vegetation reestablishment or dissipation of chemical contaminants (Satterlund and Adams 1992). The extent and duration of effects would be dependent on the geographic location, and the extent of vegetation removal, as well as on revegetation management practices.

Scoping Comments and Other Issues Evaluated in Assessment

Many comments were received concerning water quality and water issues. Some felt that important issues should be considered on a watershed basis. One respondent felt that vegetative restoration to increase infiltration and reduce runoff and erosion is important. Assessing treatment effects on water yield, quality, and salt concentration was recommended. Respondents suggested restoring natural flood regimes and degraded fluvial systems. Other respondents indicated that erosion and stabilization of treated areas should be addressed, and the effects of burning on watershed stability should be researched.

There was concern about the effects of saltcedar on water quality, quantity, and riparian areas, with one respondent noting that water yield on the Mojave River has not increased since the removal of the saltcedar. One respondent was concerned for the species diversity in vernal pools and springs. Others felt that water for wildlife should be of good quality and quantity, and that salt loading in the Colorado and other rivers is an important issue to address.

There was a considerable amount of concern from respondents regarding the negative effects of herbicides on water quality. Numerous respondents felt that the PEIS should address herbicide runoff, overspray, drift, and the effects and benefits of herbicide use in riparian areas. Respondents felt that the effects of decay products of herbicides in water should also be addressed. There was specific concern about the effects of herbicide use on aquatic life, the degradation of water quality, and the risk of herbicides accumulating in hydrological systems. Herbicide-related issues are addressed in more detail in the PEIS.

Resource Program Goals

Approximately 5% of acres would be specifically treated to improve watershed functions by restoring streambank stability and channel integrity, improving vegetation diversity, and restoring habitat function. Of these acres, approximately 60% would be treated mechanically and 20% would be treated using fire. Seedbed preparation and seeding would comprise nearly all of the mechanical treatments.

The Soil, Water, and Air Management program oversees BLM efforts to improve water quality. The program has a goal to implement water quality improvement prescriptions, including vegetation treatments, in 20% of watersheds within priority sub-basins that do not meet state or tribal water quality standards. In addition, the BLM should be achieving an upward trend in the condition of uplands in 50% of watersheds within priority sub-basins. As of FY 2005, prescriptions had been implemented in 9% of watersheds and an upward trend in condition was observed in 34% of watersheds (Office of Management and Budget 2005.

The objectives of treatments would be to reduce hazardous fuels, reduce the risk of fire in the WUI, and improve habitat for fish and wildlife. These treatments, however, would also likely improve plant community structure and function, benefiting water resources in the treatment area.

As discussed below, fire exclusion policies, buildup in hazardous fuel levels, and increase in acreage dominated by invasive vegetation have led to more frequent fires of greater severity and duration and increased soil erosion over many areas of the West.

These conditions have often led to deterioration in water quality in affected areas (USDA Forest Service and USDI BLM 2000b). Although disturbances from fire, wind, plant disease, grazing by wildlife, floods, and other factors will always be important in shaping ecosystems in the western U.S., efforts by the BLM to restore vegetation to more natural conditions, reduce the frequency of catastrophic fires, and slow hazardous fuels buildup should lead to improvement in water quality in treated areas.

Standard Operating Procedures

Standard Operating Procedures used to reduce adverse effects to water resources from non-herbicide vegetation treatments include prescribing burns that are consistent with water management objectives; planning burns to minimize negative impacts to water resources; minimizing burning on steep hillslopes or revegetating hillslopes shortly after burning; maintaining vegetated buffers between treatment areas and water bodies; and maintaining a vegetated buffer and minimizing the removal of vegetation near drinking water sources. Additionally, the BLM would not wash equipment or vehicles in water bodies, and would minimize use of domestic animals near drinking water sources and adjacent to water bodies if trampling is likely to cause soil erosion. Procedures to minimize the effects of herbicide treatments on water resources are presented in Table 2-5 of this PER and Table 2-8 of the PEIS.

Adverse Effects of Treatments

Effects Common to All Treatment Methods

Water Quantity

Removal of vegetation could temporarily affect water flows by altering the magnitude of low flows and the frequency and magnitude of peak flows, as compared to pre-treatment conditions. The removal of vegetation, especially over large areas, would improve groundwater availability over the short term by reducing water lost through evapotranspiration of plants. Low flows, which are dependent on the quantity of groundwater, would temporarily increase. These changes would be minor and usually short lived, unless long groundwater flow lines were involved (Sturges 1977, Satterlund and Adams 1992).

Several invasive plant species that occupy large expanses of public lands may play a role in the availability of groundwater. For example, western juniper that has increased markedly over the last 100 years has outcompeted mountain big sagebrush in parts of central Oregon. Removal of western juniper in some areas was followed by an increase in flow from nearby springs, so increase in flow may be related to removal of western juniper. However, Schmidt (1987) concluded that there is little reason to expect large responses in streamflow to control of pinyon-juniper woodlands, and Belsky (1996) and Wilcox (2002) noted that there have been no documented increases in streamflow as a result of juniper control and that the relationship between streamflow and the abundance of pinyon-juniper trees is inconclusive.

The removal of vegetation could cause short-term increases in surface runoff, as there would be reduced interception of precipitation and evapotranspiration by plants. At a desert shrub and evergreen woodland site in New Mexico, one study documented a strong correlation between soil infiltration and vegetative cover (Wilcox et al. 1988). Effects of vegetation treatments on surface runoff and groundwater recharge would vary by site and post-treatment restoration.

Vegetation treatments that affect the interception of precipitation could increase the magnitude and frequency of peak flows and could subsequently alter the physical characteristics of the stream channel. If channel morphology has not been substantially altered, effects should persist until vegetation is reestablished. Restoration of native plant communities and vegetation structure would ultimately improve hydrologic function and watershed processes long term (USDA Forest Service and USDI BLM 2000b).

Water Quality

Increased surface water runoff resulting from vegetation removal could contribute to increased erosion, particularly in high gradient watersheds. This could further contribute to increased sediment loadings and the potential reduction in surface water quality. Sediment, which has been described as the greatest non-point source of pollution, increases turbidity and contributes to reduction in dissolved oxygen (Spence et al. 1996).

Vegetation treatments could affect water quality by reducing nutrient uptake by plants, resulting in a pulse of nutrients to nearby water bodies. Soluble nutrients, such as nitrogen, would likely enter streams or other water bodies via groundwater, while nutrients adsorbed to soil particles (e.g., phosphorous) could be carried to surface water in runoff. Nitrogen as nitrate is most often the nutrient of concern. Streams draining red alder forest in the Pacific Northwest, chaparral in California, and grasslands in California and Arizona have shown increased nitrate concentration following vegetation disturbance (Binkley and Brown 1993). Nutrient enrichment of aquatic systems can lead to algal blooms and eutrophication (i.e., deficiencies in oxygen) of lake and stream systems (Getsinger 2004).

Removal of streamside vegetation could increase water temperatures resulting from the loss of stream shade (Clark 2001). In coldwater systems, resulting temperature increases would contribute to water quality degradation and potential effects to coldwater fisheries. In the Pacific Northwest, the majority of streams on federally-administered forestlands are impaired by elevated stream temperatures (USDA Forest Service 2005).

The removal of hazardous fuels from public lands would result in a long-term benefit to surface water quality by reducing the risk of a future high-severity wildfire on the treatment site. A high-severity wildfire that removes excessive plants and litter could subsequently increase surface soil erosion and mass failures, resulting in short-term increases in stream flows (Debano et al. 1998). In addition, fire retardants could affect water quality. Fire retardants that are used most extensively for emergency suppression contain nitrogen and phosphorus that could cause nutrient enrichment of surface waters. When mixed with water and exposed to ultraviolet radiation, fire retardants break down into hydrogen cyanide, an extremely toxic substance (Fresquez et al. 2002). In highly alkaline waters, toxic concentrations of ammonia can also be produced. Finally, use of water from nearby sources to extinguish wildfires could reduce the quantity of surface water resources, particularly in arid climates or during dry seasons.

Reduced infiltration could have negative effects on groundwater recharge, leading to a decrease in groundwater supply and a decrease in the magnitude of base flows. The magnitude of effects to runoff and infiltration would vary depending on the treatment used, local conditions, and other management steps.

Loss of vegetation and erosion in areas with extensive natural sources of salt in the soil can lead to higher levels of salinity in nearby water bodies. Natural sources of salt are responsible for about half of the salinity in the Colorado River Basin, and human activities, including soil disturbance, irrigation, and reservoir evaporation have increased the salinity level in the Colorado River Basin (USGS 1996a).

In the upper Colorado River Basin, salt enters the Colorado River and its tributaries from groundwater flows, surface runoff, and point sources such as saline springs and flowing wells. Dissolution of evaporite deposits in the upper Colorado River Basin results in highly saline ground water that ultimately contributes the largest amount of salt to the Colorado River System. The natural salt load for the Colorado River at Lees Ferry, Arizona, is estimated to be about 5.2 million tons per year. Contributions from BLM lands are included in this estimate. Surface runoff from public lands above Lees Ferry is estimated to contribute about 700,000 tons of salt per year, or about 14%. The remaining 4.5 million tons are contributed primarily by groundwater inflow and saline springs, and runoff from other federal, tribal, state, and private lands.

Effects of Fire Treatments

The potential effects of fire on water resources would depend largely on the severity and size of the fire, with a low severity burn being less likely to degrade water quality and quantity than a severe burn, and a small fire affecting a smaller surface area than a large fire. In addition, the closer the fire is to a water body, the more likely it would be to affect water quality.

Vegetation treatments using fire have produced mixed results in attempts to increase water yield from watersheds. For example, conversion of shrublands to grasslands has been thought to increase off-site water yield (Clark 2001). After large, "clean" fires, water retention by litter and debris and water loss via transpiration both decrease, offsetting the loss of water through evaporation and leading to an increase in surface water runoff. However, the effect is quickly reduced as vegetation and litter return. Small springs and streams near burned areas often produce greater amounts of water and flow longer into the summer (USDI BLM 1988a). A similar relationship has been noted in forested watersheds after wildfires. Annual water yields and short-term baseflows generally increase if overstory vegetation is removed by fire, only to return to preburn levels as vegetation recovers. Prescribed burning generally has little effect on water yields (Beschta 2000).

In Utah, soil water patterns were studied in pinyon-juniper woodlands in areas that were untreated, chained, and burned, and chained and grazed (Gifford 1982). The untreated sites had the lowest soil water, and grazing of chained sites did not affect soil water. However, burned sites had significantly more water the second year after treatment. A study of soil water in burned and unburned areas in a Mediterranean shrubland showed a similar pattern—soil moisture content was higher in burned areas (Silva at al. 2002).

The burning of vegetation would be expected to lead to an increase in surface runoff and sediment inputs to water, and a decrease in infiltration and thus groundwater recharge. The amount of runoff would be a factor of the timing and severity of the fire, the slope of the treatment site, and the timing, amount, and intensity of precipitation. High severity fires tend to burn much of the organic material on a site, exposing mineral soil, and sometimes forming hydrophobic soil layers Erosion, runoff, and water quality are often unaffected on level areas after a low severity prescribed burn, whereas adverse effects to water resources may persist for 9 to 15 months on moderate slopes, and for 15 to 30 months on steep slopes (Wright et al. 1976). Wright et al. (1976) further determined that average sediment yield was less than 0.01 tons per acre during the first 6 months after burning from level sites, but was about 10-fold to 100-fold greater on moderate to steep slopes. If a fire was of low enough severity that litter and duff layers were undamaged during the burn, effects to water resulting from runoff and erosion would be minimized (Beschta 2000). Additionally, burn timing is important; prescribed fire conducted prior to a precipitation event would have the greatest risks of increased surface runoff and sedimentation. Generally, low severity burns would result in no changes to stream flow. This is in contrast to conditions resulting after large or severe fires that increase stream flows for several years following the fire (Brooks et al. 1997). Sedimentation may be reduced by avoiding burns on steep slopes; retaining buffers along water bodies; revegetating treated sites; and minimizing use of burned sites by equipment, livestock, OHVs, and other ground-disturbing activities until the site has revegetated (Clark 2001).

The effects of fire on water chemistry occur as a function of mobilization of nutrient loading from ash (Clark 2001). Primary effects would result from increased nitrogen, phosphorus, and cations. Increased ammonium nitrogen and small increases in phosphorus and nitrate levels in water are common in burned areas (Richter et al. 1982; Swanston 1991; Knoepp and Swank 1993). Burning of pinyon-juniper woodlands in southeastern Utah, for example, resulted in a 400% increase in phosphorus (Buckhouse and Gifford 1976). Nutrient levels typically "normalize" within 1 to 2 years (Clark 2001).

Use of ground-disturbing fire equipment and firelines on erosive and/or steep slopes can exacerbate erosion and sedimentation of nearby water bodies. Limiting the use of fire fighting trucks and equipment to roads or disturbed areas can reduce soil loss.

Daily temperature fluctuations in forest streams are largely regulated by the amount of solar radiation they receive (Beschta 2000). Removal of overhead vegetation along watercourses can lead to increased water temperatures after a prescribed fire. Elevated stream temperatures are detrimental to most coldwater fish species. Retaining vegetated buffers between stream courses and treatment areas, and revegetating burned areas along streams, can help to reduce effects to water temperature and stream organisms.

Effects of Mechanical Treatments

The effects of mechanical treatments on water quality would largely depend on the techniques used to remove vegetation, the proximity of the treatment site to a stream or water body, and the slope of the site. The soil disturbance associated with machinery used to remove vegetation, such as grubbing, plowing, scraping, chaining, or rutting from wheels or tracks, would increase the likelihood of soil and plant material being carried into streams by surface runoff. In addition, the compaction of soil by heavy equipment would increase the likelihood of surface runoff by reducing the soil's infiltration capacity. However, leaving debris in place after treatments would limit the negative effects on infiltration rates and sedimentation into streams (Gifford et al. 1970). There would be risks to water quality associated with the use of heavy machinery or mechanized equipment used to treat vegetation, as fuel leaks and spills could occur. Releases of fuel would be more likely to affect surface water than groundwater, and would have the greatest effects to water quality if fuel was released directly into the water.

Effects of Manual Treatments

Because manual treatments would occur over small areas (65% of treatments would be less than 100 acres), and would involve minimal soil disturbance or vegetation removal, the effects to water resources would be minimal. Manual treatment seldom results in exposed soil, and plant materials would remain in the treatment areas, minimizing the risks of sedimentation and alterations to water flow. Precautions would be taken to minimize risks associated with the use of chainsaws or other power tools, including fuel spills.

Effects of Biological Treatments

Containment by Domestic Animals

Approximately 60% of acres treated using biological control methods would be treated using livestock, including sheep and goats. Vegetation treatments using domestic animals could affect water depending on the intensity and duration of grazing and the location of the treatment site relative to a given water body. Domestic animals can affect surface runoff as a function of trampling, soil disturbance, and soil compaction. Past studies observed that runoff from a heavily grazed watershed was 1.4 times that of a moderately grazed watershed, and 9 times greater than that of lightly grazed watershed (Rauzi and Hanson 1966). In some cases, grazing may actually improve soil infiltration by breaking up physical crusts on the soil (Walter 1984).

Livestock that graze in proximity to aquatic systems could affect water quality as a function of nutrient loading (e.g., nitrogen and phosphorous) and increase in bacterial and fecal coliforms. Cattle, for example, produce about 5 billion fecal coliforms in each feces and average 12 defecations per day, making them capable of contributing significant numbers of these organisms to surface water (Howard et al. 1983). Furthermore, the nutrients found in livestock waste stimulate algal and aquatic plant growth when deposited directly or immediately adjacent to a water body. Although this plant growth can provide a food base for aquatic organisms, an excess of nutrients can stimulate algal blooms, which reduces water quality by lowering dissolved oxygen levels. The effects of grazing treatments on water quality would depend on the number of animals, the intensity of the program, and the proximity to surface water bodies.

Biological Control Agents

Approximately 40% of acres treated using biological control methods would be treated using insects and pathogens to control vegetation. There would be minimal effects to water resources as a result of introducing insects or pathogens into treatment sites. These agents typically kill target plants slowly, after which plants remain on the site, reducing the likelihood of surface runoff and sedimentation.

Effects of Chemical Treatments

Aquatic Vegetation Control Using Herbicides

Applications of herbicides to aquatic systems would not directly modify water quantity. Indirect effects to water quantity could occur if treatments that removed unwanted aquatic vegetation reduced plant uptake of water, increasing the amount of available water.

The BLM currently uses four herbicides in riparian and aquatic habitats—2,4-D, glyphosate, imazapyr, and triclopyr—and is proposing to use diquat and fluridone in these areas, as well. The remaining herbicides available to the BLM, or proposed for use, are registered for use only on terrestrial sites.

Herbicides applied to streams, ponds, and lakes for aquatic vegetation control could affect surface water quality if applied at concentrations that exceed label requirements. Based on the HHRA (see the Human Health and Safety section and Appendix B in the PEIS), there would be low risk to drinking water in areas treated with diquat, fluridone, glyphosate, or imazapyr, even if these herbicides were accidentally spilled in streams, ponds, or lakes used by humans. However, risk is moderate to high for drinking water if treated with 2,4-D or triclopyr.

Aquatic plant control can cause a high rate of plant decomposition and may cause rapid oxygen loss from water that can seriously degrade water quality. The magnitude of this effect depends on water temperature, lake or pond stratification, and the amount and rate of plant decomposition. The effects can persist from a few weeks to an entire growing season, but are generally not permanent.

Water quality degradation could result from removal of riparian vegetation and a reduction in shade. With the loss of shade, the resulting increase in surface-water temperature fluctuations may drive water temperature beyond tolerable limits for temperature sensitive fish and other aquatic species.

Terrestrial Vegetation Control Using Herbicides

The use of herbicides to remove vegetation could affect water quantity by altering the magnitude and frequency of base flows and the magnitude of peak flows. For some treatment areas, large-scale vegetation removal could improve groundwater recharge by limiting the amount of water lost through sublimation or plant evapotranspiration. In such cases, base flow, which is dependent on groundwater discharge, would increase. These changes could be very minor or short-lived if the vegetation did not evapotranspirate or sublimate large proportions of precipitation, or if areas were revegetated quickly (Satterlund and Adams 1992).

In contrast to increasing base flows, vegetation removal could result in the reduction of groundwater discharge and reduced base flows as a function of reduced infiltration rates. Reduced infiltration rates result in more surface runoff reaching streams and lakes immediately after a rain event, thus increasing the velocity, frequency, and magnitude of peak stream flows. These changes in water quantity could alter the physical characteristics of stream channels. Any effects would persist until the sites were revegetated, unless channel characteristics were substantially changed during this period.

The four primary means of offsite movement of herbicides are runoff, drift, misapplication/spills, and leaching. Surface water could be affected by any of these means, while groundwater potentially would be affected only by leaching.

Herbicides registered for use in terrestrial habitats may affect surface water and groundwater as a result of unintentional spills or movement of herbicides from upland sites into aquatic systems. Pollution results from herbicide concentrations that are elevated enough to impair water quality and the beneficial use of that water (USDI BLM 1991a). The potential for upland herbicide applications to reach water is affected by the herbicide's physical properties, the application method and rate, and site conditions (BPA 2000).

The vegetation, ground cover, or soil type between a treatment area and a water body can influence whether herbicides will reach water. Thick vegetation might block drift or absorb an herbicide moving through water or ground before it reaches a water body. In comparison, where little to no vegetation is present, the herbicide would encounter less resistance when washing toward the water body.

Additional effects to water quality that could occur from herbicide treatments include increased nutrient loads to surface water and groundwater. Soluble nutrients can enter surface water or groundwater. Nutrients adsorbed to particles may be moved to water bodies by wind and water erosion. Nutrient enrichment of aquatic systems can lead to algal blooms and eutrophication (mineral and organic nutrient loading and subsequent proliferation of plant life), resulting in decreased dissolved oxygen contents. The extent and duration of effects would be dependent on the geographic location, and on the extent of vegetation removal, as well as on revegetation management practices. Removal of large amounts of vegetation along streams could lead to warmer water temperatures, to the detriment of fish and other aquatic organisms.

From a watershed perspective, the concentration and amount of the herbicide applied can influence the risk of water contamination. The ratio of treated to untreated surface area in any given watershed is usually sufficiently low to permit rapid dilution. This ratio is much lower than for the concentrated areas or blocks of land typically targeted by the BLM for rangeland and forestry treatments. For example, aerial application of herbicides along a 100-foot wide ROW would result in treatment of about 2% to 3% of a 640-acre area. In contrast, treatment of 10% to 75% per 640 acres is common in forestry and rangeland applications. Risk of direct application of herbicides to streams along ROWs would increase if the linear flight path of the applicator crosses several streams.

Beneficial Effects of Treatments

Over the long term, vegetation treatments that move forests and rangelands toward historical ranges of variability, with a preponderance of native plant communities in natural mosaic patterns and relatively uninterrupted disturbance regimes, would provide favorable conditions for water quality (USDA Forest Service and USDI BLM 2000b; Hann et al. 2002). To better ensure favorable long-term conditions, the BLM proposes to increase the number of acres treated annually 3-fold, and to focus treatment efforts on high priority watersheds where state or tribal water quality standards are not met.

The proliferation of invasive and unwanted aquatic vegetation in surface waters can affect water quality, resulting in water quality degradation. Blooms of weedy vegetation can result in reduced drinking water quality, potentially limit recreation opportunities, and lead to depletion of oxygen in water, which can degrade fish and wildlife habitat. Infestations can block channels or culverts, causing flooding. Use of aquatic herbicides to remove weedy and invasive aquatic vegetation could reverse such infestations and greatly improve water quality and enhance fish and wildlife habitat and recreational opportunities. Of the two herbicides proposed for use by the BLM, fluridone demonstrates the best potential efficacy to reduce dense infestations of aquatic plants while having few adverse effects on water quality and fish. Diquat is effective in aquatic weed control, but is a known groundwater contaminant that could harm native fish and plants. Its use should be limited to areas where vegetation control is paramount and risks to fish and water quality are of less concern.

Historical fire suppression may have affected water quality and quantity. On rangelands, fire suppression is partly responsible for the spread of pinyon-juniper woodlands. The spread of western juniper and increase in the density of juniper stands could lead to conditions that favor decreased soil infiltration and increase in peak discharges. Fire suppression in forests has led to increased aboveground vegetation that may contribute to increased evapotranspiration rates and decreased runoff. Where high severity fires have increased due to fire suppression, soil porosity has decreased and led to increasing soil erosion and runoff. Efforts to reduce the risk of catastrophic wildfires would reduce the potential for excessive loss of plant and litter cover and the potential for soil erosion and mass failures that cause a decrease in water quality. Fire use and other treatments that restore natural fire regimes and ecosystem processes would reduce the effects of fire suppression and benefit water resources and quality, especially in high priority watersheds, in Fire Regime Condition Class 3 areas, and in areas dominated by downy brome and other invasive species.

Mechanical and other methods to control pinyon-juniper have been used in attempts to increase water yield and groundwater recharge. Chaining and windrowing debris from pinyon-juniper woodlands may reduce infiltration and increase streamflow, while double-chaining and leaving debris in place may not affect infiltration and water yield (Williams et al. 1972; USDI BLM 1991a). Creation of large depressions in the soil during treatments could reduce runoff and increase infiltration by storing water (Richardson et al. 1979). Rootplowing of creosote bush sites in Subtropical Steppe rangelands reduced runoff by increasing surface roughness and water storage, but rootplowing of creosote bush and seeding grass in New Mexico resulted in less vegetative cover and lower infiltration rates than in untreated areas (Tromble 1980). Infiltration rates increased on rootplowed areas when seeded grass cover had sufficient time to increase.

Herbicide use can benefit water quality if vegetation removal reduces the risk of catastrophic fire. Treatment of upland areas to reduce fuel loading could contribute to long-term benefits to surface water quality by reducing the risk high-intensity wildfires. In addition, the use of herbicides to control invasive species in terrestrial and aquatic systems could provide long-term benefits to water quality with the return of more stable soils, attenuated nutrient cycling, and return to normal fire cycles.

Approximately 10% of treatment acres could be treated using new herbicides proposed for use in the PEIS, and the BLM could use additional new herbicides in the future. Diquat and fluridone could be directly applied in aquatic systems to control unwanted submersed aquatic vegetation. Approval of diquat and fluridone would provide new capabilities for controlling invasive aquatic plants and could provide benefits to water quality if invasive aquatic plants were eliminated. Fluridone, in particular, has been effective at controlling Eurasian watermilfoil without resulting in effects to drinking water quality or recreation (Washington Department of Ecology 2003). Imazapic is not known to contaminate groundwater and would be used to control downy brome infestations. Diflufenzopyr is not known to contaminate groundwater, but has a high potential to leach to groundwater. Except for fluridone, which has a high potential for surface water runoff, the proposed herbicides have low potential to flow to aquatic bodies in stormwater runoff.

Much of the effort by the BLM to reduce salinity levels in the Colorado River Basin is focused on minimizing surface disturbance and revegetating disturbed sites in soils with a high natural content of salt. Controlling salinity in rangeland surface runoff is closely related to controlling soil erosion. Vegetation cover is usually the most important management variable influencing runoff and erosion rates on rangelands. In systematically targeted watersheds, the payoff for salinity control is that decreased sediment yields and moderated flood flow energies should combine to transport less salt from the uplands, as well as from gullies and established channels.

The Forest Service and BLM used modeling to predict the effects of an aggressive program of treating vegetation and controlling land disturbances, similar to those proposed in this PER, on water resources and quality in the Interior Columbia Basin. Although few benefits would be expected during the first 10 years after treatment, long-term benefits included reduced rates of soil erosion and improvement in other water quality parameters. Implementation of restoration activities, including restoring natural fire regimes, restoring native grasses, forbs, and shrubs, managing land uses to reduce the extent of exotic plant invasions, and focusing treatments in high priority watersheds, would result in the greatest benefits.

Wetlands and Riparian Areas

The BLM manages over 23 million acres classified as riparian or wetland. Wetlands and riparian areas in the western U.S. and Alaska are influenced by human activity, natural disturbance, and local physical and biological conditions. Invasive plant species degrade wetland and riparian area function and present a challenge to vegetation management. An estimated 59,000 acres of wetland habitat and 17,500 stream miles on BLM lands lack characteristics necessary for "high" functioning wetland and riparian habitats (USDI BLM 2006d). Invasive plant species are one factor that degrades wetland and riparian function. Hazardous fuels buildup can lead to catastrophic wildfires that can also adversely affect wetland and riparian habitat.

Wetlands and riparian areas provide important ecological functions, including flood water attenuation, sediment trapping, and nutrient transformation and retention (Westbrooks 1998). In addition to physically displacing native vegetation, invasive plant species and wildfires can alter the fire frequency, hydrologic properties, soil chemistry, and physical structure of wetland and riparian ecosystems.

Invasive plants often spread quickly over large areas, displacing native vegetation and habitat for wildlife. Invasive plants outcompete native species because they have no natural predators to limit their reproduction and spread (Westbrooks 1998). Thus, removal of non-native and invasive plants would be expected to result in an improvement in the environmental health of wetland and riparian ecosystems.

Vegetation treatments would benefit wetland communities by decreasing the growth, seed production, and competitiveness of target plants, thereby releasing native species from competitive pressures and aiding in their reestablishment. The degree of benefit would depend on the success of the treatments over both the short and long term. Some treatments that are successful at removing weeds over the short term may not accommodate the establishment of native species. In such cases, seeding of native plant species would be beneficial.

Scoping Comments and Other Issues Evaluated in Assessment

Comments were received concerning water quality and water issues and the potential for increased infiltration, reduced runoff and erosion, and sediment transportation within wetlands and riparian areas from vegetation treatments. Concern was also expressed regarding the effect of grazing in riparian areas. Recommendations were made to scale back fuels reduction in riparian areas and to suppress fires near rivers.

Resource Program Goals

The Soil, Water, and Air Management and Riparian Management programs are primarily responsible for activities that affect wetlands and riparian areas. Wetland and riparian areas comprise only about 9% of public lands, but support some of the most ecologically diverse and important plant and animal communities occurring on public lands (USDI BLM 2006c).

Treatments would be focused on watersheds that fail to meet resource objectives and/or that provide habitat for greater sage-grouse. The BLM would also initiate restoration efforts in wetland and riparian areas in less than proper functioning condition, with much of the emphasis on controlling invasive and noxious weeds (USDI BLM 2006c). The BLM has ongoing programs to control invasive vegetation and noxious weeds in riparian areas, including saltcedar. The BLM is working with Ducks Unlimited and other groups to create wetlands and improve stream habitat. Substantial effort is focused on removing and revegetating abandoned logging roads to reduce erosion and sedimentation of nearby aquatic bodies, and to restore habitat for salmon and other fish in the Columbia River Basin (USDI BLM 2006c).

Fire exclusion policies, buildup in hazardous fuel levels, and increase in acreage dominated by invasive vegetation have led to more frequent fires of greater severity and duration and increased soil erosion over many areas of the West. These conditions have often led to deterioration in wetland and riparian habitat in affected areas (USDA Forest Service and USDI BLM 2000b). Although disturbances from fire, wind, plant disease, grazing by wildlife, floods, and other factors will always be important in shaping ecosystems in the western U.S., efforts by the BLM to restore wetland and riparian vegetation to more natural conditions, and to reduce fuels buildup and the frequency of catastrophic fires, should lead to a slow improvement in wetland and riparian habitat in treated areas.

Standard Operating Procedures

This assessment of effects assumes that SOPs (listed in Table 2-5) would be used to reduce potential unintended effects to riparian and wetland areas. Prevention and early detection is the least costly and most effective weed control method. Weeds colonize highly disturbed ground and invade plant communities that have been degraded, but are also capable of invading intact communities.

Reseeding or replanting may be required to revegetate sites in which the soil has been disturbed or vegetation has been removed, and where there is insufficient vegetation or seed stores to naturally revegetate the site. Disturbed riparian and wetland areas may be reseeded or planted with desirable vegetation when the native plant community cannot recover and occupy the site sufficiently. The goal of revegetation is to stabilize and restore vegetation on a disturbed site and to eliminate or reduce the conditions that favor invasive species. Plant materials that are brought onto public lands should be free of disease. Chances for revegetation success are improved by selecting seeds with high purity and percentage germination; selecting species native or adapted to the area; planting at proper depth, seeding rate, and time of the year for the region; choosing the appropriate planting method; and, where feasible, removing competing vegetation. Planting mixtures are adapted for the treatment area and site uses. For example, a combination of shrubs and trees might be favored for riparian sites.

For application of herbicides not labeled for aquatic use, the BLM would specify herbicide-free buffer zones based on risk assessment guidance, with minimum widths of 100 feet for aerial, 25 feet for vehicle, and 10 feet for hand spray applications. Buffers would reduce the potential for transport of terrestrial herbicides into wetland and riparian habitats. Operational plans should also include information on project specifications, key personnel responsibilities, communication procedures, safety, spill response, and emergency procedures. Additional SOPs for herbicide treatments may be found in Table 2-8 of the PEIS.

Adverse Effects of Treatments

Approximately 30,000 acres of wetland and riparian habitat would be treated annually. Of these acres, approximately 34% would be treated using chemical treatments, 30% using biological control methods, 28% using mechanical and manual methods, and 8% using fire. Herbicide treatments would be conducted using ground-based equipment, and over 80% of treatments would occur in the Temperate Desert and Subtropical Steppe ecoregions. Biological control treatments would primarily involve the use of insects. Although there are no current plans to use prescribed grazing to contain vegetation in riparian or wetland habitat, based on information provided by BLM field offices, there is at least some potential to use livestock grazing as a biological control in these habitats. The use of livestock to control vegetation in riparian and wetland habitats would require very careful planning and execution to avoid impacts to other resources. In these habitats the timing, amount, and duration of grazing would be very specifically designed to impact the growth and reproduction of target plant species without inhibiting the ability of native vegetation to reproduce and revegetate the treatment area. Although prescribed grazing may not be an effective tool in many riparian and wetland habitats, it may be useful in some situations and should therefore be considered. Nearly all fire treatments in riparian areas would be 100 acres or less. An increase in soil erosion and surface water runoff could result from vegetation removal, which could lead to streambank erosion and sedimentation in wetlands and riparian areas (Ott 2000). Rates of runoff would be influenced by precipitation, rate of vegetation recovery, soil types, and proximity to the treated area. All vegetation removal activities could disturb the soil and reduce the amount of vegetation that can bind to soil, potentially causing erosion and increased sedimentation of wetlands and riparian areas. Sediments can affect plants within wetlands and riparian areas by reducing the amount of sunlight reaching plants and slowing or stopping plant growth.

The removal of vegetation would decrease the amount of rainfall captured by plants, detritus, and soil, potentially leading to increased stormwater flows and runoff velocity in both ecosystems. Increased stormwater runoff can scour wetlands and modify their morphology, and affect the distribution and abundance of aquatic organisms within the area. Many species that use wetlands have evolved life-history strategies that depend on stable conditions (i.e., stable water quality and quantity). For example, vegetation removal resulting in increased water flows to wetlands during the spring could flood the breeding sites of aquatic organisms that breed or lay eggs in moist soil, harming or killing eggs or juveniles.

A reduction in non-target aquatic vegetation can result in oxygen depletion as the vegetation begins to decompose. Siltation of wetlands could reduce water quality and the amount of oxygen available to aquatic organisms. In addition, siltation could reduce the acreage of wetland and riparian habitat.

Effects of Fire Treatments

Only about 2,300 acres of wetland and riparian habitat would be treated annually using fire, the smallest acreage of all the treatment methods, and only 0.1% of all acres would be treated using fire. The effect of fire on wetland and riparian areas would depend on the natural fire regime of the area, the time of year the fire occurred, and the extent of the fire. Fires can also consume or degrade peat soil, change the vegetation composition and structure of an area, and increase erosion and turbidity in wetlands. In general, prescribed fires would have fewer impacts than wildfires, as they are low severity and can be controlled to occur in one particular area.

Because of the high productivity of wetlands, and the density at which many wetland species occur (e.g., phragmites, cordgrass, cattail, and reed canarygrass), fuel loads are often considerably higher per unit area in wetlands than in uplands. In riparian areas where vegetation density is high, the potential for hotter, more extensive burns is elevated (Thompson and Shay 1984). High intensity fires could also kill large trees, with increases in stream flow and erosion as a result of vegetation loss.

Replacement of native vegetation by exotic plant species, many of which are highly flammable, can contribute to an increased incidence of fire in riparian areas. Tamarisk, giant reed, and annual grasses such as red brome all are highly flammable. The spread of many of these exotics is due in part to the same changes in stream flow regimes that render the riparian areas more susceptible to fire.

Fire intensity, magnitude, and behavior vary with the composition, density, and structure of local vegetation, litter depth, fuel loading and moisture content, soil composition, water table, and climate (Rassman 1993 *cited in* Culver 1997). As a result, fire may lightly char or slowly burn an area or may burn rapidly, resulting in crown-destroying burns, depending on the combination of these variables and site conditions (Berndt 1971; Minshall et al. 1989; Rassman 1993 *cited in* Culver 1997).

Effects of Mechanical Treatments

Mechanical treatments would occur on approximately 3,500 acres of wetland and riparian habitat annually, or about 0.2% of all acres treated using mechanical methods. Treatments would involve mowing, disking, and chopping. The effects of mechanical treatments on wetland and riparian areas would be related to the types and amounts of soil disturbance and vegetation removal, the proximity of the treatment to a wetland or riparian area, and the incidence of accidental spill.

Methods for controlling aquatic vegetation include harvesting aquatic plants using machines that can cut the plant in an area 6 to 20 feet wide and from 5 to 10 feet below the water surface. These harvesters can "open" up an area, but can also lead to the spread of aquatic vegetation to new areas. In addition, harvesters may affect fish and other aquatic organisms by removing them in harvested material. Cutting plant stems too close to the bottom can result in resuspension of bottom sediments and nutrients (Madsen and Stewart 2004).

Weed rollers, which can be up to 30 feet long, compress the sediment and plants in an area. Frequent use of rollers allows only limited growth of vegetation, and may disturb bottom-dwelling organisms and spawning fish. A rotovator is similar to an underwater rototiller. The equipment dislodges and removes plants and roots. Since the rotovator greatly disturbs the bottom sediments, there is concern that use of the equipment can: 1) resuspend contaminated sediments; 2) release nutrients absorbed or precipitated in the sediment (e.g., phosphorus); 3) adversely affect benthic organisms; or 4) affect fish spawning areas.

Blading, tilling, and grubbing disturb soil and can increase erosion, and thus may degrade aquatic habitat, especially when the treatment is performed on hillslopes. Erosion can be a problem on slopes greater than 20%. Thus, such mechanical methods should be avoided on steep hillslopes. To reduce effects, the BLM would limit blading to relatively level areas, and would reseed bladed and grubbed sites to prevent runoff and erosion.

Chaining, roller chopping, and mowing that mulches plant debris can aid in erosion control. Retention of a vegetated buffer between the treatment area and water could also reduce the risk of sedimentation and stabilize soils within an area. Emergent plants, such as cattail, common reed, whitetop, and sedge, that are mowed as close as possible to the substrate to facilitate inundation of the stubble during the growing season, can be effective in reducing shoot density by 50% or more (Kaminski et al. 1985). Dense stands of cattail and or other emergents can be controlled by burning during winter, shredding the remaining stubble, and then flooding the cut stalks for at least 2 weeks (Weller 1975, Murkin and Ward 1980).

The use of heavy equipment can result in soil compaction, particularly in areas of moist soils that can increase surface runoff from the surrounding treated areas. Compaction by vehicles and other heavy equipment can reduce the porosity of soils, thus limiting water infiltration. The magnitude of effects to wetlands would depend on soil compaction and weather. One means to minimize the effect of heavy equipment on soil involves the use of tracked or low-pressure tires, which distribute vehicle weight over a larger area, thus reducing pressure on soil. Treatment by mechanical methods during dry months can also minimize the effects to wetlands by reducing the potential for surface water runoff into wetlands.

Spills resulting from fueling, equipment maintenance, and operation could adversely affect water quality and the health of wetland or riparian areas. These risks would be minimized by having provisions for incident response in the SOPs.

Effects of Manual Treatments

Manual treatments, which can target smaller areas, would be less likely to affect wetland and riparian areas than the other methods. Manual treatments would occur on approximately 4,400 acres of wetland and riparian habitat. Over 50% of the acres treated would be in Nevada. Treatments would involve the use of chainsaws and seeding or planting.

Hand treatments would remove the overstory and would cause little soil disturbance or erosion. In most cases, unwanted vegetation near a wetland or riparian area could be removed without disturbing more desirable species. Typically, plant debris would be mulched and left on site. Fuel and lubricant spills that could result from using chainsaws and trimmers would be contained or cleaned up before contamination spread to surrounding sensitive areas.

Effects of Biological Treatments

Approximately 9,400 acres of wetland and riparian habitat would be treated using biological control methods. Nearly all acres would be treated using insects. Most of the acres treated would occur in the Temperate Steppe Ecoregion.

Containment by Domestic Animals

Although most biological control in wetlands and riparian areas would be accomplished using insects, there could be some use of livestock. The degree of effect to wetlands and riparian areas from treatments using domestic animals would be dependent on the timing, duration, and intensity of grazing. Direct effects could include stream channel/wetland morphology alteration, and loss of native wetland or riparian vegetation. Improper grazing management can have a considerable effect on vegetation vigor and biomass, and species diversity (Kauffman and Krueger 1984). The potential loss of vegetation as a function of improper grazing management can lead to further loss of aquatic habitat as channels widen and water depths become shallower (Hubert et al. 1985; Platts and Nelson 1985; but see George et al. 2002). These potential impacts highlight the need for very carefully planned prescribed grazing which would require control of the timing, amount, and duration of grazing to limit these potential impacts. Temporary electric fencing, short term use of a pasture, preconditioning livestock to encourage grazing of the targeted vegetation, and herding are examples of measures that could be taken to minimize impacts.

Biological Control Agents

In most cases, these biological treatments would involve the release of organisms intended to weaken or kill vegetation. Vegetation would remain in place, resulting in little soil disturbance in the treatment area. If treated successfully, the plant community near or within the wetland or riparian area should improve.

Effects of Chemical Treatments

Approximately 10,000 acres of wetland and riparian habitat would be treated annually using herbicides. Herbicides may directly or indirectly affect the survival, health, or reproduction of non-target wetland or riparian plants or may affect characteristics of these plant communities and their ecosystem functions. Additionally, aquatic system herbicides are not species-specific, and the use of these herbicides may result in direct and indirect effects on wetland and riparian species diversity, competitive interactions, species dominance, and vegetation distribution (Kleijn and Snoeijing 1997). Herbicide applications could reduce plant cover leading to increased sedimentation, increased nutrient loading, alterations in native vegetation, and changes to temperature and hydrologic conditions. The effect of an herbicide's damage to non-target plants and the surrounding ecosystem can be evaluated by looking at its effects on 1) species diversity, 2) functionality of the wetland or riparian area in terms of wildlife habitat, recreational use, or groundwater recharge, 3) forest product (e.g., timber, wood pulp) production, and 4) aspects affecting environmental quality (e.g., soil erosion, invasion of noxious weeds, creation of vegetative barriers; Obrigawitch et. al 1998).

An increase in soil erosion and surface water runoff could result from vegetation reduction near riparian and wetland areas, which could lead to streambank erosion and sedimentation (Ott 2000). The amount and likelihood of streambank erosion and sedimentation would be directly proportional to the size of the treatment area (i.e., larger treatment areas would have increased risk of streambank erosion and sedimentation). Additionally, sedimentation could result in a reduction in the acres of wetland and riparian habitat.

Risks to wetland and riparian non-target species would depend on a number of factors, including the amount, selectivity, and persistence of the herbicide used; the application method used; the timing of the application; and the plant species present. Risks to wetlands and riparian areas from surface runoff would be influenced by precipitation rates, soil types, and proximity to the application area. Some herbicides (e.g., sulfometuron methyl) that adsorb into soil particles could be carried off-site, increasing their risk of affecting vegetation in wetlands and riparian areas.

Unintentional applications could have severe negative effects for wetlands and riparian systems. In particular, accidental spills near wetland and riparian areas could be particularly damaging to wetland and riparian vegetation. Spray drift can also degrade water quality in wetlands and riparian areas and could damage non-target vegetation.

Beneficial Effects of Treatments

Successful control of invasive plants in wetlands and riparian areas would lead to improved conditions in these habitats over the long term. The eventual growth of desirable vegetation in treated areas would moderate water temperatures, buffer the input of sediment and herbicides from runoff, and promote bank stability in riparian areas. Ongoing efforts by the BLM to enhance wetland and riparian vegetation would also help to increase the number of miles of stream and acres of wetlands that are in proper functioning condition. Improvement of riparian and wetland habitat would also benefit salmonids and other species of concern that depend on these habitats for their survival (USDA Forest Service and USDI BLM 2000b).

Control of aquatic and riparian vegetation can improve habitat quality for fish and wildlife, improve hydrologic function, and reduce soil erosion. Much of the BLM's vegetation control efforts in wetlands and riparian areas would focus on non-native species that can substantially alter wetland and riparian habitats, such as purple loosestrife, water-thyme, and Eurasian watermilfoil. Purple loosestrife forms extensive monotypic stands that displace native vegetation used by wetland animal species for food and cover (Bossard et al. 2000). Purple loosestrife can also alter the hydrology and soil conditions of wetland pastures and affect recreational activities. Water-thyme is an aquatic species that forms large mats that fill the water column and can severely restrict water flow, leading to a decrease in habitat for fish and wildlife and degraded water quality. Eurasian watermilfoil is another aquatic species that has spread across the West and that has been found to alter the physical and chemical characteristics of lakes and streams.

Vegetation treatments that reduce hazardous fuels would benefit wetlands and riparian areas by reducing the potential for catastrophic wildfires and resultant loss of high quality wetland and riparian habitat. Hazardous fuels reduction would also decrease the likelihood that wildfire suppression activities would occur in or near aquatic habitats.

Effects of Fire Treatments

Fires in wetlands or riparian areas can have both a positive and negative effect on the ecosystem. In addition to restoring conditions that more closely resemble those that would occur under natural fire conditions, prescribed fire may decrease hazardous fuels, trigger germination of some plant species, stimulate growth of new vegetation, and open up and create new habitat for wildlife (Agee 1994, Brennan and Hermann 1994, Payne and Bryant 1998). By removing vegetative debris, cover burns temporarily release more desirable plants that have an earlier growing season than more objectionable plants, such as cordgrass. Peat burns made during a drought can convert a marsh into aquatic habitat (Payne and Bryant 1998).

Fire may provide indirect benefits to wetlands by raising the pH of soil in certain areas. Since nutrient availability is related to soil acidity, elements critical for plant growth, such as phosphorus and nitrogen, become more available to plants as the soil pH increases. Fire also helps to release nutrients that may be tied up in forms that are unavailable to plants, such as woody material. The burning of surface organic matter releases some nutrients onto the soil in the form of ash, resulting in increased calcium, phosphorus, and potassium. This influx of nutrients could contribute to vegetation growth (DeBano et al. 1998).

Fires that kill trees create a source of standing wood that ultimately provides fish habitat. The input of woody debris can continue for a year or more after a burn (Young 1994; Minshall et al. 1997; Berg et al. 2002). Large wood in streams and wetlands provides hydraulic roughness, serves as a food source for aquatic and wildlife species, and provides habitat for wildlife. Conversely, devastating fires that result in fewer trees on a site would limit the input of woody debris to aquatic systems.

Prescribed fire or low intensity fires would be more likely to kill shrubs and deciduous trees than larger conifers. Since many species of shrubs and trees resprout, soil stability should not be impaired and conifers could continue to serve as a source of wood to aquatic habitats. For a comprehensive treatment of a site, however, prescribed fire may be followed by additional treatment. For example, burning followed by mechanical treatment has proven to be a successful treatment for invasive vegetation such as saltcedar (Ball et al. 2001).

Effects of Mechanical and Manual Treatments

Mechanical methods are appropriate for vegetation treatments near water where a high degree of control is necessary to reduce the risk to aquatic habitats from the use of fire and herbicides. Manual treatments, which tend to be more selective and involve smaller treatment areas than other methods, would be less likely to affect wetland and riparian areas than the other methods. Stump cutting and application of Arsenal® has been effective in control of saltcedar. Saltcedar topgrowth should not be removed for 3 years following herbicide application or resprouting will occur (Lym 2002).

Effects of Biological Control Treatments

With proper management, grazing can result in desirable plant response from riparian vegetation. Seasonal exclusion of cattle is effective in minimizing effects to soil and vegetation. With the right timing and amount of grazing pressure, invasive plants such as reed canarygrass, river bullrush, and cattail can be effectively controlled. The extensive root systems of these species are shredded by the cow's hooves. Studies have shown that rest-rotation and/or specialized grazing management of riparian zones as special use pastures is successful (Kauffman and Krueger 1984). For example, Davis (1982 *cited in* Kauffman and Krueger 1984) in Arizona found that a four-pasture rest-rotation system was a cost-effective and successful method for rehabilitating riparian areas when each pasture received spring/summer rest for 2 years out of 3.

Brush and weed management through grazing can benefit riparian areas. Goats and sheep have long been used for weed control. Goats are often used to control weeds and non-native brush species in riparian areas. Grazing allows for the release of more desirable plants, contributing to improved riparian and wetland conditions (Luginbuhl et al. 2000; Pittroff 2001). For example, the use of goats in areas infested with leafy spurge has proven successful. Goats show a strong preference for spurge and are less costly to use than chemical control measures.

Insects have been used effectively for biological control. For example, *Diorhabda elongata deserticola*, a leaf beetle from central Asia, has been used as a biological control agent for saltcedar. This insect can defoliate large areas of saltcedar (USDA 2003).

Several insects feed upon purple loosestrife, including the black-margined loosestrife beetle, golden loosestrife beetle, loosestrife root weevil, and blunt loosestrife seed weevil. These insects feed upon the exposed shoots during early spring. The golden loosestrife beetle was found to reduce flowering spike density by over 80% at two sites in Oregon. The loosestrife root weevil larvae feed on the roots of purple loosestrife, while the adults feed upon the foliage. The blunt loosestrife seed weevil feeds on leaves and immature seed capsules, while larvae eat the developing seeds within the capsules. Larvae destroy about 50% of the seeds within the capsules they infest (Rees et al. 1996).

The salvinia weevil has been shown to be an extremely effective biological control agent for giant salvinia. This highly specific insect feeds only on salvinia species from South America, rejecting closely related species from Africa and Europe. Biomass declined from more than 100 tons of fresh weight salvinia per acre at some sites in Louisiana and Texas to less than 2 tons during the same period. At two sites, one each in Texas and Louisiana, the mats of giant salvinia have almost completely collapsed. These waterbodies formerly choked with the weed are now mostly open water (USDA ARS 2004).

Effects of Herbicide Treatments

The BLM's ability to use four new chemicals (fluridone and diquat for aquatic applications, and imazapic and Overdrive® for terrestrial applications), and new herbicides as they would become available and approved for use, would provide new capabilities to the BLM for controlling problematic invasive species and would provide benefits to these wetland and riparian areas if invasive species were controlled or eliminated.

Risks to wetland and riparian areas from use of these herbicides are similar to or lower than for risks associated with currently-approved herbicides. The risks to wetland and riparian plants from accidental spill and drift scenarios would be lower with the proposed herbicides than with currently-approved herbicides. In addition, fluridone is specifically indicated for aquatic use, whereas none of the other currently-approved herbicides are strictly aquatic herbicides. Under the other herbicide treatment alternatives, diquat and fluridone would be used to treat aquatic vegetation, and both have shown to be effective in the control of Eurasian watermilfoil, water-thyme, water hyacinth, and giant salvinia. The other herbicides registered for aquatic use, glyphosate and triclopyr, are not as effective in controlling these species. However, disking with a follow-up spraying of Rodeo® (formulation of glyphosate), was effective in treating reed canarygrass in Washington State wetlands (Killbride and Paveglio 1999, Paveglio and Killbride 2000)

Overdrive® and imazapic would primarily be used on rangelands, but could still provide benefits. Overdrive® would be used to treat thistles and knapweeds, while imazapic could be used to control downy brome. These invasive plant species degrade riparian habitats and can lead to shortened fire cycles, followed by soil erosion and sedimentation.

The BLM does not propose to use herbicides in Alaska, where the majority of the wetland and riparian areas on BLM lands are found. However, the BLM would retain the option to use herbicides in Alaska should the need arise and the benefits of using herbicides outweigh the risks of other treatment methods.

Vegetation

The present-day composition and distribution of plant communities in the western U.S. are influenced by many factors, including physical factors (e.g., climate, drought, wind, geology, topography, elevation, latitude, slope, exposure) and natural disturbance and human-management patterns (e.g., insects, disease, fire, cultivation, domestic livestock grazing, wildlife browsing; Gruell 1983). In addition, competition with invasive plant species has resulted in the loss of some native plant communities in the western U.S. The rapid expansion of invasive plant species across public lands continues to be a primary cause of ecosystem degradation, and control of these species is one of the greatest challenges in ecosystem management. The recent increase in wildfires has been influenced by changes in vegetation on public lands over the past 100 years, which have resulted in increases in hazardous flammable fuels.

Scoping Comments and Other Issues Evaluated in Assessment

The largest number of comments submitted pertained to vegetation. Numerous scoping comments were centered around a desire for the BLM to focus on long-term ecosystem sustainability and biological diversity. Numerous comments suggested that the PEIS and PER address all invasive plants, not just weeds. One respondent proposed focusing on minimizing the spread of existing weed infestations, while others wanted to ensure that weed control measures do not result in more ecological disturbances than the weeds themselves. A large number of comments recommended evaluating the effect of herbicides on other plant and animal species within the areas considered for treatment. Several comments called for the PEIS to address the effects of new-generation, high-potency herbicides on non-target plants. There was some concern about weeds becoming resistant to herbicides, and how the BLM would prevent the death of beneficial native plants from herbicides. To improve greater sage-grouse habitat, one respondent recommended that instead of burning sagebrush, strips of vegetation should be treated with herbicides, then cattle allowed to break the vegetation down, followed by planting with grass.

Resource Program Goals

The goals of vegetation management are to manage vegetation to sustain the condition of healthy lands, and, where land conditions have degraded, to restore desirable vegetation to more healthy conditions. Eventually, the number of acres needing treatment should be reduced as a result of overall improvement in conditions.

To achieve these goals, the BLM must 1) understand and plan for the condition and use of public lands, 2) focus on restoring those sites that would most benefit from treatments, 3) select the appropriate treatments and SOPs to improve the likelihood of restoration success, 4) monitor treatments to better understand what works and what does not work, and 5) convey information about treatment activities to BLM staff and the public.

Concurrently, public lands must be administered under the principles of multiple use and sustained yield in accordance with the intent of Congress as stated in the FLPMA. Thus, vegetation must be managed to protect and enhance the health of the land while providing a source of food, timber, and fiber for domestic needs (USDI BLM 2000c). Land-disturbing activities must be conducted in a manner that minimizes ecosystem fragmentation and degradation, and lands should be rehabilitated when necessary to safeguard the long-term diversity and integrity of the land.

A discussion of individual BLM vegetation treatment programs and their responsibilities is in Chapter 2, Vegetation Treatment Programs, Policies, and Methods.

Standard Operating Procedures

This assessment of treatment effects assumes that SOPs listed in Table 2-5 would be used to reduce potential unintended effects to non-target vegetation. For all treatment methods, the BLM would identify and implement any temporary domestic livestock grazing and/or supplemental feeding restrictions needed to enhance the recovery of desirable vegetation following treatment, and consider adjustments in the existing grazing permit (including the application of state or regional grazing administration guidelines) needed to maintain recovery of desirable vegetation following treatment.

For fire use, the BLM would keep fires as small as possible to meet the treatment objectives, conduct low intensity burns to minimize adverse impacts to large vegetation, limit the area cleared for fire breaks and clearings to reduce the potential for weed infestations, and use mechanical treatments to prepare forests for the reintroduction of fire, where appropriate.

For mechanical and manual treatments, the BLM would remove damaged trees and treat woody residue to limit subsequent mortality by bark beetles. For mechanical treatments, workers would power wash vehicles and equipment to prevent the introduction and spread of weed and exotic species. For chaining activities, the BLM would use lighter chains with 40- to 60-pound links where the objective is to minimize disturbance to the understory species; avoid chaining in areas where annual rainfall is less than 6 to 9 inches, especially if downy brome is present; and use two chainings to reduce tree competition and prepare the seedbed, as appropriate. The second chaining would be carried out at the most advantageous time for seeding.

For biological control treatments, domestic animals would be used at the time they are most likely to damage invasive species, and animals would be managed to prevent overgrazing and to minimize damage to sensitive areas. For herbicide treatments, SOPs include using drift reduction agents, using the appropriate application rate to treat weeds and other noxious vegetation to minimize effects to non-target vegetation, and conducting pre-treatment surveys for sensitive habitat and species of concern.

Prevention and early detection are the least costly and most effective weed control methods. Weeds colonize highly disturbed ground and invade plant communities that have been degraded, but are also capable of invading intact communities. Passive treatments, such as removing the cause of disturbance (e.g., livestock, OHVs) may be more effective over the long term than active treatments, and would be evaluated for their merit before implementing active treatments.

Reseeding or replanting may be required to revegetate sites in which the soil has been disturbed or vegetation has been removed, and where there is insufficient vegetation or seed stores to naturally revegetate the site. Disturbed areas may be reseeded or planted with desirable vegetation when the native plant community cannot recover and occupy the site sufficiently. The goal of revegetation is to stabilize and restore vegetation on a disturbed site and to eliminate or reduce the conditions that favor invasive species. Plant materials that are brought onto public lands should be free of weeds and disease. Chances for revegetation success are improved by selecting seeds with high purity and percentage germination; selecting species native or adapted to the area; planting at proper depth, seeding rate, and time of the year for the region; choosing the appropriate planting method; and, where feasible, removing competing vegetation. Planting mixtures are adapted for the treatment area and site uses. For example, a combination of shrubs and trees might be favored for riparian sites.

These procedures would help minimize effects on plants to the extent practical. As a result, long-term benefits to natural communities from the control of invasive species would likely outweigh any short-term negative effects to non-target plants associated with treatments.

Adverse Effects of Treatments

Some vegetation treatments would cause disturbances to plant communities by killing both target and non-target plants, while others would improve the vigor and health of plants (e.g., seedings and plantings and treatments that "release" more desirable vegetation). The extent of these disturbances would vary by the extent and type of treatment, as discussed in the sections that follow. In many cases, the treatments would return all or a portion of the treated area to an early successional stage, killing off disturbance intolerant species, such as sagebrush, and freeing up resources such as light and nutrients for early successional species, such as perennial grasses and forbs. In areas where fire suppression has historically occurred, vegetation treatments would be expected to benefit native plant communities by mimicking a natural disturbance component that has been missing from these communities, altering them over time. In areas that have been highly degraded, merely restoring disturbance to the ecosystem may in some cases adversely affect native plant communities because many of the desired native species are no longer present, and treatments can result in the spread of weeds or the persistence of an altered vegetation structure and species composition. These effects, which would vary depending on the treatment used, the type of vegetation on the treatment site, the amount of degradation on the site, as well as numerous other factors, are discussed in more detail by treatment type, ecoregion, and vegetation type in the sections that follow.

Approximately 2.2 million acres would be treated annually using mechanical methods, and 2.1 million acres using fire. The remaining treatments would involve chemical (932,000), biological control (545,000) and manual (270,000) methods. Most treatments would occur in the Temperate Desert (50% of all treatments), Temperate Steppe (28%), and Mediterranean (8%) ecoregions. Fewest treatments would occur in the Subtropical Desert (1%) and Marine (2%) ecoregions. Over 40% of treatments would occur in the evergreen shrubland (31% of all treatments) and evergreen woodland (12%) plant communities. Twenty-two percent of treatments would involve multiple plant communities (e.g., evergreen shrubland and riparian).

Effects of Fire Treatments

Fire treatments would injure and kill plants, causing the most harm to species that are intolerant of fire, and in most cases benefiting fire-adapted or fire-dependent species. Fire would also stimulate the growth of certain plants, such as grasses and aspen. Many woody species would be top-killed by fire. Forbs, grasses, shrubs, and deciduous trees that have the capacity to resprout would be capable of recovering quickly. Some species readily reproduce from seed. Established perennial plants that can recover vegetatively would typically have a short-term competitive advantage over plants developing from seed because their well-developed root systems and stored energy reserves support rapid regrowth. Plants with growing points near the surface (e.g., black grama) or dense growth at their base that concentrates heat (e.g., bluegrasses, Idaho fescue, and needle-and-thread grass) are more likely to be negatively affected by fire (Paysen et al. 2000). Plants with their growing points protected by soil, such as perennial forbs and shrubs with deep roots, would generally respond more favorably to burning. Tables 4-5 through 4-8 show the effects of fire on representative invasive species and the ability of native trees and brush to regenerate after fire.

Approximately 63% of fire treatments would occur in the Temperate Desert Ecoregion, and 12% and 9% would occur in the Subarctic and Subtropical Steppe ecoregions, respectively. Nearly half (48%) of treatments would occur in evergreen shrublands and 19% would occur in evergreen woodlands. Six percent of treatments would occur in evergreen forest and perennial graminoid communities (Table 4-9).

Fire Effects by Ecoregion

Tundra Ecoregion. Fire use is not planned for the Tundra Ecoregion. If fire was used, it would likely consist of wildland fire use for resource benefit. As stated in the *Alaska Interagency Wildland Fire Management Plan* (Alaska Wildland Fire Coordinating Group 1998), "lightning caused wildland fires are an important component of the boreal forest and arctic tundra ecosystems, and the complete exclusion of these fires is neither ecologically sound nor economically feasible."

Tundra environments are fire-dependent ecosystems that have evolved in association with fire and lose their vigor and floral diversity if fire is excluded. Fire may be the chief factor maintaining productivity in cold Alaska soils, where most nutrients are tied up in the vegetative overstory, and in the thick moss and organic layers, and are not available to plants. Burning organic material changes nutrients from complex forms unavailable to plants to simpler and readily available forms in ash (Alaska Wildland Fire Coordinating Group 1998).

The effects of fire on northern ecosystems are discussed in Alaska Wildland Fire Coordinating Group (1998) and Duschesne and Hawkes (2000). The following discussion, and references cited therein, is from these reports. Generally, fire favors rapidly growing species, particularly grasses, and there is a decreased abundance of slow-growing species such as evergreen shrubs following a fire. The recovery of mosses and lichens is slow, as opposed to sedges and grasses (Bliss and Wein 1971). Establishment of pioneer species is mainly by wind-borne seeds (Viereck and Schandelmeier 1980, Auclair 1983). Most lichens establish within the first years following a burn, but their slow growth limits their abundance for the first 25 to 30 years.

The depth of burn has a great effect on the postfire community. If a fire just scorches or burns the surface of the organic mat, for the most part killing just the aboveground stems, rapid and often prolific sprouting occurs from roots, rhizomes, and root crowns of species found in the surface organic layers. If fire heat penetrates into the organic mat, killing plant parts to some depth but not consuming all organic matter, sprouts may develop from deeply buried plant parts. Severe wildfire favors species with deeply buried structures over those with structures primarily in the upper organic layer.

Efforts to contain or stop the spread of fire in the tundra often produce more drastic long-term effects than the fire itself (Brown 1971, Viereck and Schandelmeier 1980). Construction of firelines with bulldozers strips away all insulating moss and peat layers and exposes bare mineral soil. This allows the summer heat to penetrate directly into the frozen ground, which in turn increases the depth of the active layer under the firelines compared to under burned areas. As a result, there is a more rapid and greater degree of subsidence under the firelines than under the burned areas due to the melting of ground ice (Brown 1971), erosion, and gully formation (Brown 1983).

Subarctic Ecoregion. About 12% of proposed fire treatments would occur in the Subarctic Ecoregion. Natural fire return intervals in these communities are generally greater than 100 years, and are typified by surface fires of low to moderate intensity that generally kill conifers and aboveground plant parts, but do not destroy underground parts (Viereck and Schandelmeier 1980).

Prescribed fires of low to moderate severity that mimic natural fires would be expected to benefit plant communities in this ecoregion by facilitating the recovery of species such as sedge tussock and bluejoint that readily resprout after fire. Shrubs such as willows, cloudberry, and Labrador tea would begin to recover from fire quickly by resprouting from underground rhizomes, stems, or stump sprouts.

A high severity fire could destroy more of the organic layer, delaying the recovery of shrubs, and requiring some species to reestablish from seed sources. Areas of exposed mineral soil would favor forb seedlings such as fireweed, Jacob's ladder, and other early-successional species, as well as black and white spruce. In areas near the treeline, scattered trees could also be eliminated by fire because of the colder soils and increased soil moisture that would follow a high severity fire. All of these effects of fire, however, would be within the normal range of succession within subarctic plant communities, and would be unlikely to harm native communities unless areas were burned at a much greater frequency than under historical fire regimes.

Temperate Desert Ecoregion. Over 60% of fire treatments would occur in the Temperate Desert ecoregion, predominantly in evergreen shrubland (sagebrush) and evergreen woodland (pinyon-juniper) vegetation types.

Evergreen Shrubland. As discussed in Chapter 3, the sagebrush communities in the Temperate Desert Ecoregion vary in terms of species of sagebrush, shrub density, and richness of understory vegetation, largely in response to the amount of soil moisture on the site. In general, most species of sagebrush are quite susceptible to fire, and habitats may take many decades to recover (Brown and Smith 2000). Sagebrush is typically killed during a burn, and because most species do not resprout (Young and Evans 1977; Cluff et al. 1983), it must reseed after fire, requiring a fire-free period of at least 30 to 50 years to regain its dominance (Brown and Smith 2000) on most sites. Sagebrush communities in the temperate desert historically had a fire return frequency of 50 to 100 years, with fires typically increasing the importance of grass species until shrubs regained their dominance of the site. A typical "healthy" site, then, experiences periodic disturbances and

TABLE 4-5
Effects of Fire on Representative Invasive Species

Species	Enhancement of Colonization by Fire	Effects of Fire on Survival	Ability to Regrow after Fire
Bermudagrass	Unknown	Direct mortality unlikely	Dormant season burns enhance growth
Chinese tallow	Likely	Hot fires can topkill even large trees	Rapid recovery
Cogongrass	Slight enhancement	Mortality unlikely	Very rapid recovery
Crested wheatgrass	Likely	Various results reported	Various results reported
Downy brome	Likely	Killed by fire	Must reestablish by seed
Common buckthorn	Unknown	Seedlings die and mature trees topkilled	Rapid recovery
Japanese brome	Fire removes litter and inhibits colonization	Plants and seeds killed	Populations slow to recover
Kentucky bluegrass	Likely	Direct mortality low	Burns during spring growth period more strongly reduce plant density
Leafy spurge	Unclear	Mortality unlikely	Extremely rapid recovery
Musk thistle	Likely	Survival likely	Rapid recovery
Purple loosestrife	Unknown	Most survive	Rapid recovery
Quackgrass	Unknown	Direct mortality low	Plants can regrow quickly; may depend on burn time
Russian knapweed	Unknown	Some survival likely	Unknown
Saltcedar	Likely	Topkilled, but most survive and resprout	Rapid recovery
Smooth brome	Likely	Direct mortality low	Burns during spring growth period more strongly reduce plant density
Spotted knapweed	Enhanced	Substantial mortality	Population recovery aided by persistent seedbank
Yellow starthistle	Enhanced	Adult plants killed	Must recover by seed
Yellow sweetclover	Enhanced	Killed by growing-season burns	Rapid recovery by seed if burning infrequent

Source: Grace et al. 2001.

supports a mosaic of sagebrush communities in varying states of successional development.

At sites in which fires have been suppressed and the density of sagebrush plants has increased, prescribed burns would likely mimic a natural fire event by killing sagebrush and increasing the importance of the grass component of the community over the short term. At a site in Idaho, for example, prescribed fire in a sagebrush community generally supported increased grass cover for about 12 years, until shrubs regained their importance (Harniss and Murray 1973). Sagebrush regained its dominance after 30 years. Provided the site does not have a large component of non-native species, a prescribed fire would not alter the community over the long term. Repeated fires in less than 30- to 50-year cycles would generally adversely affect native communities by interfering with the cycle of plant succession, eventually reducing the dominance of sagebrush on the site, although mountain big sagebrush can be burned at intervals less than 30 years and still thrive.

On sites with a large component of invasive annual grasses, prescribed fires would likely negatively affect sagebrush communities by helping to maintain the dominance of downy brome, which outcompetes seedlings of most native perennial species on sites that have been burned. Once established, downy brome increases the frequency of fires and the uniformity with which they burn the landscape, thereby precluding the establishment of sagebrush and other perennial shrubs and grasses (Moseley et al. 1999).

Evergreen Woodland. It is believed that fire was the most important natural disturbance in pinyon-juniper woodlands before the introduction of livestock in the 19th century (Gottfried et al. 1995). It is estimated that small surface fires historically occurred every 10 to 30 years (Leopold 1924) Large, stand-replacing fires occurred every 100 to 300 years (Paysen et al. 2000). Fires apparently restricted the junipers to shallow, rocky soils and rough topography (Arend 1950, Burkhardt and Tisdale 1969, O'Rourke and Ogden 1969). Under natural fire cycles, the successional stages following fire are typically annuals; mixed annuals and perennials; perennial forb; grass and shrub; shrub and pinyon-juniper; and climax pinyon-juniper. On sites with frequent fire, pinyon-juniper communities are rarely dominant, because pinyon pines and juniper trees are killed by fire when they are young. Older stands may be less susceptible because trees have thicker bark and more open crowns. On sites where pinyon pines and juniper trees become dense and canopies overlap or canopy gaps are small. Competition from trees usually causes a loss of the shrub and herbaceous layer, making the site less capable of carrying fire, or of supporting a fire of sufficient intensity to carry into the crowns of the trees.

TABLE 4-6
Plant Communities and Their Tolerance to Fire (based on interval between fire and recovery)

Level of Tolerance[1]	Plant Communities
Tolerant	Tallgrass prairie Northern mixed prairie Southern mixed prairie Chaparral Palouse prairie Oak woodland Mesquite-acacia woodland
Moderate tolerance	Shortgrass prairie California annual grassland Pinyon-juniper Mountain shrub
Low tolerance	Desert Alpine tundra Arctic tundra Semidesert grasslands Subarctic forests

[1] Tolerant = Interval between fire and recovery is 2-5 years; Moderate tolerance = Interval between fire and recovery is 5-15 years; Low tolerance = Interval between fire and recovery is 20+ years.
Source: Payne and Bryant (1988).

The effect of fire on pinyon-juniper communities would depend on the successional stage and species composition of the site. Pinyon-juniper communities that are regarded as "invasive" are those in which trees have established, or densities have increased as a result of fire exclusion, and in which pinyons and junipers outcompete herbaceous species for soil moisture and nutrients, altering the community structure. In many of these cases, pinyon-juniper woodlands have expanded into grassland and shrub-steppe/sagebrush habitats. Burning of these encroaching woodlands would benefit the plant communities that they have invaded.

Typically, the response of native understory species to fire is rapid and vigorous when the canopy cover of the pre-burned site is relatively open (Huber et al. 1999). Burning of sites with this amount of canopy coverage that are relatively undisturbed by human activities and non-native species could have a long-term positive effect by mimicking natural fire, opening up the site, and reducing accumulated fuel loads. However, in pinyon-juniper stands with over 40% canopy cover, post-fire succession would be reduced because of reduced numbers of understory plants capable of resprouting, and depleted seed reserves, negatively affecting native plant communities by allowing weeds such as downy brome to invade if the site is not reseeded.

Although a primary goal of fire treatments would be to utilize light burns to return dense pinyon-juniper communities to an earlier successional stage, adverse effects to native communities could occur if site conditions were not considered. For example, regrowth of native understory vegetation can be enhanced on sites with high soil moisture (Everett and Ward 1984) and restricted under dry conditions, such as drought (Paysen et al. 2000). An older stand of junipers with minimal understory diversity will recover differently than a younger stand with a highly diverse understory (Bunting 1984). Regrowth of native shrubs and grasses is unlikely to occur if these understory species are not present on the site prior to the burn. If downy brome or other undesirable species are present on the site, however, these species can increase in dominance after a fire treatment. Very hot fires, in particular, can seriously slow initial succession of desirable species (Bunting 1984). Use of fire treatments in areas where fire has been excluded could potentially increase fuels and associated fire risk on a site if fire-adapted annuals such as downy brome are present to spread into the treated site. Use of other treatment methods and/or

TABLE 4-7
Trees, Their Fire Resistance, and Their Ability to Regenerate after Fire[1]

Species	Ability to Regenerate after Fire	Size when Fire Resistance Gained[2]	Fire Resistance at Maturity
Pines			
Jack pine	None[3]	None	Low
Jeffrey pine	None	Pole	High
Longleaf pine	Root crown	Seedling[4]	High
Pinyon pine	None	None	Low
Pitch pine	Root crown, stump sprouts	Mature	Medium
Ponderosa pine	None	Sapling/pole	High
Red pine	None	Pole	Medium
Rocky Mountain lodgepole pine	None	Mature	Medium
Shortleaf pine	Root crown	Sapling[4]	High
Western white pine	None	Mature	Medium
Whitebark pine	None	Mature	Medium
Firs			
Balsam fir	None	None	Low
Douglas-fir	None	Pole/mature	High
Douglas-fir, Rocky Mountain	None	Pole	High
Grand fir	None	Mature	Medium
Noble fir	None	Mature	Medium
Pacific silver fir	None	None	Low
Subalpine fir	None	None	Very low
White fir	None	Mature	Medium
Junipers			
Eastern red cedar	None	None	Low
Oneseed juniper	None	Mature	Low/medium
Utah juniper	None	Mature	Low/medium
Western juniper	None	Mature	Low/medium
Other Conifers			
Alaska cedar	None	None	Low
Black spruce	None	Mature	Low/medium
Blue spruce	None	None	Low
Engelmann spruce	None	None	Low
Sitka spruce	None	None	Low
Tamarack	None	Mature	Medium
Western hemlock	None	None	Low
Western larch	None	Pole	High
Western red cedar	None	Mature	Medium
White spruce	None	Mature	Medium
Oaks			
California black oak	Root crown, stump sprouts	Mature	Low/medium
Canyon live oak	Root crown, stump sprouts	Mature	Medium
Gambel oak	Root crown, roots	None	Low
Oregon white oak	Root crown, stump sprouts	Pole	Medium
Post oak	Root crown, stump sprouts	Mature	Low/medium
White oak	Root crown, stump sprouts	Mature	Low/medium

TABLE 4-7 (Cont.)
Trees, Their Fire Resistance, and Their Ability to Regenerate after Fire[1]

Species	Ability to Regenerate after Fire	Size When Fire Resistance Gained[2]	Fire Resistance at Maturity
Other Hardwoods			
Aspen	Roots, root collar	Mature	Low/medium
Bigleaf maple	Root crown, stump sprouts	None	Low
Honey mesquite	Root crown, roots	None	Very low
Pacific madrone	Root crown	None	Low
Paper birch	Root collar	None	Low
Red alder	Stump sprouts	Mature	Low/medium
Red maple	Root crown, stump sprouts	Mature	Low/medium
White ash	Root crown, stump sprouts	None	Low

[1] The ratings of physical attributes are relative among the range of conditions observed for all tree species based on reviews of the literature.
[2] Sizes are defined as follows: seedlings = < 1 inch diameter at breast height [dbh]; saplings = 1-4 inches dbh; pole = 5-10 inches dbh; and mature = > 11 inches dbh. This is the size when medium or high fire resistance is gained.
[3] This species has serotinous cones and regenerates by seed following fire.
[4] For seedlings (longleaf and shortleaf pines) and saplings (shortleaf pine), shortleaf pine is a fairly strong sprouter and longleaf pine is a weak sprouter.
Source: Miller (2000).

reseeding after treatments would likely be necessary at these sites.

Mechanical methods of clearing pinyon-juniper woodlands are increasingly expensive, but prescribed fire is an economical alternative. The method used in Arizona is to ignite the crowns from prepared fuel ladders of cut lower limbs that are piled around the base of the tree. Ladders are ignited one season after the limbs are cut. In denser stands, fire spreads into the crown layer and through the stand from fuel ladders that are created below strategically placed trees. A method used in central Oregon on sites converted to juniper from sagebrush/grass is to conduct prescribed fires several years after cutting trees. The increased production of herbaceous vegetation following cutting provides fuels to carry the fire, which reduces residual slash and kills juniper seedlings (Paysen et al. 2000).

Research in the Great Basin suggests that fire is most effective on sites with scattered trees (9% to 23% cover) where the trees begin to dominate the understory and in dense stands (24% to 35% cover; Bruner and Klebenow 1979), because there is enough fuel to carry the fire, and enough understory vegetation to rapidly revegetate the site. Dense stands where pinyon pine is more common than juniper are easier to burn than pure juniper stands (Wright et al. 1979). Bunting (1984) indicated that burning of western juniper stands in southwestern Idaho was only successful during the mid-August to mid-September period; burning in the fall did not achieve desired results because of low temperatures, low wind speeds, and lack of fine fuels. Prescribed fire can be used in previously treated areas to control new tree regeneration. This technique is most effective if the area is ungrazed for one or two seasons prior to burning (Paysen et al. 2000).

Subtropical Desert Ecoregion. About 2% of fire treatments would occur in the Subtropical Desert Ecoregion, predominately in evergreen shrubland and perennial grassland communities. About half of the acres would be treated to reduce hazardous fuels, and half would be treated to improve watershed functions.

In many areas of the Mojave and Sonoran deserts, plant communities are too sparse during most years to adequately carry a prescribed fire. Therefore, this type of treatment would not be suitable for these areas. In areas that have increased fuel loading as a result of invasive annuals like downy brome, prescribed fire would negatively affect plant communities by encouraging the further spread of these invasive species. In the denser desert shrublands, where there is an adequate amount of fuel to support a fire, many shrubs, trees, and cacti could be severely affected by burning, as these species are not adapted to fire. Paloverde, burroweed, bursage, broom snakeweed, ocotillo, and creosote bush are examples of desert species that can

TABLE 4-8
Generalized Influence of Selected Brush Control Treatments on Vegetation.

Vegetation Control Method	Influence on Vegetation	
	Woody Plants	Grasses and Forbs
Fire	Short-term reduction in woody plant canopies and some woody plants often rapidly regrow.	Varies, but short-term decrease in herbaceous cover; fine mulch consumed; and there may be flush of herbaceous growth the first growing season because of increase in available nutrients.
Mechanical		
Top removal		
Shredding	Removes top ground and many species regrow vigorously.	Grass cover increases, but improvement may be short term.
Roller chopping	Generally the same as for shredding.	Generally the same as for shredding.
Hand slashing	Generally the same as for shredding.	Generally the same as for shredding.
Entire plant removal		
Grubbing	Individual plants extracted and little or no regrowth. Removes rhizomatous and stump-sprouting species.	General increase in herbaceous species.
Bulldozing	Removes stumps and large trees. Individual plants extracted; little or no regrowth. Small or limber plants may remain. Does not control rhizomatous and stump-sprouting species. Not suited for shallow or rocky soils. Least efficient clearing method.	Grass cover increases in interspaces; forbs increase in disturbed areas; and weeds may appear initially, but should revegetate to perennials.
Chaining/cabling	Large woody plants extracted. Small or limber plants remain. Thins or clears dense extensive mature trees stands. Most economical tree-felling method.	Grasses and forbs generally increase.
Root plowing	Woody plants removed by severing below ground line. Controls stump-sprouting species on large areas.	Grasses may be reduced and short-term increase in forbs.
Disk plowing	Thins or clears dense extensive mature shrub stands. Large woody plants extracted. Small or limber plants may remain.	Grasses are reduced and short-term increase in forbs.

Source: USDI BLM (1991a) and Payne and Bryant (1998).

suffer high mortality rates from burning (Wright and Bailey 1980).

Although fires would negatively affect desert shrublands, they would likely be beneficial in areas where fire suppression and/or overgrazing have resulted in the invasion of shrubs into desert grassland communities. The elimination of shrubs from these areas would encourage the return of native grass-dominated communities.

Fire as a management tool for controlling mesquite has its limitations. Mesquite may become more prevalent 5 years following a burn than it was before fire (Martin 1983). Mesquite can root sprout; top-killed individuals may resprout from dormant buds found in upper branches or from the base of the trunk below the ground surface. Mesquite seedlings can survive fire (Cable 1961), but on a burned site mesquite is sometimes reduced (Wright 1980). Fire may kill a good proportion of mature mesquite, particularly the smaller trees (<2 inch diameter; Cable 1949, 1973). It is most susceptible to fire during the hottest and driest part of the year (Cable 1973). Drought years may increase mortality of mesquite if eradication is attempted.

Low-intensity fire may allow mesquite to retain apical dominance on upper branches while reducing overall foliage. Single and repeated summer burns kill mesquite aboveground, but do not kill roots (Ansley et al. 1995). Prescribed burning may be used to kill mesquite seedlings while leaving tree sized and

TABLE 4-9
Percentage of Acres Projected to be Treated using Fire in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregions	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	6	0	0	7	57	1	1	4	22
Deciduous forest	2	0	0	0	0	0	0	3	4
Mixed evergreen/deciduous forest	1	0	0	0	<1	0	0	1	4
Evergreen woodland	19	0	0	92	30	0	15	16	19
Deciduous woodland	<1	0	0	0	3	0	<1	<1	0
Mixed evergreen/deciduous woodland	<1	0	0	0	<1	0	0	0	0
Evergreen shrubland	48	0	0	0	3	53	37	69	28
Deciduous shrubland	12	0	100	0	0	9	0	<1	0
Evergreen dwarf-shrubland	<1	0	0	0	0	0	0	<1	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	6	0	0	1	0	12	46	<1	16
Annual graminoid or forb	2	0	0	0	6	0	0	2	0
Perennial forb	<1	0	0	0	<1	0	<1	<1	0
Riparian/wetland	<1	0	0	<1	<1	<1	1	<1	0
More than one subclass	5	0	0	0	<1	25	0	6	7
Total for all ecoregions	100	0	12	2	5	2	9	63	7

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

shaped older individuals, preventing mesquite density from increasing.

Temperate Steppe Ecoregion. Seven percent of fire treatments would occur in the Temperate Steppe Ecoregion. Vegetation types that would likely receive fire treatments include evergreen forests, evergreen shrubland, and perennial graminoid communities.

Perennial Graminoid. Prescribed fire could have either positive or negative effects on plains grasslands of the Temperate Steppe Ecoregion, depending on its timing and severity. In some areas, use of infrequent, low severity fires could benefit grasslands by preventing the encroachment of woody species. Some shrubs, however, would be difficult to control using fire. Honey mesquite and sand shinnery oak, for example, both have the ability to resprout vigorously after fire (Wright and Bailey 1980). In addition, fires may not reach high enough to kill taller shrubs that are encroaching into shortgrass habitats.

Frequent or severe fires could harm plains grasslands communities by removing vegetative cover and facilitating erosion. These effects would be exacerbated during periods of drought, when wind erosion can retard the process of succession. Prairie grasses would also take longer to recover from fires occurring during dry years than from fires occurring during years with above-normal precipitation. For example, buffalograss, annual bluegrass, and western wheatgrass can take 3 or more years to recover from burns during dry periods (Wright and Bailey 1980). However, during years with precipitation that is above-normal, these grass species can be very tolerant of fire (Wright 1974).

In mountain grassland communities, where fire has been actively suppressed, prescribed fires could be beneficial by removing encroaching woody species such as ponderosa pine, Douglas-fir, lodgepole pine, and sagebrush. Frequent or severe fires could harm Idaho fescue, which can withstand burning under some conditions, but recovers slowly from fire when killed because it has to rely on its seedbank for recovery. Needlegrasses can also be severely damaged by fire. Burning when soils are moist would be expected to result in the least amount of harm to native grass species in mountain grassland communities.

Evergreen Forests. Open forest types (e.g., ponderosa pine, Douglas-fir, and western larch) would likely benefit from low-intensity prescribed fires, which would reduce the density of understory shrubs and tree seedlings, and encourage vigorous and abundant herbaceous vegetation. In areas with substantial fuel accumulations, pre-treatment fuel reductions would be necessary in order to avoid high-intensity stand-replacing fires. Such high-intensity fires, much like stand-replacing wildfires, would harm these forest communities by damaging the dominant overstory tree species and cause soil damage, long-term structural conversion to brush, and loss of biodiversity (Brown and Smith 2000).

Failed attempts to restore more natural stand conditions with prescribed burning alone may result from inappropriate use of fire as a selective thinning tool in dense fire-excluded stands, or from burning too little or too much of the accumulated forest floor fuels. A better approach to the latter problem may be to apply two or even three burns to incrementally reduce loadings (Harrington and Sackett 1990). Once a semblance of the desired stand and fuel conditions have been established, stands can thereafter be maintained with periodic burning or a combination of cutting and fire treatments. Prescribed fire can be used in wilderness and natural areas to maintain natural processes.

Forests dominated by aspen often occur as interspersed or extensive stands within the evergreen forests of the Rocky Mountains. Fire exclusion has threatened the continued existence of aspen by allowing conifer seedlings to increase in dominance. The return of fire disturbances to aspen forests would stimulate their regeneration. Low severity fires kill conifer seedlings and thin aspen to encourage all-aged stands, while high severity fires result in new even-aged stands (Duchesne and Hawkes 2000). However, it is often difficult to get fires to carry in aspen stands under conditions that would support low severity fires. Fires in aspen stands often cannot occur until a large number of conifers are present.

Subtropical Steppe Ecoregion. Approximately 9% of fire treatments would occur in this ecoregion. Vegetation types that are proposed for vegetation treatments include perennial graminoid communities, evergreen shrublands, and evergreen woodlands. Treatments would focus on reducing hazardous fuels, improving conditions in the WUI, and controlling weeds.

Perennial Graminoid. The xerophytic grasslands of the Subtropical Steppe Ecoregion support sparse shrubs and low trees, and exist on a continuum with evergreen woodlands (described below). The common plant species of Subtropical Steppe grasslands would show a variety of responses to fire.

Fire may stimulate or damage grasses, depending on climatic conditions, season, and fire severity (Brown and Smith 2000). In addition, perennial grasses are mildly to severely harmed by fires during dry years, but quickly recover during wet years (Wright and Bailey 1980). Although bunchgrass species vary in their individual susceptibility to fire damage, repeated fires at intervals of about 5 to 40 years historically maintained the bunchgrass community. Encroachment into grasslands by woody species was an ongoing process kept in check by repeated fires (Gruell et al. 1986).

Evergreen Shrubland. Chaparral shrub species in the Subtropical Steppe Ecoregion are fire-dependent and comprised of highly flammable species, and sites recover rapidly after fire (Brown and Smith 2000). The production of dead fuels in chaparral stands is not well understood, but probably increases with age and after a drought. Fuels in chaparral communities are not as easily ignited as grass fuels, but will burn readily under hot, dry conditions.

Prescribed burns in chaparral communities would be expected to benefit these communities, provided fires were not too frequent or too hot, by reducing fuel accumulations and increasing structural diversity (Paysen et al. 2000). Typically, the aboveground shrub biomass would be killed by fire, but many species (e.g., scrub oak, leather oak) are deep rooted and would sprout readily from the root crown after burning (D.E. Brown 1982). The seeds of many species can withstand high soil temperatures (Agyagos et al. 2001). After prescribed fire, early successional herbaceous plants, especially annual grasses and forbs, would initially be abundant, but shrubs would dominate the site again after about 4 years. Too-frequent fires could negatively affect chaparral habitats by damaging young or resprouting shrubs before they became reproductively mature, thus depleting the seedbank. These alterations in the fire cycle could cause the typically dominant chaparral shrubs to be outcompeted by herbaceous vegetation. In addition, some chaparral communities have accumulated so much fuel that the severity of a prescribed fire in these areas would be much larger than that of historical fires, potentially causing excessive damage to chaparral communities and requiring a long recovery time. Burning during a drought would also increase the severity of a fire in chaparral stands.

Individual shrubs can be killed outright by fire, and shrubs lacking in vigor will probably not respond to fire normally. Thus, stresses such as drought might cause an unexpected effect if fire were to be introduced. An extremely severe fire can result in little reproduction from either sprouting or seed germination. A series of fires with short return intervals may result in reduced chaparral shrub density if shrubs burn before they reach seed-bearing age, or if young shrubs developing from sprouts are physiologically unable to respond (Paysen et al. 2000).

Evergreen Woodland. The general effects of fire on pinyon-juniper woodlands in this ecoregion would be largely the same as the effects on pinyon-juniper woodlands in the Temperate Desert Ecoregion. There would be benefits to surrounding communities being invaded by pinyons and juniper trees, and potentially negative effects to communities with a large component of non-native species, or in pinyon-juniper stands with over 40% canopy cover (Paysen et al. 2000).

Mediterranean Ecoregion. Fire treatments in the Mediterranean ecoregion would be directed at evergreen forest and evergreen woodland. About 5% of fire use would occur in this ecoregion, and treatments would support efforts to improve forest health and reduce hazardous fuels.

Evergreen Forest. Evergreen forests in this region historically had an understory fire regime or a mixed severity fire regime, and are presently at risk for high-intensity, stand-replacing crown fires due to large fuel accumulations. Suppression of the mixed patchy fires in high elevation forests may eventually result in a landscape mosaic consisting largely of contiguous stands with comparatively heavy loadings of dead trees (standing and fallen) and canopy fuels. Prescribed fire treatments could benefit these forests by creating open, early successional conditions, reducing hazardous fuel loads, and improving forest health (Arno 1988). In addition, open forest types could benefit from understory burns, as discussed under evergreen forests the Temperate Steppe Ecoregion. In many cases, pre-treatment fuels reductions (e.g., thinning and pile burning) would be necessary to reduce the severity of prescribed burns. High severity or too-frequent fires could kill overstory species and reduce post-fire recovery rates, altering the species composition of forests over the long term. Fire history and experience burning in white fir types suggest that understory burning might be useful in some California red fir/lodgepole forests (Petersen and Mohr 1985; Weatherspoon 1990).

Evergreen Woodland. In recent centuries, fire regimes in western oak forests were characterized by frequent, low intensity fires. This was probably due to use of these areas by Native Americans, who probably carried out programs of frequent underburning. Frequent, low intensity fires helped to maintain open stands with a grassy understory. In the last half of the 20th century, higher severity fires at longer intervals were more common. Such fires can kill a stand of oaks outright (Brown and Smith 2000), although most oaks will resprout after fire if the underground portions of the plant are still alive (Plumb 1980). Because conditions in oak woodlands have changed significantly since historic fire regimes, there are many concerns surrounding the use of prescribed fire in these systems. Reintroduction of low severity fire into these communities could benefit them by killing young oaks and other woody species, restoring the open conditions that these ecosystems historically supported. Large oaks would be unlikely to be harmed during a low severity fire. A high severity wildfire, however, could kill much of an oak woodland's understory, increasing the recovery time of the community and potentially altering species composition.

Marine Ecoregion. Approximately 2% of fire treatments would occur in the Marine Ecoregion, primarily in evergreen woodlands and forests.

Evergreen Woodlands. Oak woodlands are maintained by frequent, low severity burning (Agee 1993). The effects of prescribed fire in these communities would be similar to those discussed for oak woodlands in the Mediterranean Ecoregion, above.

Evergreen Forest. Maritime forests are extensive at lower and middle elevations west of the Cascades and British Columbia Coast Range. The cooler, wetter, and more northerly portions of the coastal Douglas-fir type (generally associated with the mountains of western Washington and southwestern British Columbia) burned in stand-replacement fires at long intervals, averaging 200 to several hundred years (Agee 1993).

Western hemlock is the potential climax dominant tree, but seral Douglas-fir, which arose after replacement fires during the last several hundred years, is the actual dominant. The greater size and longevity of Douglas-fir allows it to persist in considerable quantities for 700 to 1,000 years between major stand-opening disturbances such as fire or severe blowdowns (Agee 1993). Scattered individual Douglas-fir survived fires and served as seed sources in the burn. Seeds of this species may also survive and mature in the crowns of some trees whose foliage was killed (but not consumed) by a late-summer fire. The seeds are also wind-dispersed from unburned stands. Douglas-fir seedlings grow readily on burned seedbeds and outcompete other conifers in the postburn environment.

Due to the great length of natural fire intervals, it is unlikely that significant successional changes have occurred in most of these forests (especially in Washington) as a result of attempts to exclude fire during this century. Large areas of these forests have been clearcut in recent decades, sometimes followed by broadcast burning. This has given rise to large areas of early seral communities dominated by native flora, often with planted Douglas-fir, which might offset a shortage of early seral communities resulting from natural fires. However, natural burns and clearcuts differ ecologically, for example, in seedbed preparation, in providing residual large woody debris, and in having an overstory of dead trees (Kauffman 1990).

Effects of Mechanical Treatments

Approximately 80% of mechanical treatments would occur in the Temperate Desert Ecoregion, and 7% and 5% would occur in the Temperate Steppe and Mediterranean ecoregions, respectively (Table 4-10). Forty-one percent of treatments would occur in evergreen shrubland and 18% in evergreen woodland communities. Drill seeding would be the most common method used, comprising a third of treatments; mowing and chaining would comprise 10% and 6% of treatments, respectively.

Mechanical treatments would injure or kill plants by removing some or all of the plant material on the treatment site. Undesirable vegetation and fuel loads would be targeted, with an overall goal of restoring ecosystem health. Mechanical treatments are typically selective and would minimize damage to non-target plants present at the treatment site.

Mechanical methods are effective in removing thick stands of vegetation, but have limited use for noxious weed control, unless followed up with herbicide treatments, because the machinery can spread seed and not kill roots.

Methods that remove entire plants by plowing or cutting roots would cause the most mortality to non-target plants, limiting their ability to recover without seeding. In many cases, revegetation would be required after treatments to ensure the recovery of the plant community and limit the invasion of the treated site by non-native species. Thus, mechanical treatments associated with revegetation, such as drill-seeding, would typically have both short-term and long-term positive effects by aiding in the recovery of native plant communities on a treated site. Methods that remove only aboveground plant biomass (e.g., mowing) would have few lasting effects on native plant communities, as non-target species would typically be able to recover quickly by resprouting.

Mechanical treatments would generally have the greatest effect on woody plant species, which typically take about 10 years or longer to recover and regain their dominance, depending on the effectiveness of control and the reproductive success of the species. Herbaceous plants would typically be more resilient to top-removal treatment methods, as many of these species die back annually. Growth of herbaceous plants often increases after mechanical treatments as a result of reduced competition with woody species for light, nutrients, and water (Cox et al. 1982). Treatments occurring during the growing period and prior to seed maturation and dispersal would have the greatest potential effects on herbaceous species.

The use of vehicles and other mechanical equipment could negatively affect native plant communities by bringing the propagules of non-native species into treatment sites and creating sites for weed establishment. In addition, repeated mechanical treatments, or treatments that remove large areas of vegetation, could adversely affect native communities by altering species composition.

Tundra Ecoregion. No mechanical treatments are proposed to occur in this ecoregion. However, if mechanical treatments were to occur in this ecoregion, effects to vegetation associated with mechanical equipment would depend on the type of equipment, the vegetation type, and whether or not snow was present. In general, low ground-pressure wheeled vehicles would have less effect on tundra than tracked vehicles or sleds on skids (USDI BLM 2005c).

The use of OHVs such as four-wheel vehicles and snowmachines could cause localized effects to tundra. Snowmachines used during the winter when the ground is frozen and there is adequate snow cover would have

TABLE 4-10
Percentage of Acres Projected to be Treated using Mechanical Methods in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregions	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	8	0	0	15	22	1	19	3	41
Deciduous forest	1	0	0	0	0	0	0	1	3
Mixed evergreen/deciduous forest	1	0	0	0	<1	0	0	0	1
Evergreen woodland	20	0	0	81	56	1	63	14	18
Deciduous woodland	<1	0	0	0	<1	0	1	0	0
Mixed evergreen/deciduous woodland	<1	0	0	0	<1	0	0	0	0
Evergreen shrubland	40	0	0	0	16	13	13	46	22
Deciduous shrubland	<1	0	0	0	0	16	0	<1	<1
Evergreen dwarf-shrubland	0	0	0	0	0	0	0	0	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	4	0	0	3	2	2	0	4	<1
Annual graminoid or forb	8	0	0	0	3	0	0	9	1
Perennial forb	<1	0	0	0	0	0	<1	<1	<1
Riparian/wetland	<1	0	0	<1	<1	6	0	<1	0
More than one subclass	18	0	0	0	1	60	4	21	14
Total for all ecoregions	100	0	0	4	5	1	3	80	7

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

little or no effect to the vegetation. However, heavy use of a trail could cause compaction of vegetation. In addition, the use of snowmachines during fall or spring or in areas without adequate snow cover could result in damage to the vegetative mat leading to thermokarst. Similarly, use of four-wheel vehicles on tundra could disrupt the vegetation and churn soil in the upper portion of the profile, leading to thermokarst in wet tundra and damage or death of plants in drier areas. The use of airboats in shallow marsh areas could also affect vegetation and soil, although if confined to the river channel, airboats would have no effect on vegetation.

Subarctic Ecoregion. No mechanical treatments are proposed to occur in this ecoregion. If mechanical treatments did occur, they would occur predominantly in mixed evergreen/deciduous forests and evergreen forests. Treatments would involve thinning of spruce, aspen, and poplar forests to reduce hazardous fuels, particularly in the WUI. Treatments would be expected to improve the health and vigor of overstory trees by reducing competition for nutrients and water from dense understory vegetation. Thinning would increase light availability to understory vegetation and encourage early-successional, light-dependent species. The overall effect of understory thinning treatments would be positive, as it would reduce the risk of future stand-replacing fires, and make the treated area more suitable for supporting fire treatments that mimic the historical fires in these forests.

Temperate Desert Ecoregion. An overwhelming majority of the proposed mechanical treatments would occur in the Temperate Desert Ecoregion, in evergreen shrubland (sagebrush) and evergreen woodland (pinyon-juniper) communities.

Evergreen Shrubland. Most of the mechanical treatments in evergreen shrubland would involve tilling or plowing of sagebrush, followed by seeding or drilling. Other mechanical treatments, such as mowing, chopping, and chaining, would be used to a lesser extent. Treatments would target woody species (e.g., big sagebrush, rabbitbrush, and greasewood), with the goal of encouraging certain species of perennial bunchgrasses, forbs, and shrubs. Plowing would be used in areas with little herbaceous understory, where soil disturbance would help prepare the seedbed for revegetation.

After treatment, there would be a temporary reduction in overall shrub cover, including both undesirable species (e.g., rabbitbrush, horsebrush, and greasewood) and desirable species (e.g., bitterbrush, cliffrose, and western serviceberry). In addition, the understory composition and environmental conditions of the treatment site would determine which herbaceous species would increase in cover following treatments. Overall grass production generally doubles after sagebrush removal, because the cover of sagebrush is reduced and soil nutrient and water availability is increased (Sturges 1975, USDI BLM 1991a).

Mechanical treatments that do not uproot vegetation would have little overall effect on plant species composition. However, compositional changes to overstory shrub species may occur, as certain shrub species are more adapted to this type of disturbance and would resprout readily, while others must reseed themselves from shrubs that survive treatment or from adjacent areas. Mowing treatments would favor herbaceous species rather than shrubs. However, mowing is generally not considered to be useful for long-term control of sagebrush, as the effects last less than 5 years (Davis 1982) and in general little overall effect on plant species composition would be expected in the long term. Mowing treatments are useful in improving the structural diversity of sagebrush stands.

Herbaceous species present on the site prior to treatment would uniformly increase in abundance, and some species of shrubs would resprout fairly quickly. Undesirable species on the site would be unlikely to decrease in abundance, and could be favored by quickly taking advantage of the resources released by the removal of shrubs. Methods of uprooting vegetation, such as plowing and disking, would be more likely to alter the species composition of sagebrush communities. Plowing would typically result in 70% to 90% sagebrush mortality, which would generally be higher in summer, when the soil is dry and firm, than during the spring, when the soil is moist and compactable (Cluff et al. 1983). However, plowing, when used alone, is not an effective method of controlling sagebrush, which is capable of reseeding rapidly, and could eventually result in greater canopy coverage of sagebrush than was present on the site prior to treatment (Wambolt and Payne 1986).

Although the use of mechanical treatments in evergreen shrublands would have some benefit to herbaceous species over the short term, these methods could have adverse effects to native communities over the long term if used inappropriately. For example, repeated control of sagebrush through methods such as plowing would eventually alter the species composition of native plant communities, especially if revegetated with seed mixtures, which may only contain seeds for a small portion of the herbaceous species native to the site. Furthermore, mechanical treatments would not adequately mimic the fire disturbance regime of sagebrush communities. In most cases, mechanical treatments would need to be combined with other types of treatments in order to avoid adverse effects to native plant communities.

<u>Evergreen Woodlands</u>. Mechanical treatments in pinyon-juniper woodlands would primarily consist of thinning and machine piling of debris, as well as chipping/shredding and chaining to reduce the occurrence of pinyon and juniper species. In some instances, trees might be cut and removed from the site. As a result of tree removal, many native perennial grass species, forbs, and shrubs would increase on the site (Clary 1971, Jacobs and Gatewood 1999). Therefore, successful treatments would benefit native plant communities. However, partial removal of trees would not have lasting benefits to native communities, and benefits would be minimal on sites where low precipitation or shallow soils limit revegetation of understory species. In addition, mechanical treatments on sites with a large component of non-native herbaceous species could result in increased dominance of these undesirable species. Pinyon-juniper sites that are mechanically treated would have to be retreated fairly often, as small trees and seedlings often survive these treatments and may rapidly regrow once free from competition.

Temperate Steppe Ecoregion. In the Temperate Steppe Ecoregion, mechanical treatments would likely occur in evergreen forest, evergreen shrubland, and evergreen woodland communities.

<u>Evergreen Forest</u>. Mechanical treatments in forest communities would largely consist of treatments to reduce tree density, remove ladder fuels, reduce crown bulk density, and alter tree species composition in favor of fire-resilient species. In forests where fires have been suppressed, mechanical treatments could create openings in the canopy usually caused by fire, increasing the germination of grasses in open forests (e.g., ponderosa pine) and of shade-intolerant tree species in more closed forests (e.g., aspen). These disturbances could benefit evergreen forests by

returning the treated site to an earlier successional stage, thereby mimicking the historical role of fire.

Improvement cutting, thinning, and understory cutting with whole-tree removal or pile burning may be necessary to achieve open stocking levels that will sustain vigorous tree growth and to reduce ladder fuels (Fiedler et al. 1996). Harvesting and thinning should be designed to retain the most vigorous trees. If stems are tall and slender, as in dense second growth stands, it may be necessary to leave clumps of three to five trees for mutual protection against breakage by wet snow and windstorms. The restoration cutting process may require thinning in two to three steps over 15 to 20 years. Spot planting of the desired seral tree species in open burned microsites can be used when shade-tolerant species have taken over.

Evergreen Shrubland. The general effects of mechanical treatments on sagebrush communities in this ecoregion would be largely the same as the effects on sagebrush communities in the Temperate Desert Ecoregion. However, plant communities in the Temperate Steppe Ecoregion would generally experience more rapid and favorable rates of recovery following treatments due to the greater precipitation that falls in this region compared with the Temperate Desert Ecoregion.

Removal of shrubs using techniques that cut only aboveground portions of vegetation would result in very little change to plant communities, as shrub species would rapidly resprout from buds in the base, rhizomes, or roots (Cable 1975). Techniques that uproot vegetation, however, would favor pioneer species. Given the lack of an undeveloped understory, the spread of weeds into these communities would be encouraged. Shrubs would also return from seeds, favoring species that do not require fire to germinate. Therefore, these treatments would be likely to affect native plant communities by altering their species composition over the long term.

Evergreen Woodland. The general effects of mechanical treatments on pinyon-juniper woodlands in this ecoregion would be largely the same as the effects on pinyon-juniper in the Temperate Desert Ecoregion, except they would be less limited by moisture availability.

Subtropical Steppe Ecoregion. In the Subtropical Steppe Ecoregion, mechanical treatments would likely occur in evergreen woodland and evergreen forest communities.

Evergreen Woodland. The general effects of mechanical treatments on pinyon-juniper woodlands in this ecoregion would be largely the same as the effects on pinyon-juniper in the Temperate Desert Ecoregion. The warmer and wetter conditions in the Subtropical Steppe Ecoregion would likely result in more favorable vegetation response following treatment compared to similar vegetation types in the Temperate Desert Ecoregion.

Evergreen Forest. The general effects of mechanical treatments on evergreen forests in this ecoregion would be largely the same as the effects on evergreen forests in the Temperate Steppe Ecoregion.

Subtropical Desert Ecoregion. In the Subtropical Desert Ecoregion, some mechanical treatments are likely to occur in evergreen and deciduous shrublands. Mechanical treatments could increase the cover of annual weeds, such as halogeton and Russian thistle, thereby adversely affecting native plant communities. Because of the extremely low and irregular rainfall of this region, it would be difficult to revegetate native species after widespread treatments (Bleak et al. 1965; Jordan 1981; Cox et al. 1982; Blaisdell and Holmgren 1984; Roundy and Young 1985). Reestablishment of perennial vegetation, in particular, may require successive years of unusually high precipitation. Therefore, mechanical treatments, because of their large area of influence, could have longer-lasting effects to native plant communities in the Subtropical Desert Ecoregion than to plant communities in the other ecoregions receiving treatments.

Mediterranean Ecoregion. In the Mediterranean Ecoregion, mechanical treatments would likely occur in evergreen woodland, evergreen forest, and evergreen shrubland communities.

Evergreen Woodland. Some changes in understory species composition could occur as a result of mechanical treatments, as certain species would respond favorably to mechanical treatments, and others would not. Finally, the use of heavy equipment in oak woodlands could negatively affect oaks. The shallow root systems of oaks could be physically damaged by heavy equipment.

Evergreen Forest. The general effects of mechanical treatments on evergreen forests in this ecoregion would be largely the same as the effects on evergreen forests in the Temperate Steppe Ecoregion.

Evergreen Shrubland. The general effects of mechanical treatments on chaparral communities in this ecoregion would be largely the same as the effects on chaparral in the Temperate Steppe Ecoregion.

Marine Ecoregion. In the Marine Ecoregion mechanical treatments would likely occur in evergreen woodland and evergreen forest communities.

Evergreen Woodland. The general effects of mechanical treatments on oak woodlands in this ecoregion would be largely the same as the effects on oak woodland in the Mediterranean Ecoregion.

Evergreen Forest. The general effects of mechanical treatments on evergreen forests in this ecoregion would be largely the same as the effects on evergreen forests in the Temperate Steppe or Mediterranean ecoregions. However, evergreen forests in the Marine ecoregion would likely recover more quickly from mechanical treatments due to the more abundant rainfall in this region.

Effects of Manual Treatments

Over half (53%) of manual treatments would occur in the Temperate Desert Ecoregion, and one-quarter of treatments in the Mediterranean Ecoregion. A third of manual treatments would occur in evergreen forest, 23% in evergreen woodlands, and 9% in evergreen shrublands (Table 4-11).

Manual treatments would generally benefit native plant communities on public lands, without the risks of adverse effects to non-target species associated with most of the other treatment methods. Manual methods are highly selective, causing injury and mortality only to target plants/fuels, and because of their high cost, would only be used in limited areas where other treatment methods were not feasible. Most of the manual treatments would occur in evergreen shrublands and woodlands of the Temperate Desert Ecoregion, and in evergreen forests of the Mediterranean and Marine ecoregions. Manual treatments in evergreen forests would consist primarily of hand thinning by chainsaws to reduce stand densities and reduce hazardous fuels, and pruning to reduce ladder fuels. In all ecoregions and vegetation types, manual treatments could result in small amounts of trampling or accidental removal of non-target plants, particularly since repeated treatments are often required to prevent the reestablishment of aggressive weeds. There would also be minor risks associated with spilling oil and fuels from hand-held equipment, such as chainsaws, which could kill or harm plants. The overall effects to native communities, however, would be minimal and short term in duration.

Effects of Biological Treatments

Nearly 90% of biological control treatments would occur in the Temperate Steppe (48%) and Mediterranean (40%) ecoregions (Table 4-12). Over half of treatments would control annual grasses or forbs (e.g. medusahead and yellow starthistle) and 25% of treatments would control perennial forbs (e.g., some knapweeds, some thistles, leafy spurge, purple loosestrife, and dalmatian toadflax).

Containment by Domestic Animals. About two-thirds of the acres to be treated using biological methods would be subject to grazing by animals. These treatments would generally occur in herbaceous communities (annual and perennial grassland and perennial forb communities) that have significant weed infestations.

Domestic animals would likely affect non-target vegetation by browsing and trampling/kicking up plants. The extent of effects to non-target vegetation would depend on the animal species used, the plant species' tolerance to grazing, management of the grazing system (i.e., timing, area, intensity, frequency, and duration), and the site's pre-treatment condition and disturbance history. Different types of livestock have different food preferences. Sheep and goats typically prefer broadleaved forbs, although sheep will generally consume more grass than goats (Walker et al. 1994). Cattle prefer grasses (Olson 1999). These diet preferences could result in alterations to plant species composition after prolonged periods of grazing.

Many weed species are of poor forage quality and have low palatability due to toxins, spines, and distasteful compounds, which would cause domestic animals to avoid them in favor of native plant species. The effects of grazing would be greatest when conducted before plants have produced seed (resulting in reduced reproductive capacity), during times of drought or stress, or if conducted repeatedly.

Because of the numerous factors involved in determining the extent of effects to native plant communities from grazing, the BLM's grazing management systems would be required to involve the right combination of animals, timing, and stocking density, and be carefully designed, managed, and monitored, in order to avoid effects to native plant communities on treatment sites (Olson 1999).

TABLE 4-11
Percentage of Acres Projected to be Treated using Manual Methods in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregion	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	32	0	0	89	86	0	3	2	34
Deciduous forest	<1	0	0	0	0	0	0	1	1
Mixed evergreen/deciduous forest	2	0	0	0	<1	0	0	1	2
Evergreen woodland	21	0	0	8	3	0	61	28	23
Deciduous woodland	<1	0	0	<1	0	0	0	0	0
Mixed evergreen/deciduous woodland	0	0	0	0	0	0	0	0	0
Evergreen shrubland	14	0	0	0	2	98	9	23	9
Deciduous shrubland	<1	0	0	0	0	<1	0	0	0
Evergreen dwarf-shrubland	0	0	0	0	0	0	0	0	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	10	0	0	2	<1	0	0	20	1
Annual graminoid or forb	<1	0	0	0	1	0	0	<1	0
Perennial forb	2	0	0	0	5	0	0	1	7
Riparian/wetland	2	0	0	2	2	1	26	1	<1
More than one subclass	15	0	0	0	<1	1	0	22	22
Total for all ecoregions	100	0	0	12	24	<1	4	53	7

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

The use of domestic animals could indirectly affect native plant communities by encouraging weed infestations as a result of soil disturbance, which creates sites for weed establishment, and by spreading propagules in fur or dung. For example, livestock have been a major contributor in the dissemination of mesquite seeds into mesquite-free areas (Archer 1995). Therefore, grazing treatments not confined to areas of high weed infestation could adversely affect the surrounding native plant communities, or other sites to which grazers were moved, by increasing the coverage of weeds within them.

Livestock could alter the nutrient cycling processes of native plant communities receiving grazing treatments by depositing organic nitrogen in urine and feces, and by mixing surface organic matter. In traditionally nitrogen-limited ecosystems, such as those found in the arid West, increased nitrogen could benefit native plants (LeJune and Seastedt 2001). However, most nitrogen-limited systems contain species that are adapted to low nutrient levels, and deposition of nitrogen could actually favor weeds that require high nitrogen concentrations to become established (Evans and Ehleringer 1993). High soil nitrogen could also assist in the spread of established weeds, such as downy brome and medusahead, by stimulating seed germination (Belsky and Gelbard 2000).

Significant biological control treatments are proposed for the annual graminoid/forb communities of the Mediterranean Ecoregion. Of note is a single large proposed grazing project. Because annual grasslands in California evolved in conjunction with heavy grazing regimes, grazing treatments would be unlikely to cause major changes to the vegetation communities that currently exist (Sims 1988).

Biological treatments would also be prevalent in the Temperate Steppe Ecoregion, spread over a number of vegetation types. Prominent treatments would include grazing in perennial graminoid/forb and riparian communities in Montana.

Biological Control Agents. The effects of insects and pathogens on native plant communities are difficult to assess, as they have not been well documented. In some cases, biological control agents can be very beneficial to plant communities with heavy weed infestations by reducing the vigor and dominance of their target weed species. For example, the release of flea beetles at one site was found to reduce densities of leafy spurge stems by 65% within 3 to 5 years after their release (Lym and Nelson 2000). Regardless of their degree of success in restoring degraded communities, the insects and pathogens approved for release under the proposed treatment programs would be unlikely to affect non-target species or cause any adverse effects to native plant communities. Biological control agents are tested extensively before being approved for field release to ensure host specificity (i.e., acting only on their target plants), and reports of extensive damage to non-target organisms are not widespread. However, the relationship between laboratory testing and field behavior is not always predictable, and there may be some potential risks to non-target plants. For example, a weevil released to control exotic thistles has also been observed to feed on native thistle flowerheads (Louda et al. 1997). Though adverse effects to native plant communities are not expected as a result of treatments using insects and pathogens, there would still be risks associated with unforeseen effects to these communities.

Release of insects would be prevalent in the Temperate Steppe Ecoregion in perennial graminoid and forb communities. Other plant communities currently scheduled to receive biological control treatments include perennial forb communities in the Temperate Desert Ecoregion, perennial graminoid communities in the Subtropical Desert and Marine ecoregions, and evergreen forests in the Subtropical Steppe Ecoregion. Biological treatments are not proposed for the Tundra or Subarctic ecoregions.

Effects of Chemical Treatments

The effectiveness of herbicide treatments in managing target plants and the extent of disturbance to native plant communities would vary by the extent and method of treatment (e.g., aerial vs. ground) and chemical used (e.g., selective vs. non-selective), as well as by local plant types and physical features (e.g., soil type, slope) and weather conditions (e.g., wind speed) at the time of application. Treatments would likely affect the plant species composition of an area and could affect plant species diversity. Species composition and species diversity are equally important contributors to ecosystem function (USDA Forest Service 2005). Because certain herbicides target certain types of plants (e.g., broadleaf species), an herbicide treatment program for a given ecosystem and area should include multiple types of herbicides. For example, if picloram or clopyralid were the only herbicides used in a highly invaded area, weedy annual grasses, such as medusahead, downy brome, and barbed goatgrass could begin to dominate. The following sections detail the possible effects of herbicide treatments on both target and non-target plants.

Over 70% of the treatment acres would be in the Temperate Desert Ecoregion, a much greater proportion than at present (Table 4-13). Sixteen percent of treatments would occur in the Temperate Steppe Ecoregion. Treatments in the Temperate Desert Ecoregion would primarily target sagebrush, rabbitbrush, and other evergreen shrubland species, and annual grass and perennial forb weeds, while those in the Temperate Steppe Ecoregion would focus on control of invasive annual and perennial grasses and forbs.

Non-target Plants. Herbicides could come into contact with and affect non-target plants through drift, runoff, wind transport, or accidental spills and direct spraying. Potential effects include mortality, reduced productivity, and abnormal growth. Risk to off-site plants from spray drift would be greater for applications with smaller buffer zones and from greater heights (i.e., aerial application or ground application with a high boom). Risk to off-site plants from surface runoff is influenced by precipitation rate, soil type, and application area. Most accidental scenarios (i.e., direct spray or spill) pose a risk to plant receptors. Persistent herbicides (e.g., bromacil) adsorbed to soil particles could also be carried off site by wind or water, affecting plants in other areas. Application rate is a major factor in determining risk, with higher application rates more likely to pose a risk to plants under various exposure scenarios.

Applications that would pose the greatest risk to non-target plant species, assuming SOPs were followed, are those with the greatest likelihood of off-site transport. The risk characterization process of the ERAs indicated that risk to typical terrestrial plants associated with off-site drift of bromacil, clopyralid, chlorsulfuron, dicamba, imazapyr, metsulfuron methyl, and triclopyr would be moderate to high. The risks to special status terrestrial plants associated with off-site drift of bromacil, clopyralid, chlorsulfuron, dicamba, diquat, diuron, imazapyr, metsulfuron methyl, sulfometuron methyl or triclopyr would be

TABLE 4-12
Percentage of Acres Projected to be Treated Using Biological Control Methods in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregion	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	<1	0	0	14	<1	0	49	0	0
Deciduous forest	0	0	0	0	0	0	0	0	0
Mixed evergreen/deciduous forest	0	0	0	0	0	0	0	0	0
Evergreen woodland	<1	0	0	0	<1	0	0	0	0
Deciduous woodland	0	0	0	0	0	0	0	0	0
Mixed evergreen/deciduous woodland	0	0	0	0	0	0	0	0	0
Evergreen shrubland	4	0	0	0	3	0	51	14	0
Deciduous shrubland	0	0	0	0	0	0	0	0	0
Evergreen dwarf-shrubland	0	0	0	0	0	0	0	0	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	14	0	0	86	<1	100	0	7	23
Annual graminoid or forb	38	0	0	0	97	0	0	6	<1
Perennial forb	13	0	0	0	<1	0	0	59	18
Riparian/wetland	2	0	0	0	<1	0	0	0	4
More than one subclass	29	0	0	0	0	0	0	14	4
Total for ecoregion	100	0	0	<1	40	2	<1	8	48

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

moderate to high. There would be moderate risk to aquatic plants associated with off-site drift of diuron applied at the maximum application rate. None of the herbicides pose risk under wind erosion scenarios.

Effects to non-target plants would be minimal if herbicides were able to selectively target the desired species type. Herbicides that are selective for broad-leaved plants (e.g., imazapic and clopyralid) would only affect broad-leaved species, which are typically the only target species in grass-dominated plant communities. However, some changes in species composition could occur in these communities as a result of altered competitive relationships. The lasting effects of treatments using non-selective herbicides would depend on reestablishment of species present in the seedbank. In many cases, reseeding or replanting treatments would be required after the application of non-selective herbicides to ensure the presence of native species on the site following treatment.

The ALS-inhibiting herbicides evaluated in the PEIS are chlorsulfuron, imazapic, imazapyr, metsulfuron methyl, and sulfometuron methyl. These herbicides would be applied at low application rates, since only small concentrations are necessary to damage target plants. These herbicides would pose some risks to non-target plants; however, risks would be similar to those associated with the other evaluated herbicides. Nevertheless, because of the potency of these herbicides, they would be most appropriate for use against a dominant target species or a particularly aggressive invasive species that has not been controlled by other methods (USDA Forest Service 2005).

Target Plants. The effects of herbicides on target plants would depend on their mode of action. Contact herbicides (e.g., diquat) only kill the plant parts that they touch, while translocated herbicides (e.g., dicamba) are transported throughout the plant. Herbicides that provide long-term weed management (e.g., bromacil) affect plants when they are present in the soil, with the degree of damage and non-selectivity often increasing with herbicide concentration (Holecheck et al. 1995).

TABLE 4-13
Percentage of Acres Projected to be Treated Using Herbicides in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregions	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	4	0	0	79	76	0	<1	1	1
Deciduous forest	<1	0	0	0	0	0	0	<1	<1
Mixed evergreen/deciduous forest	<1	0	0	0	0	0	0	0	<1
Evergreen woodland	2	0	0	0	6	0	1	2	<1
Deciduous woodland	<1	0	0	0	<1	5	5	0	0
Mixed evergreen/deciduous woodland	0	0	0	0	0	0	0	0	0
Evergreen shrubland	33	0	0	0	8	26	42	36	21
Deciduous shrubland	<1	0	0	0	0	32	4	<1	0
Evergreen dwarf-shrubland	0	0	0	0	0	0	0	0	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	13	0	0	21	<1	0	33	8	26
Annual graminoid or forb	15	0	0	0	10	0	8	20	2
Perennial forb	12	0	0	0	<1	<1	1	12	23
Riparian/wetland	1	0	0	0	<1	2	4	1	0
More than one subclass	20	0	0	0	0	34	3	21	26
Total for all ecoregions	100	0	0	<1	4	<1	9	71	16

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

Selective herbicides only affect certain plant species, whereas non-selective herbicides affect all or most plant species. The non-selective herbicides evaluated in the PEIS include bromacil, diquat, diuron, fluridone (except at low concentrations), glyphosate, sulfometuron methyl, and tebuthiuron. The other herbicides (2,4-D, chlorsulfuron, clopyralid, diflufenzopyr, hexazinone, imazapic, imazapyr, metsulfuron methyl, Overdrive®, picloram, and triclopyr) exhibit some selective qualities. Diquat and fluridone would be used exclusively for the management of aquatic plants. 2,4-D, glyphosate, imazapyr, and triclopyr could be used for management of aquatic as well as terrestrial vegetation.

Beneficial Effects of Treatments

Treatments that remove hazardous fuels from public lands would be expected to benefit the health of plant communities in which natural fire cycles have been altered. The suppression of fire results in the buildup of dead plant materials (e.g., litter and dead woody materials), and often increases the density of flammable living fuels on a site (e.g., dead branches on living shrubs or live plants, especially during dry periods). The resultant fires burn hotter, spread more quickly, and consume more plant materials than the historical fires that occurred under conditions of lower fuel loading. In addition, human-caused fires occur with greater frequency than they historically did, resulting in altered plant community structure. Treatments that restore and maintain fire-adapted ecosystems, through the appropriate use of mechanical thinning, fire use, and other vegetation treatment methods, would decrease the effects from wildfire to communities and improve ecosystem resilience and sustainability. Treatments should also reduce the incidence and severity of wildfires across the western U.S.

Treatments that control populations of non-native species on public lands would be expected to benefit native plant communities by reducing the importance of non-native species and aiding in the reestablishment of native species. The use of fire, herbicides, or other treatment methods to simply kill vegetation is often inadequate, especially for large infestations. Introducing and establishing competitive plants is also needed for successful management of weed infestations and the restoration of desirable plant communities (Jacobs et al. 1999). The degree of benefit would depend on the success of these treatments over both the short and long term. Some treatments are very successful at removing weeds over the short term, but are not successful at promoting the establishment of native species in their place. In such cases, seeding of native plant species would be beneficial. Weeds may resprout or reseed quickly, outcompeting native species, and in some cases increasing in vigor as a result of treatments. The success of treatments would depend on numerous factors, and could require the use of a combination of methods discussed below to combat undesirable species.

Although modeling was not done as part of this PER to determine the long-term effects of vegetation treatments, modeling done for similar treatments proposed by the BLM and Forest Service in the Interior Columbia Basin showed that improvements in land condition would be slow. The drier parts of the restoration area would likely take longer to restore than wetter areas because the vegetation would respond more slowly and because treatment methods are less refined for more arid ecosystems (USDA Forest Service and USDI BLM 2000b).

Based on conclusions drawn from the Interior Columbia Basin assessment, public land treatments would provide a better mix of habitats so that vegetation would be more resilient to disturbance and sustainable in the long term. Treatments should reduce the extent of Douglas-fir and other shade tolerant species from current levels. Treatments would reduce the encroachment and density of woody species in shrublands and/or herblands. As a result, plant communities that have declined substantially in geographic extent from historical to current periods (e.g., big sagebrush and bunchgrasses) would increase. Although the acreage of weeds and other exotic and undesirable plants could continue to increase, the rate of expansion should be slower (USDA Forest Service and USDI BLM 2000b).

Effects of Fire Treatments

Fire suppression has altered natural fire regimes and led to an increase in hazardous fuels and the associated risk of catastrophic fire in the West. In addition, several weed and invasive plant species have increased dramatically due to altered fire cycles. Use of fire would help to restore native vegetation and natural ecosystem processes. It is effective in controlling some invasive annuals with short-live seed banks, such as downy brome, especially when followed up with herbicide treatments (Asher et al. 2001; Grace et al. 2001). One strategy for altering the balance between non-native annuals and native perennials is to burn early during the spring after the ground has dried out. Fires at this time would destroy much of the seed crop of both annuals and perennials, although the resprouting of the latter would make them more resilient to burning (Keeley 2001). However, other invasive species populations, such as leafy spurge, burningbush, bull thistle, sowthistle and diffuse knapweed, could be stimulated with fire, especially if large seedbanks were present (Harrod and Reichard 2001). In addition, restoration, including seeding, would have to occur in a timely manner after treatment to minimize the potential for erosion or weed invasion (Brooks and Pyke 2001).

Prescribed fire treatments in the arid perennial grasslands would potentially benefit these communities by controlling the invasion of shrubs such as mesquite, creosote bush, and tarbush. Fire can be used to deter the growth and invasion of several invasive shrubs, including mesquite (Grace et al. 2001). Fires may kill the seeds of this species, and be effective in topkilling smaller shrubs (Drewa et al. 2001). Fire has also been used to control cholla and pricklypear. In the Chihuahuan Desert, fire can be used to stimulate herb and grass production. If invasion by weeds is not likely, fire can be used in chaparral to open dense stands and improve habitat for wildlife. In mountain shrublands, fire use can improve species diversity (Payne and Bryant 1998). Fires at 5- to 40-year intervals would maintain perennial bunchgrass communities. Vegetation can be used as living firebreaks or greenstrips. Crested wheatgrass has been used as a firebreak because it photosynthesizes longer into the growing season compared with most native species in the Temperate Desert Ecoregion and therefore stays greener longer and is less capable of carrying a fire.

Effects of Mechanical and Manual Treatments

Mechanical and manual treatments would allow for more precise control of vegetation in the treatment area than other methods. In addition, mechanical and manual treatments pose fewer human health risks than fire use and use of herbicides, and would thus be favored for treatments in the WUI, along ROWs, and near high public use areas.

Manual and mechanical methods are often used for maintenance of ROWs and public facilities. Common manual techniques used at these sites include pulling, cutting, girdling, topping, and pruning. Chainsaws are used by crews that travel along ROWs and remove target vegetation. Manual methods can be highly selective and remove only targeted vegetation. They can also be safer to use around powerlines and other hazard sites (BPA 2000).

Manual and mechanical treatments are effective in sensitive areas, such as wetland and riparian habitat, or near the habitat of plant and animal species of concern, where greater control over treatment effects is required or effects to non-target species are a concern. Equipment can be used to thin trees to increase the distance between tree crowns in order to reduce the chance that fire will spread between them, or to remove ladder fuels to reduce the possibility that a surface fire will become a crown fire. Chaining and shredding are effective in the control of shrubs, such as mesquite and juniper, and for management of sagebrush (Payne and Bryant 1998).

Materials generated from thinning and other vegetation treatments are available for use as soil amendments, as pulp chips for the paper industry, as construction material, or as biomass for fuel. The conversion of unwanted vegetation to biomass energy has gained more importance as our nation has become more reliant on foreign sources of energy. Specific sources of residue to biomass energy production include lands that have been degraded by the expansion in the distribution of woody species, such as western juniper, and by the accumulation of shade tolerant species within the Intermountain West. It is estimated that the BLM alone has the available biomass equivalent to 100,000 tons of coal on lands suitable for biomass production (USDI BLM 2006c).

Mechanical methods are often used to prepare a seedbed before planting. Dozer blades, grubbers, rootplows, disks, chains, and cables can be used to remove brush, roughen the seedbed, or shred vegetation that can be used as mulch. Seeding is accomplished by broadcast seeding, drill seeding, and by hand planting, among other methods (Payne and Bryant 1998).

Chaparral communities would receive mechanical treatments to reduce woody vegetation and increase herbaceous vegetation for improved forage or water yield, as well as for fuels reduction. Many species of chaparral communities are highly flammable, fire-dependent species. Chaparral communities tend to produce an abundance of dead fuels, which could be reduced with mechanical treatments.

Mechanical treatments could benefit native communities by controlling woody shrub species, which have invaded desert grasslands and now occur in much greater densities than they have historically. Mechanical treatments, when properly conducted and timed, can effectively control desert shrub species, such as creosote bush (Wood et al. 1991).

Mechanical treatments in oak woodlands would benefit native plant communities by removing conifers and other encroaching woody species that have increased the density of these communities, and by stimulating the growth of understory forbs and grasses. In these regards, mechanical treatments could act as a "replacement" for the historical fire disturbances that maintained the openness of oak woodlands. Treatments that favor oaks would also allow oaks to grow large and increase their reproductive success.

Effects of Biological Treatments

Biological control is a useful and proven method for controlling rangeland and aquatic weeds. The aim of biological control is not to eradicate the target species, but rather to put enough pressure on the species to reduce its dominance to more acceptable levels. Biological control is cost-effective, environmentally safe, self-perpetuating, and is well-suited to integration within an overall weed program (Wilson and McCaffrey 1999). Biological control agents have the additional advantage of not harming non-target vegetation.

A number of biological control agents are effective in controlling noxious weeds and invasive vegetation. The BLM would use insects, pathogens, and livestock to control vegetation. Insects are prominent in biological control of weeds because many species exhibit high host-specificity (Wilson and McCaffrey 1999). However, the success of biological control programs often depends on the presence of a more desirable plant community that can fill in the spaces opened by the removal of the weed. Thus, biological control would not be effective where large stands of annual grasses, such as downy brome, are present and have displaced native vegetation. If the weed is controlled, the space is often filled by another weed, or the plant community reverts to the weed annual grass understory.

The use of grazing animals has a greater likelihood of affecting non-target vegetation than insects and pathogens. Although grazing animals such as goats, sheep, and cattle are often looked upon negatively in terms of effects on vegetation, they can beneficially alter the appearance productivity, and composition of plant communities if used in moderation and at appropriate stocking densities (Payne and Bryant 1998). Goats are effective in controlling shrubs such as oaks, mesquite, chamise, and sumac on desert shrublands and chaparral (USDI BLM 1991a). Goats are also effective in controlling vegetation in sensitive areas where use of fire or herbicides is undesirable, such as near residential areas or near streams and wetlands.

Effects of Chemical Treatments

Herbicides offer an effective and often resource-efficient means of treating and managing unwanted vegetation. Mechanical and manual treatments are often more time and labor intensive than herbicide applications, and they cause soil disturbance, which can provide the appropriate conditions for invasive weeds to resprout from roots and rhizomes or grow from dormant seeds. In addition, herbicide use may be less dangerous than treatment with prescribed fire in dry areas that have high fire risk. The use of herbicides would benefit plant communities with weed infestations by decreasing the growth, seed production, and competitiveness of target plants, thereby releasing native species from competitive pressures (e.g., water, nutrient, and space availability) and aiding in their reestablishment. The degree of benefit to native communities would depend on the toxicity of the herbicide to the target species, and its effects on non-target species, as well as the success of the treatments over both the short and long term.

Some treatments are very successful at removing weeds over the short term, but are not successful at promoting the establishment of native species in their place. In such cases, seeding of native plant species would be beneficial. The success of treatments would depend on numerous factors, and could require the use of a combination of methods to combat undesirable species. In addition, repeated use of a particular herbicide on a particular site could cause target weeds to develop a certain level of resistance to that herbicide over time, reducing the effectiveness of repeated treatments.

The focus of treatments in the Temperate Desert Ecoregion is to benefit greater sage-grouse and other wildlife that use sagebrush communities by creating openings in dense and crowded sagebrush and rabbitbrush stands, removing invasive species, and promoting production of perennial grasses and forbs desired by wildlife (Paige and Ritter 1999).

Treatments in the Temperate Steppe Ecoregion would be focused on annual and perennial grasses and forbs, including downy brome, knapweeds, and thistles. Control of broadleaf plants by selective herbicides, such as 2,4-D, usually increases grass production. 2,4-D is also effective in controlling weedy forbs, such as bull, musk, and Scotch thistle. 2,4-D can be tank mixed with other herbicides, such as glyphosate, dicamba, picloram, and triclopyr to enhance the activity of these herbicides. Applications of selective herbicides, such as 2,4-D, are expected to increase grasses and decrease broadleaf species (USDI BLM 1991a).

Herbicides such as picloram and tebuthiuron are used to control woody species such as mesquite, creosote bush, and snakeweed in Subtropical Desert Ecoregion habitats. These herbicides usually decrease woody plant growth and increase growth of grasses, although it may take several years before grass and forb production increases in response to reduced competition from shrubs. Picloram is effective in controlling snakeweed, while tebuthiuron is effective in controlling creosote bush and tarbrush (USDI BLM 1991a).

New herbicides proposed for use by the BLM (Overdrive®, diquat, fluridone, and imazapic) pose lower risks to terrestrial plants than bromacil and chlorsulfuron, and present similar or lower risks to terrestrial plants than the other currently-approved herbicides. Imazapic has been reported to successfully control the spread of aggressive invasives, including downy brome, Russian knapweed, and perennial pepperweed, would pose few risks to non-target vegetation, and would have positive effects on native prairie restoration (Whitson 2001, Shinn and Thill 2002).

Effects to Special Status Plant Species

Public lands in the western U.S. support over 1,000 plant species that have been given a special status based on their rarity or sensitivity. Special status plants include approximately 150 species that are federally-listed as threatened or endangered, or are proposed for federal listing. The remaining special status species include candidates for federal listing, and other species that warrant special attention and could potentially require federal listing in the future. Many of these species are threatened by competition with non-native plants and other invasive species. The *Final Programmatic Biological Assessment Vegetation Treatments on Bureau of Land Management Lands in 17 Western States* (BA; USDI BLM 2007b) provides a description of the distribution, life history, and current threats for each federally-listed plant species, as well as species proposed for listing.

In general, the potential effects to special status plant species from the proposed vegetation treatments would be similar to those described for vegetation as a whole in the previous section. However, the rarity and sensitivity of special status species and their habitats make them more likely to be affected by disturbances associated with treatments. For all treatments, additional mitigation is required. In addition, populations of special status species may in some cases benefit more from fuels reduction and control of non-native species than plants with secure populations.

Standard Operating Procedures

The BLM would implement SOPs to minimize the risks to special status plant species from vegetation treatments. Examples of SOPs include surveying for species of concern if the project may impact federally- and/or state-listed species; minimizing direct impacts to species of concern from fire treatments, unless studies show that these species will benefit from fire; minimizing the use of ground-disturbing equipment near species of concern; and using temporary roads when long-term access to treatment sites is not required (see Table 2-5).

Adverse Effects of Treatments

Effects of Fire Treatments

As discussed in the BA, the potential effects of fire treatments on special status plant species would vary depending on a number of factors. The timing of the burn; the area, frequency, and severity of the burn; the level of resistance or adaptation by individual species to fire; the presence of fire-adapted vegetation; and the historical fire disturbance regime of the habitat would all influence the effects on special status population in the area. In most cases, mortality of some plants would occur if a fire were to burn directly through a population. The negative effect on the population would increase if a severe fire were to kill subsurface reproductive structures, or buried seeds. If an entire population was burned, extirpation of that population could potentially occur. Low intensity burns in fire adapted habitats could potentially benefit some special status species by increasing flower production and/or seed germination.

The indirect effects on special status plant species as a result of changes in habitat would largely depend on conditions of the site. Many special status species on public lands, particularly species found in the Marine Ecoregion, are early-successional species that would be expected to benefit indirectly from prescribed burns. In some cases special status plants would need to be protected from fire while the surrounding habitat was burned.

In habitats where non-native species have become adapted to fire (often in rangelands), fire treatments would be expected to further degrade the quality of the habitat because the fire-adapted invasive species would potentially outcompete native special status species in occupying sites cleared by burning.

As discussed in the BA, the majority of desert special status species (in Temperate Desert and Subtropical Desert ecoregions) occur in desert shrub communities. Pending an assessment at the local level prior to treatment, it is assumed that most special status plant species in desert habitats would be adversely affected by fire treatments because they are not likely to be adapted to fire. It is also assumed that the majority of special status plant species in the Subtropical Steppe Ecoregion would be adversely affected by fire. Many of these species are members of stable, climax communities that would not be expected to benefit from fire treatments. Many special status plants in the Temperate Steppe Ecoregion would be expected to respond positively to fire treatments, as many habitats in this ecoregion adapted with fire and grazing. The Mediterranean Ecoregion Division also contains a variety of habitat types, such as chaparral, oak woodlands, and grasslands, which are fire adapted and would be expected to benefit from the use of prescribed fire. Special status plant species in the Marine Ecoregion Division are also likely to benefit from fire. At the local level, BLM offices would need to make a determination about the possible effects of fire on special status plant species and their habitats prior to implementing fire treatments.

Effects of Mechanical and Manual Treatments

Because mechanical treatments are intended to control entire stands of vegetation or to enhance structural diversity, they could result in injury or mortality to any special status plants present on the treatment site if these plants were not avoided. In instances where the top layer of soil was removed, the seed bank of the species would also be negatively affected. Species with small populations or very limited distributions could be extirpated by such an occurrence. Populations of annual special status plants, however, should not be adversely affected, provided seedbank and germination conditions were not negatively affected by the treatment.

Effects to the habitat of special status plant species, in addition to the potential long-term benefits from the removal of weeds, would include short-term adverse effects such as erosion and hydrologic alteration, as discussed under effects to vegetation.

Over the long term, the suitability of the treatment site for supporting special status plant species would depend on the suite of species that became established after the site was cleared. A site cleared but not replanted or reseeded would typically favor early successional species, and would be expected to be beneficial for early successional special status plants. However, noxious weeds are also well-adapted to disturbed sites, and in many cases can outcompete special status plant species. It is expected that mechanical treatments would occur on sites with a large amount of undesirable vegetation, and it is likely that propagules of these species would be able to recolonize the site. Thus, it is possible that mechanical treatments alone would have no long-term effect on special status species habitat, or would have a negative effect. However, if replanting or reseeding with native species was also done at the site, long-term effects could be positive, by eventually replacing a site dominated by non-natives species to one dominated by native species.

Manual treatments would potentially provide benefits to special status species without causing injury to individual plants, provided workers were able to identify special status species and avoid disturbing them.

Effects of Biological Treatments

Containment by Domestic Animals. Adverse effects to special status plants and/or their habitat from weed containment by domestic animals could include foraging of individual plants, trampling, compaction of soils, and, for wetland species, hydrologic alteration. Although plants are typically able to recover from removal of their aboveground portions, heavy grazing could cause a reduction in plant biomass, vigor, and seed production (Kauffman 1988, Heady and Child 1994). In the case of non-secure populations of special status plants, the stresses associated with grazing could cause long-term adverse effects, particularly if special status plants were browsed or grazed before producing seed, or during times of drought or other environmental stress, or if the same plants were grazed repeatedly. Although treatments with domestic animals can improve the habitat of some special status species by reducing the cover and vigor of non-native or undesirable species, grazing can reduce the quality of habitat by spreading weed propagules. Since many populations of special status species occur in areas that have a large component of native species, introduction of weed propagules into these areas would be expected to have long-term adverse effects on special status populations.

Other Biological Control Agents. No adverse effects to special status plant species are expected from the use of biological control agents, since these insects and pathogens generally do not affect non-target plant species or habitats. However, there have been some instances of biological control agents attacking species other than the target plant. An example is the seed-head weevil, which was released to control alien species of thistle, but has also attacked the Chorro Creek bog thistle, an endangered species in the same genus. Under the review process, biological control agents undergo an extensive screening and testing process by USDA Animal and Plant Health Inspection Service before an organism can be released. Despite these safeguards, there is always a risk that the release of an agent into a habitat in which it does not occur could result in unforeseen ecological repercussions.

Effects of Chemical Treatments

The potential effects of herbicide treatments on special status plant species would depend on a number of factors, including the location of the application in relation to special status populations, the type of application method utilized, the type of chemical formulation used, and the timing of the application in relation to the phenology of the special status species. In the case of special status plant species, manual spot applications of herbicides may be the only suitable means of applying herbicides that can adequately ensure the protection of sensitive populations.

All of the herbicides analyzed in ERAs would pose risks to terrestrial special status plant species in a situation where plants were directly sprayed. Herbicides with the greatest likelihood of harming special status plants would include bromacil, chlorsulfuron, clopyralid, diflufenzopyr, diquat, imazapyr, metsulfuron methyl, Overdrive®, picloram, sulfometuron methyl, and triclopyr. These herbicides would also present the most risk to terrestrial special status plant species as a result of drift from a nearby application site. The herbicide with the lowest risk to terrestrial plants is imazapic, which, according to its ERA, can be broadcast sprayed by ground methods 25 feet from a sensitive plant without risk (ENSR 2005c-l; Syracuse Environmental Research Associates, Inc.[SERA] 2005).

Herbicides with the greatest likelihood of affecting special status plant species via surface runoff include imazapyr, metsulfuron methyl, picloram, and triclopyr. Of these herbicides, picloram has the longest soil half-life (see Soil Resources section). Herbicides with the least likelihood of affecting special status terrestrial plant species include imazapic, chlorsulfuron, glyphosate, and bromacil.

Aquatic special status plants could be harmed by a normal application of an aquatic herbicide, accidental direct spray or spray drift of a terrestrial herbicide from a nearby upland, accidental spill, or surface runoff from an upslope area into the water body where the plant is located. Use of 2,4-D and diquat to control vegetation in aquatic habitats would pose the greatest risks to any special status plant species also in the habitat. Aquatic herbicides that would be safe for use in aquatic habitats where special status plant species occur include fluridone and the low-toxicity formulations of glyphosate. In addition, triclopyr acid could be applied directly to the water column at the standard concentration without harm to sensitive aquatic plants. The safest terrestrial herbicides to use near aquatic habitats would be picloram and diflufenzopyr.

Beneficial Effects of Treatments

Many special status plant species are threatened by the spread of non-native plants. Although a discussion of individual plant species is beyond the scope of this PER, the BA provides additional information on which threatened, endangered, and proposed plants are most at risk from competition with non-native plants. The continued spread of non-native plants is expected to result in further encroachment on rare or sensitive plant populations, possibly resulting in reduced population size and vigor, and even extirpation of particularly vulnerable populations. Therefore, all vegetation treatments that limit the spread of non-native plants in habitats occupied by special status species would benefit these vulnerable populations. Improvement of habitat near populations of special status species could also be extremely beneficial by providing suitable habitat for expansion of populations, perhaps aiding in their recovery.

Because populations of special status plants are often small and isolated from other populations, they are highly susceptible to extirpation by catastrophic wildfires, even in habitats that are, or were once, adapted to fire. Therefore, vegetation treatments that reduce fuels in and near populations of special status species would be expected to provide long-term benefits to these species by reducing the likelihood that a future wildfire would extirpate or further weaken sensitive populations (Sheppard and Farnsworth 1997).

Prescribed fires may release resources to the benefit of special status plants. Plant height and numbers of flowerheads of Thompson's clover were significantly higher in burned than unburned areas where fires removed competing grasses and shrubs (Scherer et al. 1997).

Hand removal of competing vegetation and fuel sources within populations of special status species would likely help improve or maintain the vigor of these populations. Though not feasible over large areas, manual treatments are often the most appropriate means of improving habitats occupied by threatened and endangered species.

Fish and Other Aquatic Organisms

The BLM administers lands directly affecting almost 155,000 miles of fish-bearing streams and 4 million acres of reservoirs and natural lakes (USDI BLM 2006c). These habitats range from isolated desert springs of the Southwest to large interior rivers and their numerous tributaries throughout the Pacific Northwest and Alaska. Today, the rapid expansion of invasive species and build-up of hazardous fuels across public lands are threats to ecosystem health and one of the greatest challenges in ecosystem management.

The BLM vegetation treatment program is designed to benefit ecosystems by removing and controlling the spread of invasive plant species. In aquatic systems, these plants (e.g., Eurasian watermilfoil and water-thyme) may clog slow-moving water bodies, contaminating water with an overabundance of organic material. Dense concentrations of invasive aquatic plants also reduce light and dissolved oxygen levels, eliminating habitat and decreasing growth or killing native species of plants and animals (Payne and Copes 1986). Fire exclusion policies, buildup in hazardous fuel levels, and increase in acreage dominated by invasive vegetation have led to more frequent fires of greater severity and duration and increased soil erosion over many areas of the West. These conditions have often led to deterioration in water quality and fish habitat in affected areas. Efforts to improve upland habitat conditions by reducing hazardous fuel levels and controlling invasive species and noxious weeds should lead to improved habitat for fish and other aquatic organisms.

Scoping Comments and Other Issues Evaluated in Assessment

Numerous scoping comments were centered around a desire for the BLM to focus on long-term ecosystem sustainability and biological diversity. There was some concern about herbicide bioaccumulation in fish. Many reviewers expressed a desire that the BLM use newer, less toxic herbicides and/or limit or avoid herbicide use.

Resource Program Goals

Approximately 30,000 acres of wetland and riparian habitat would be treated annually to benefit fish and other aquatic organisms. Of these acres, approximately 34% would be treated using chemical treatments, 30% using biological control methods, 28% using mechanical and manual methods, and 8% using fire. Herbicide treatments would be conducted using aerial and ground-based equipment, and more than 80% of treatments would occur in the Temperate Desert and Subtropical Steppe ecoregions. Biological control treatments would mostly involve the use of insects. Nearly all fire treatments in riparian areas would be 100 acres or less.

Uplands would be treated to meet other project objectives, including reducing hazardous fuels, reducing the risk of fire in the WUI, and improving habitat for wildlife. These treatments, however, would also likely improve plant community structure and function to the benefit of fish and other aquatic organisms in the treatment area.

The BLM has ongoing programs under the direction of the Fisheries Management, Riparian Management, and Soil, Water and Air Management programs to control invasive vegetation and noxious weeds, including saltcedar, in riparian areas. The BLM is working with Ducks Unlimited and other groups to create wetlands and improve stream habitat. Substantial effort is focused on removing and revegetating abandoned logging roads to reduce erosion and sedimentation of nearby aquatic bodies, and to restore habitat for salmon and other fish in the Columbia River Basin (USDI BLM 2005a). Columbia River Basin activities include fencing riparian areas to better control livestock access. In addition, the BLM is actively restoring degraded lands in the Colorado River Basin to reduce the amount of salt loading to the Colorado River.

Fire exclusion policies, buildup of hazardous fuels, and increase in acreage dominated by invasive vegetation have led to more frequent fires of greater severity and duration and increased soil erosion over many areas of the West. These conditions have often led to deterioration in water quality and fish habitat in affected areas (USDA Forest Service and USDI BLM 2000b). Although disturbances from fire, wind, plant disease, grazing by wildlife, floods, and other factors will always be important in shaping ecosystems in the western U.S., efforts by the BLM to restore vegetation to more natural conditions, and reduce fuels buildup and the frequency of catastrophic fires, should lead to a slow improvement in habitat for fish and other aquatic organisms in treated areas.

Standard Operating Procedures

This assessment of effects assumes that SOPs (listed in Table 2-5 of the PER and Table 2-8 of the PEIS) are used to reduce potential unintended effects to fish and other aquatic organisms. These include developing and updating an operational plan for each project, which would include information on project specifications, key personnel responsibilities, communication procedures, safety, spill response, and emergency procedures. In addition, the BLM would maintain vegetated buffers between treatment areas and aquatic habitats. Vehicles would not be washed in streams or wetlands, and equipment would be fueled and serviced at least 100 feet from water bodies. Treatments would be minimized near fish-bearing streams, particularly during periods when fish are in sensitive life stages, and access of domestic animals to streams and other water bodies would be limited to minimize sediments entering water and potential for damage to fish habitat. For herbicide treatments, SOPs would include using spot, rather than aerial treatments, near water bodies, and using the herbicide that is least toxic to fish and other aquatic organisms, while still being effective. Minimum buffers and other herbicide use restrictions would be established based on guidance given in risk assessments prepared for the PEIS (see Appendix C of the PEIS) and the herbicide label.

Adverse Effects of Treatments

All vegetation removal activities could disturb the soil and reduce the amount of vegetation that can bind to soil, potentially causing erosion and sedimentation of water bodies. Fish typically avoid turbid or silty water, and the density and diversity of fish and macroinvertebrate populations tend to decline as streams become more silted (Gore 1985; Wagner and LaPerriere 1985; Aldridge et al. 1987; Steinman and

McIntire 1990). Sedimentation can affect the feeding success of fish species that rely on visual search strategies, bury prime spawning habitat, prevent fry (early-stage fish) from emerging from spawning gravels, and foul the gills of aquatic organisms (Gardener 1981). Sediments can also affect plants that are used as food by aquatic organisms by reducing the amount of sunlight reaching plants and slowing or stopping their growth.

Removal of riparian vegetation would increase the amount of sunlight reaching water bodies, which could raise water temperatures above normal. Water temperature affects the metabolism, behavior, and survivorship of aquatic species (Beschta et al. 1987, Bjornn and Reiser 1991). Salmon and trout are cold-water fish that are especially sensitive to above-normal water temperatures. Temperatures above 80°F are lethal to most salmonids. Many streams in the West that once supported cold-water species now host mostly warm-water species, such as common carp and red shiner, as stream temperatures have risen due to loss of streamside vegetation from agriculture and other vegetation-removing practices. Warmer water temperatures also stimulate the production of algae, especially in waters with a high nitrogen content. While increased algae production may benefit macroinvertebrate production, algae can also crowd out more desirable plant species.

The removal of vegetation and soil disturbance decreases the amount of rainfall captured by plants, detritus, and soil, and can lead to increased stormwater flows and runoff velocity (Spence et al. 1996). Increased stormwater runoff can scour stream channels and modify stream channel morphology, affecting the distribution and abundance of aquatic organisms (Hicks et al. 1991). Although many aquatic species have evolved life-history strategies that allow them to succeed under rapidly changing water conditions, other species, such as those using wetlands, depend upon more stable conditions. For example, vegetation removal resulting in increased water flows to wetlands during the spring could flood the breeding sites of aquatic organisms that breed or lay eggs in moist soil, harming or killing eggs or juveniles.

The loss of large trees to mechanical or manual treatments could reduce the amount of large woody debris that would later fall into the water body and provide food and shelter for fish and other aquatic organisms. Loss of woody debris has been identified as a contributing factor in the decline of salmon populations in the Pacific Northwest (BPA 2000). Woody debris provides food and shelter for aquatic organisms, helps to capture and store sediments, reduces the erosional effects of high stream flows, and enhances pool development and maintenance (Bisson et al. 1987). The effects of debris removal would be greatest for smaller water bodies, or where vegetation was removed along lengthy stretches (300 feet or more) of a stream.

Effects of Fire Treatments

Embers, burning vegetation, and radiant heat generated by fire can raise water temperature (Fresquez et al. 2002). High mortality of juvenile coho and cutthroat trout were observed in Oregon when water temperature rose from 55 °F to 82 °F during a wildfire (Hall and Lantz 1969). However, evidence suggests that the increase in water temperature due to fire is usually short-term and confined to the immediate area (Amaranthus et al. 1989).

Hazardous fuels reduction would also decrease the likelihood that wildfire suppression activities would occur in or near aquatic habitats. Fire suppression activities can adversely affect aquatic organisms and their habitats. Fire retardants contain chemicals (e.g., ammonium polyphosphate or ammonium sulfate) that are especially harmful to aquatic organisms (Viereck and Schandelmeier 1980, Finger 1995), with retardant foams being more harmful than other types of retardants (Gaikowski et al. 1996a, 1996b; McDonald et al. 1996, 1997). Retardant that drops in or close to streams could have negative effects on fish.

Ash and smoke produced by fires can affect water chemistry. Ash falling into a stream can increase ammonia concentrations and acidity (pH) in the stream (Spencer and Hauer 1991), which are harmful to a variety of fish (Minshall et al. 1989). Changes in water temperature and water quality can be especially harmful to macroinvertebrates. For example, one study found that nearly all macroinvertebrates died in a stream in Arizona where a wildfire occurred, and even a year later, population numbers were only one-third of normal (Rinne 1996). Changes in temperature and nutrients were related to the volume of water in affected streams.

High intensity fires could kill large trees, with increased stream flow and erosion caused by the loss of vegetation toppling these trees into aquatic habitats. Over the short term, this woody debris would provide new fish habitat, sometimes continuing to fall into the water body for a year or more (Young 1994; Minshall et al. 1997; Berg et al. 2002). Eventually, however, the loss of trees would result in little new woody debris entering the stream for many years.

Fires also cause changes in soil structure that may exacerbate erosion problems. The burning of litter and organic matter can reduce infiltration and increase runoff. Although many soils are naturally water repellant when dry, the consumption of litter over coarse textured soils can sometimes cause a waxy coating to form around soil particles below the surface. These layers repel water, increasing runoff, and can persist for years, unless the physical structure of the soil is somehow altered.

There would typically be fewer effects to aquatic organisms from heat, smoke, and ash from low intensity fires than from large, high severity fires. Prescribed fires can be designed to kill mostly shrubs and deciduous trees, rather than larger conifers. Since large trees would remain, soil stability would not be impaired, and conifers would still be available to contribute large woody debris to aquatic bodies in the future.

Different groups of invertebrates vary in their sensitivities to fire-caused changes in aquatic systems. Both generalist insects (which can live under a range of physical conditions and eat a wide range of foods) and mobile insects (which can readily flee intolerable conditions) tend to be least affected by burning (Minshall 2003). The abundance of aquatic invertebrates, however, is unlikely to differ from that in unburned streams shortly after a prescribed fire.

Alaska and the Pacific Northwest

No fire treatments are scheduled to occur in the Tundra Ecoregion of Alaska. In the Subarctic Ecoregion of Alaska, forestlands and deciduous shrublands would receive most of the fire treatments. Natural fire return intervals in these communities are generally greater than 100 years, and are typified by surface fires of low to moderate intensity that generally kill aboveground plant parts, but do not destroy underground parts (Viereck and Schandelmeier 1980).

In the Marine Ecoregion of the Pacific Northwest, fire treatments are proposed to occur in evergreen woodlands. These communities typically existed as fire climax oak woodlands maintained by frequent, low intensity burning (Agee 1993). Evergreen forests within this ecoregion include rain-fed coastal streams and snow-fed streams. Salmonids are the key fish species, located throughout tributaries and mainstems in this region.

Fire has been a relatively common occurrence in evergreen forests of the Pacific Northwest over the last 10,000 years (McMahon and deCalesta 1990). Fish in this region are apt to seek refuge in waters unaffected by adjacent burning, leaving burned areas poorly stocked until conditions become favorable once again (Minshall et al. 1990; Rieman and Clayton 1997; Gresswell 1999). Fish isolated from safe havens due to the extent of the burn or the lack of connectivity between affected and unaffected waters, however, must suffer any ill effects of burning on their habitat. The short-term effects of fire on fish populations are a function of both the degree and duration of fire-caused changes in water quality and quantity, and the proportion of each inhabited stream network affected by burning. An isolated or fragmented fish population would recover far more slowly from any adverse effects of burning than would a population inhabiting a widespread and well-connected stream system.

Severe fires that burn much or most of the organic layer down to mineral soil or permafrost could result in increased siltation and runoff into streams, negatively affecting local fish populations with an increase in turbidity and a potential loss of habitat. Furthermore, water temperatures could rise as a result of increased exposure of the stream surface to direct sunlight after removal of riparian vegetation by fire. Fire can also increase landslide potential for up to 5 years after the event because of the decay of anchoring root systems (Meehan 1991).

Frequent or intense fires could harm fish populations by removing vegetative cover and facilitating erosion. The extent to which surface runoff would affect water bodies would depend on the timing of the fires and the surrounding gradient; the steeper the topography the greater the runoff. However, maintaining buffers between burning areas and the aquatic resources would ensure that effects from runoff would be lessened.

The eastern portion of the Pacific Northwest is predominantly Temperate Steppe and Subtropical Steppe ecoregions. Basin vegetation types that would likely receive fire treatments in these ecoregions include evergreen forests, evergreen shrubland, and perennial graminoid communities.

The evergreen shrubland areas supporting chaparral shrub species in the Subtropical Steppe Ecoregion are fire-dependent, comprised of highly flammable species that grow rapidly after fire, taking about 25 years to mature and senesce (Brown and Smith 2000). A wildfire could alter riparian vegetation and affect aquatic areas. Burning riparian vegetation would reduce available riparian habitat, increase streambank erosion, raise water temperatures, and reduce oxygen levels (Wright and Bailey 1982). Fish species, such as longfin dace and desert suckers, could be more affected by large wildfires and associated suppression activities (e.g., fire line construction and retardant drops) than is desirable in evergreen shrubland riparian communities. These effects could include displacement, mortality, and adverse loss or modification of habitat (e.g., cover and food resources). Severe wildfires occurring during critical reproductive periods for these species would be the most detrimental.

Prescribed fire in this ecoregion is not expected to result in direct mortality of local fish communities or cause indirect adverse effects to their habitat, including loss of forage, thermal cover, and hiding cover, as these projects would be designed to protect riparian vegetation and maintain unburned patches of vegetation in upland areas.

The perennial graminoid grasslands in the eastern Pacific Northwest support sparse shrubs and low trees, and exist on a continuum with evergreen woodlands (USDA Forest Service and USDI BLM 2000b). Aquatic bodies are very susceptible to surface runoff and erosion upon removal of grasslands. This increase in vegetation removal could have a major effect on native fishes and their habitat. The extent to which surface runoff would affect water bodies would depend on the timing of the prescribed fires and the surrounding gradient; the steeper the topography the greater the potential runoff. If streamflow increases because of the removal of encroaching conifers, riparian and aquatic organisms could benefit.

The Arid Environment

The Great Basin. The main vegetation types that would be treated in the Temperate Desert Ecoregion are evergreen shrubland (sagebrush habitats) and evergreen woodland (pinyon-juniper habitats), with fire treatments predominantly occurring in evergreen shrublands.

While fish are adapted to extreme conditions in this region, those fishes living in small water bodies are most vulnerable to fire, which would modify the surrounding habitat and could change the amount of water in the system.

Fire is a natural process in the Great Basin, but with the spread of invasive grasses throughout evergreen shrublands, fires have increased in intensity and frequency. Fires have the potential to spread to riparian habitats, where loss of vegetation in riparian buffer zones is likely to destabilize stream banks and lead to erosion and sedimentation into aquatic habitats and potentially degrade fish habitat. Fire occurrence has decreased in upper elevation shrub communities, allowing establishment of substantial acreages of pinyon and juniper. Moisture competition eventually eliminates understory vegetation, resulting in substantial soil loss. Increased cover of surface vegetation and possible increase in soil water could lead to improved conditions in riparian and wetland areas.

On sites with a large component of invasive annual grasses, fires could negatively affect fish communities in the evergreen shrubland (sagebrush) areas. Because of the more continuous fuel loading on these sites, fires would affect a greater percentage of the surface on sites with a native-dominated understory. Residual vegetation would be less and initial recovery of weedy species would provide less protection to the soil surface than would a resprouting native grass community. Hot fires could increase the potential for surface erosion, although this is generally a temporary effect under prescribed fire conditions (DeBano 1981, Wright and Bailey 1982). Prescribed fires would likely be rare in sites dominated by invasive annual grasses, and would mostly used as a preparation for reseeding.

Lower Colorado River Basin. The Family Cyprinidae (chubs, dace, and suckers) is the most dominant native fish group within the Subtropical Desert Ecoregion. Vegetation types that are proposed for treatments include perennial graminoid communities, evergreen shrublands, and evergreen woodlands. Fire treatments would predominately occur in evergreen shrubland and perennial grassland communities in the Subtropical Desert Ecoregion.

Like the perennial graminoid grasslands in the Pacific Northwest, the perennial graminoid grasslands of the Lower Colorado River Basin support sparse shrubs and low trees, and exist on a continuum with evergreen woodlands. As a result, the general effects of fire on fish communities found within perennial graminoid grasslands and evergreen shrublands in this region would be largely the same as those described for fish in perennial graminoid and evergreen shrubland communities in the Subtropical Steppe and Temperate Steppe ecoregions of the Pacific Northwest.

The effects of prescribed fire to fish in evergreen woodland (pinyon-juniper) communities in this region would be similar to those discussed for evergreen woodland (pinyon-juniper) communities in the Temperate Desert Ecoregion of the Upper Colorado River Basin below.

Upper Colorado River Basin

Evergreen forests of the Rocky Mountains have historically had variable fire regimes, ranging from frequent, low severity understory burns in ponderosa pine forests to infrequent, stand replacing fires in lodgepole pine forests (Arno 2000). Fish in this region exhibit characteristics similar to those of fish in the Pacific Northwest. They are apt to seek refuge in waters unaffected by adjacent burning, leaving burned areas poorly stocked until conditions become favorable once again (Minshall et al. 1990; Riemann and Clayton 1997; Gresswell 1999).

Frequent or intense fires could harm fish populations by removing vegetative cover and facilitating erosion. The extent to which surface runoff would affect water bodies would depend on the rate and amount of vegetation recovery, the timing of the fires, and the surrounding gradient (the steeper the topography the greater the runoff). However, maintaining buffers between burned areas and the aquatic resources would ensure that effects from runoff would not be substantial.

Increases in water yield and surface water runoff within a watershed would be more dramatic immediately after a storm event. With the exposure of bare soils by fire, surface erosion could also increase. The increase in sedimentation into local streams could overload a channel and alter channel morphology, causing significant habitat changes for fish. Furthermore, heat from a fire can raise water temperatures to levels lethal to fish. After such fires, a lack of a riparian canopy would also expose fish to increased stream temperatures, potentially displacing local populations within an area.

Fish are apt to seek refuge in unaffected waters, leaving burned areas poorly stocked until conditions become favorable once again (Minshall et al. 1990; Riemann and Clayton 1997; Gresswell 1999). The short-term effects of fire on fish populations are a function of both the degree and duration of fire-caused changes in water quality and quantity, and the proportion of each inhabited stream network affected by burning.

Many areas occupied by fish (such as Gila trout and Lahontan cutthroat trout) in pinyon-juniper forests are under prescribed fire management that allows fires to burn in certain areas at certain times. Prescribed fires of low to moderate intensity that mimic natural fires are not likely to negatively affect fish populations within the areas proposed for burning, since these fires are unlikely to cause increases in stream temperature or turbidity, or increased streamflow during subsequent storms.

Any accelerated rates of runoff and sedimentation resulting from prescribed fires in upland areas would progressively diminish as these surrounding areas achieved proper functioning condition. Timing burns in these areas so that they occur during periods of little precipitation, and limiting the burning to areas designated outside of riparian areas, would reduce the effects of surface erosion and sedimentation entering aquatic habitats, reducing the effects to aquatic populations.

The general effects of prescribed fire to fish in evergreen shrubland communities of the Rocky Mountains would be similar to those discussed for evergreen shrubland communities in the Pacific Northwest.

California

Fire treatment in the California hydrologic region would be directed at evergreen forests and evergreen woodlands. Fish habitat characteristics in this area are very similar to those observed in the western Pacific Northwest (as discussed above). Evergreen forests in this region historically had an understory fire regime or a mixed severity fire regime, and are presently at risk for high-intensity, stand-replacing crown fires due to large fuel accumulations.

Streams and rivers throughout the evergreen woodlands (oak woodlands) in this ecoregion are found at low elevations, and are used for rearing and foraging, rather than spawning, by salmonids (USDA Forest Service 2002a). Oak woodlands historically supported frequent, low intensity fires, which helped to maintain open stands with a grassy understory. Large oaks would be unlikely to be harmed during a low intensity fire, so that riparian areas and canopy coverage of water bodies would remain intact.

A concern within oak woodlands is the potential for erosion after a fire. High intensity fires can cause changes in soil structure that may exacerbate erosion problems (Neary et al. 1999), which can result in sediment from burned slopes clogging streams and reducing water quality. Oak woodlands typically occur in low gradient areas, so the potential effects to fish from surface erosion from these habitats would be minimized. The reduced potential for surface erosion effects, combined with the low severity of prescribed fires, would minimize effects to fish within the project area.

The effects of prescribed fire to fish in evergreen shrublands of the Subtropical Desert Ecoregion would be similar to those discussed for evergreen shrubland in the eastern Pacific Northwest. In many areas of the Mojave and Sonoran deserts, plant communities are too sparse during most years to adequately carry a prescribed burn. Therefore, fire treatments would not be suitable for these areas, and fish would not be affected from prescribed fire in this region.

Missouri River Basin

The Missouri River Basin is predominantly in the Temperate Steppe Ecoregion. Basin vegetation types that would likely receive fire treatments in this ecoregion include evergreen forests, evergreen shrubland, and perennial graminoid communities. The general effects of fire on fish and other aquatic organisms found within these communities would be very similar to those observed in the eastern Pacific Northwest.

Effects of Mechanical Treatments

The effects of mechanical treatments on fish and other aquatic organisms would be related to the types and amounts of soil disturbed and vegetation removed, proximity of the treatment to water, and potential for equipment fuel and lubricant spills to enter the water. Mechanical methods are appropriate for vegetation treatments near water in all ecoregions where a high level of control over vegetation removal is needed, the risks to aquatic organisms from the use of fire and herbicides are great, and residual vegetative cover is needed to minimize soil erosion.

A number of mechanical techniques are used to control aquatic vegetation. Mechanical harvesters are used to cut and collect aquatic plants. These machines can cut the plant from 5 to 10 feet below the water surface and may cut an area 6 to 20 feet wide. Harvesters can open up areas, but can also fragment and spread aquatic vegetation to new areas. In addition, harvesters may affect fish and other aquatic organisms by removing them with harvested material. Cutting plant stems too close to the bottom can result in resuspension of bottom sediments and nutrients (Madsen and Stewart 2004).

Weed rollers, which can be up to 30 feet long, compress the sediment and plants in an area. Frequent use allows only a small amount of invasive vegetation growth, but may disturb bottom-dwelling organisms and spawning fish. A rotovator is similar to an underwater rototiller, and functions to dislodge and remove plants and roots. Since the rotovator greatly disturbs the sediment, there is concern that use of the equipment can: 1) resuspend contaminated sediments; 2) release nutrients absorbed or precipitated in the sediment (e.g., phosphorus); 3) adversely affect benthic organisms; or 4) affect fish spawning areas.

Mechanical treatments used in upland areas, such as blading, tilling, and grubbing would likely disturb soil, which can degrade aquatic habitat if carried in stormwater runoff. Sediment entering stream channels can affect channel shape, stream substrate, fish habitats, and the structure and abundance of local fish populations. To reduce effects, the BLM would limit blading to relatively level areas, and would reseed bladed and grubbed sites to prevent runoff and erosion.

Chaining, roller chopping, and mowing would leave plant debris on the surface, which would aid in the control of erosion. Leaving a vegetated buffer between the treatment area and water could also reduce the risk of sediments entering water.

Alaska and the Pacific Northwest

No mechanical treatments are scheduled to occur in the Tundra and Subarctic ecoregion. In the Marine and Temperate Steppe ecoregions of the Pacific Northwest, mechanical treatments would occur predominantly in mixed evergreen/deciduous forests and evergreen forests, and would potentially affect salmonid species. Treatments could involve thinning of spruce, aspen, and poplar forests to reduce hazardous fuels. Small streams are responsible for a high proportion of salmonid production, but are very responsive to alterations by forest management activities. Treatments within the riparian zone of small streams would be expected to increase light availability to aquatic habitats, but decrease the available organic matter entering the stream. Therefore, thinning along these streams could increase water temperature, and reduce food (i.e., macroinvertebrates) availability and woody debris input. The overall effect of mechanical treatments within the riparian zone would be positive, as this treatment would be selective, creating openings in the canopy and enhancing primary production, while ensuring continued woody debris input and suitable rearing habitat.

In the eastern Pacific Northwest, most of the mechanical treatments in evergreen shrubland would involve tilling or plowing of sagebrush, followed by seeding or drilling. Other mechanical treatments, such as mowing, chopping, and chaining, would also be used, but to a lesser extent. Treatments would target woody species (e.g., big sagebrush, rabbitbrush, and greasewood), with the goal of encouraging certain species of perennial bunchgrasses, forbs, and shrubs. Plowing would be used in areas with little herbaceous understory, where soil disturbance would help prepare the seedbed for revegetation.

Removal of vegetation could temporarily increase surface erosion into nearby streams. Increases in water yield and surface water runoff within a watershed would be more dramatic immediately around storm events. The increase in sedimentation into local streams could overload a channel and alter channel morphology, causing significant habitat changes for fish. However, as a result of tree removal, many native perennial grass species, forbs, and shrubs would increase on the site (Clary 1971, Jacobs and Gatewood 1999). Grass production generally doubles after sagebrush removal, because the cover of sagebrush is reduced and soil nutrient and water availability is increased (Sturges 1975). With the introduction of these grasses, runoff and erosion into nearby waterbodies would be minimized.

The Arid Environment

The general effects of mechanical treatments on fish and other aquatic organisms in sagebrush areas in this region would be largely the same as the effects on these organisms in the sagebrush areas of the Pacific Northwest. Removal of vegetation could temporarily increase surface erosion into nearby streams or vernal pools. Increases in water yield and surface water runoff within a watershed would be more dramatic immediately around storm events. With the exposure of bare soils by mechanical treatment, surface erosion could also increase. Because of the extremely low and irregular rainfall of this region, increase sedimentation in pools or streams from mechanical treatments would not be significant to fish.

In the Subtropical Desert Ecoregion of the Lower Colorado River Basin, some mechanical treatments are likely to occur in evergreen and deciduous shrublands. Because of the extremely low and irregular rainfall of this region, increased sedimentation in pools or streams from mechanical treatments would not substantially alter aquatic habitats. Many trout species in this region occur in high elevation habitats that consist of small headwater streams with limited pool availability and low base flow. Removal of canopy vegetation could alter the diversity of macroinvertebrates available for trout to feed upon.

Upper Colorado River Basin

Mechanical treatments in pinyon-juniper woodlands would primarily consist of thinning and machine piling of debris, as well as chipping/shredding and chaining to reduce the occurrence of pinyon and juniper species on sites they have invaded. Any accelerated rates of runoff and sedimentation from upland areas as a result of mechanical treatments would progressively diminish as these surrounding areas achieved proper functioning condition. Timing burns in these areas so that they occur during periods of little precipitation, and limiting the burning to areas designated outside of riparian areas would reduce the effects of surface erosion and sedimentation entering aquatic habitats, reducing the effects to aquatic populations.

The warmer and wetter conditions in the Upper Colorado River Basin would likely result in a more favorable vegetation response following treatment compared to similar plant community types in the lower Pacific Northwest, Great Basin, and Lower Colorado River hydrologic regions, reducing the longevity of the effects.

Effects to trout species at high elevations from mechanical treatments would be similar to those for fish populations in evergreen forest and woodland communities in the Temperate Steppe Ecoregion in the Pacific Northwest and Missouri.

California

Mechanical treatments in oak woodlands would remove conifers but stimulate the growth of understory forbs and grasses. These treatments would reduce canopy coverage, increasing the amount of sunlight reaching streams and reducing food availability. The general effects of mechanical treatments on salmonid populations in mountainous area and evergreen forests in this region would be largely the same as the effects on salmonid populations in the Pacific Northwest.

Missouri River Basin

Mechanical treatments in forest communities in the Missouri River Basin would largely consist of thinning to reduce the density of trees and the accumulation of understory fuels.

Many of the rivers in this basin historically carried heavy silt loads, collected from tributaries in the northern part of the drainage. Using mechanical treatments in this area could increase surface erosion in nearby water bodies. Fish such as sturgeon and sicklefin chub are suited to turbid and dynamic conditions historically observed throughout this area, and changes to instream sedimentation would have little effect on these species.

Effects of Manual Treatments

Manual treatments, which tend to be more selective and involve smaller treatment areas than other methods, would be less likely to affect aquatic organisms than other methods. Hand pulling and hand cutting are the two primary methods used to remove invasive aquatic vegetation. During hand pulling, the whole plant should be removed, and the process must be repeated often to control regrowth. When hand pulling, the entire root system and all fragments of the plants must be collected or plant and root fragments may result in additional growth of the species. Hand cutting is done with both powered and non-powered tools and is generally appropriate for small patches of vegetation in water that is less than 4 feet deep. As with hand pulling, vegetation can become fragmented and spread to other portions of the lake or stream. Removing aquatic plants may also result in increased shoreline erosion, as the roots are no longer present to stabilize the soils and dampen wave action. Replanting disturbed areas with native vegetation can help reduce or correct this problem (Madsen and Stewart 2004).

In most cases, unwanted vegetation near a stream or wetland could be removed without disturbing more desirable vegetation. Typically, plant debris would be left in place. Fuel and lubricant spills could occur during the use of chainsaws and trimmers. However, these spills would be small and, in most cases, easily cleaned up before they spread to aquatic bodies.

Effects of Biological Treatments

Approximately 9,400 acres of wetland and riparian habitat would be treated using biological control methods. Nearly all acres would be treated using insects. Most of the acres treated would occur in the Temperate Steppe Ecoregion. Approximately 317,000 acres of upland habitat would be treated and livestock would be used for about 60% of treatments; insects and pathogens would be used to treat the remaining acreage.

Containment by Domestic Animals

Although livestock can be used to control vegetation, they can also potentially have additional effects on wetlands, riparian areas, and aquatic organisms. The degree of effect would be dependent on the duration and intensity of grazing. Removal of riparian vegetation by livestock has led to stream channels that are wider and shallower than streams in ungrazed areas (Hubert et al. 1985; Platts and Nelson 1985), although this is not always the rule (George et al. 2002). With increasing width and water depth, streams become warmer, and cold-water species are displaced by more tolerant, warm-water species.

There may also be some direct effects on aquatic organisms as a result of livestock wading in streams. Animals defecating into aquatic systems could create water quality conditions that cause injury or mortality to aquatic organisms.

Biological Control Agents

Biological control can involve the use of 1) host-specific organisms, 2) opportunistic native or exotic pathogens or insects, 3) general feeders, such as grass carp that control most types of aquatic vegetation, and 4) native herbivores. A disadvantage of biological control is that it can take many years, and thus is most effective in low-priority areas, where other vegetation control methods are cost prohibitive or are not practical.

Biological treatments using insects or plant pathogens would have little or no effect on aquatic organisms, but could alter their habitats by killing or harming host plants. In most cases, these biological treatment organisms would be released on foot or from ATVs, and vegetation weakened or killed by these organisms would remain in place, resulting in little soil disturbance in the treatment area.

Effects of Chemical Treatments

The use of herbicides to control noxious and nuisance aquatic plant species represents one of the most widely known and effective management options available. Herbicide control of invasive aquatic weeds is often the first step in a long-term integrated control program. Herbicides that could be used by the BLM in aquatic and riparian areas include 2,4-D, glyphosate, imazapyr, and triclopyr. In addition, the BLM proposes to use diquat and fluridone, and has prepared an HHRA and ERAs to address the risks associated with using these herbicides (see Appendixes B and C in the PEIS).

The remaining herbicides currently approved for use, or proposed for use, by the BLM would be used on uplands. Herbicides used to treat terrestrial vegetation on public lands would have the potential to enter water bodies and affect aquatic organisms through direct application into aquatic environments (of herbicides approved for use in these habitats), through accidental spraying (via aerial or ground applications), or through the movement of herbicides from upland areas to nearby water bodies in stormwater runoff. At low concentrations, herbicides would typically have little or no effect on aquatic organisms. At moderate concentrations, herbicides may not kill fish or other aquatic organisms, but could be detrimental to the survival, growth, reproduction, or behavior of certain organisms. At high concentrations, herbicides can be lethal to aquatic organisms.

Ecological risk assessments were conducted by the BLM and Forest Service to evaluate the risks to fish and other aquatic organisms from the use of 18 herbicides. The results of these assessments, including study methodology, herbicide mode of action, exposure scenarios, and toxicity characteristics for each herbicide, are summarized in the PEIS.

The purpose of the risk assessments was to identify the chronic and acute toxicity of herbicides to salmon and other aquatic organisms for typical exposures (runoff from nearby rangeland) as well as worst-case exposures (direct spray of water or accidental release of tank load from helicopter). For streams, the assessment assumed that fish reside in a small stream with limited water volume and dilution potential, characteristics that are typical of streams used by salmon for spawning and early rearing habitats. For each herbicide, the concentration of active ingredient likely to be found in the water under each exposure scenario was calculated, and then compared to the concentration that has been shown in scientific studies to be harmful to aquatic organisms, to determine whether the herbicides could affect aquatic species.

The extent of disturbance to fish and other aquatic populations caused by herbicide treatments would vary by the extent and method of treatment and chemical used. Herbicides could come into contact with and affect fish and aquatic invertebrates through drift, runoff, wind transport, or accidental spills and direct spraying. Potential effects include mortality, reduced productivity, abnormal growth, and alteration of critical habitat. In general, risk to aquatic invertebrates and fish from spray drift is greater with smaller buffer zones and application rates, and with application from greater heights (i.e., aerial application or ground application with a high boom). Risk to aquatic invertebrates and fish from surface runoff is influenced by precipitation rate, soil type, and application area. Under most accidental scenarios (direct spray or spill), there would be risks to aquatic invertebrates and fish. Furthermore, persistent herbicides adsorbed to soil particles could be carried off site by wind or water, affecting fish and aquatic invertebrates in nearby aquatic areas. However, in this analysis, wind transport of herbicide particles posed no risk, or only a low risk (diuron), to fish under the evaluated scenarios. Application rate was a major factor in determining risk, with scenarios involving maximum application rates most likely to pose a risk to fish.

The risk characterization process of the ERA suggested that chlorsulfuron, dicamba, diflufenzopyr, Overdrive®, and sulfometuron methyl are very safe to fish and aquatic invertebrates, as no risk was predicted for exposures involving these herbicides under any of the evaluated scenarios, including accidental direct spray and spill scenarios. In addition, imazapic does not pose a risk to fish or aquatic invertebrates, except when directly sprayed over a stream at the maximum application rate. There is no risk to fish or aquatic invertebrates associated with off-site drift of bromacil or tebuthiuron. Diuron can present a moderate to high risk to fish and aquatic invertebrates under surface runoff scenarios, if applied at the maximum application rate. The aquatic herbicides (i.e., diquat, fluridone, and glyphosate) do present a risk (low to high) to fish and aquatic invertebrates when applied to ponds and streams. This risk is greater for diquat than fluridone, which at the typical application rate only poses a risk to aquatic invertebrates in streams (aquatic herbicides are not typically applied to streams; therefore, this is an accidental scenario).

Beneficial Effects of Treatments

About two-thirds of wetland habitats and one-half of stream habitats in the western U.S. are considered by the BLM to be properly functioning. Nearly 100% of the streams and wetlands in Alaska are properly functioning. Much of the habitat management for fish in the western U.S. is guided by several policy documents. Prior to the 1990s, habitat management for fish and other aquatic organisms was primarily addressed in land use plans. In 1991, the Columbia River Basin Anadromous Fish Policy, a policy for anadromous fish protection in the Columbia Basin, was implemented. The PACFISH strategy, developed in 1995, outlines a strategy for anadromous fish habitat management, while the inland native fish strategy (INFISH), also implemented in 1995, provides guidance on management of resident fish outside of anadromous fish habitat in the Pacific Northwest. In addition, numerous Biological Opinions prepared by the USFWS and NMFS have helped to shape wetland and riparian habitat management.

Overfishing, mining, timber harvest, livestock grazing, agriculture, residential and commercial development, road building, and dam development and hydropower operations have been the primary factors contributing to the loss and modification of fish habitat in the western U.S. In addition to outright loss of habitat, turbidity, flow alteration, and high water temperatures are the primary factors that limit habitat quality for fish and other aquatic organisms on public lands. Habitat loss has not been uniform across the West; in wilderness and other protected areas, high quality habitat for fish and other aquatic organisms can still be found (USDA Forest Service and USDI BLM 2000b).

Of special concern to habitat managers in the West is the potential for a catastrophic event to occur, such as a wildfire or drawdown of water in a vernal pool, which would remove all of a species' habitat or severely limit the species' ability to move to more suitable habitat.

The BLM's highest priority is to use vegetation treatments to restore high priority subbasins within key watersheds to benefit fish and other aquatic organisms. Over the short term, adverse effects to aquatic organisms from vegetation treatment activities proposed by the BLM would occur, but treatments would lead to improved conditions for aquatic species over the long term. The eventual growth of desirable vegetation in treated areas would moderate water temperatures, buffer the input of sediment and herbicides from runoff, promote bank stability, and contribute woody debris to aquatic bodies. Ongoing efforts by the BLM to enhance riparian vegetation would also help to increase the number of miles of BLM-administered streams that are classified as "Proper Functioning."

Invasive aquatic vegetation spreads and rapidly colonizes water bodies. The canopy formed by invasive species can displace native species and alter animal communities in littoral zones and wetlands. An overabundance of an invasive species can create a visual barrier that interferes with the ability of larger predatory fish to feed. Reduced predation causes slower fish growth, favors smaller-sized fish, reduces the number of larger, harvestable fish, and results in poor quality sport fishing.

Removal of dense aquatic vegetation can lead to improved habitat for fish and other aquatic organisms (Dibble et al. 2004). Promotion of conditions that favor diverse aquatic plant communities increases the habitat complexity of aquatic systems, thereby providing a refuge for prey species and young predator species. Plants also provide habitat for invertebrates that are the food of many fish. Most fisheries studies have concluded that a moderate amount of vegetation is optimal for fish habitat. However, if a monoculture of an invasive species establishes that covers more than 85% of the pond or stream, most fish decrease in size and number. Thus, mechanical, manual, and herbicide treatments, and in some cases biological treatments, that reduce the amount of invasive aquatic vegetation would improve habitats for fish and other aquatic organisms. Because of concern over the spread of invasive aquatic species, two of the four new herbicides proposed for use by the BLM, fluridone and diquat, were chosen for evaluation based on their effectiveness against aquatic and riparian invasive species.

Vegetation treatments that restore native plant communities and ecosystem function would reduce sediment input into streams by improving degraded areas and providing suitable vegetative cover between areas of erosion and streams and other aquatic bodies (USDA Forest Service and USDI BLM 2000b). Improved cover adjacent to aquatic habitats would shade the water and reduce water temperatures. Removal of invasive vegetation, such as pinyon and juniper, could increase streamflow, while replacement of invasive species with native grasses, forbs, shrubs, and trees would stabilize streambanks and moderate streamflows. Furthermore, replacement of annual and perennial weeds and other invasive species with shrubs and trees would also increase the amount of woody debris in water bodies that can be used as habitat by fish.

Effects of Fire Treatments

Vegetation treatments that reduce hazardous fuels would benefit aquatic animals by reducing the chances that a large, uncontrolled wildfire would destroy a large amount of high quality aquatic habitat. Fire can adversely affect aquatic organisms by degrading water quality and raising water temperature. However, effects would be less severe for prescribed fires than wildfires.

Prescribed fire treatments could benefit salmon species by reducing hazardous fuel loads, and therefore the risk of a destructive high intensity wildfire. In many cases, pre-treatment fuels reductions (e.g., thinning and pile burning) would be necessary to reduce the severity of prescribed burns near or within riparian zones.

Effects of Mechanical and Manual Treatments

Mechanical methods are appropriate for vegetation treatments near water where a high level of control over vegetation removal is needed or the risks to aquatic habitats from the use of fire and herbicides are great. These treatments are especially effective in treating sensitive habitats or habitats that support sensitive fish species.

Manual treatments, which tend to be more selective and involve smaller treatment areas than other methods, would be less likely to affect wetland and riparian areas than the other methods.

Effects of Biological Treatments

Although most biological control would be accomplished using insects, there is at least some potential to use livestock to control riparian vegetation. Wetland grazing has been shown to provide desirable plant response when applied under the right conditions. Seasonal exclusion of cattle has been proven to be an effective management tool in regulating soil and vegetation effects. With the right timing and amount of grazing pressure, invasive plants such as reed canarygrass, river bullrush, and cattails can be severely injured. The extensive root systems of such species are shredded by the cow hooves. Brush and weed management is the greatest potential benefit that managed grazing provides to riparian areas. Goats and sheep have long been used for weed control. The use of goats in areas infested with leafy spurge has proven to be successful. Goats, which show a strong preference for spurge, are less costly than chemical control measures.

If treatments using insects and pathogens are successful, the plant community near the water body should improve and provide good habitat for aquatic organisms. It is possible that some biological treatment organisms could provide food for fish. When used in conjunction with other treatment methods, such as mechanical and chemical methods, biological control can provide effective long-term control of unwanted vegetation. Grass carp are effective in controlling water-thyme and other plant species. Weevils (*Neochetina* spp., *Hydrellia* spp.) are effective in controlling water hyacinth and water-thyme. Several species of weevils and leaf beetles (loosestrife root weevil, black-margined loosestrife beetle, golden loosestrife beetle, blunt loosestrife seed weevil, and salvinia weevil) have been used to control purple loosestrife and giant salvinia (Confrancesco et al. 2004).

Effects of Chemical Treatments

This risks and benefits of herbicide treatments to aquatic organisms are discussed in more detail in the PEIS. Each of the currently available and new herbicides evaluated in the PEIS has different properties (e.g., mode of action), is suggested for different uses, and is most effective/least risky in different scenarios. The more herbicides available for use, the easier it is to select one or more that would result in the least risk to fish and aquatic invertebrates for specific aquatic applications or terrestrial applications near waterbodies.

The BLM's ability to use four new chemicals (fluridone and diquat for aquatic applications, and imazapic and Overdrive® for terrestrial applications) would allow the BLM to use herbicides that have less risk to fish and other aquatic organisms than herbicides that are currently available for use by the BLM.

Effects to Special Status Fish and Other Aquatic Organisms

Public lands in the western U.S. support over 100 species of aquatic animals that have been given a special status based on their rarity or sensitivity. Included are 59 species of fish, 13 species of aquatic mollusks, and 6 species of aquatic arthropods that are federally-listed as threatened or endangered, or are proposed for federal listing. Some of these species have habitat requirements that have been or are being altered or reduced by invasions of non-native plant species. Populations of non-native aquatic species and riparian weeds may alter aquatic habitats, making them less suitable for special status fish and aquatic invertebrates. The *Final Programmatic Biological Assessment Vegetation Treatments on Bureau of Land Management Lands in 17 Western States* (USDI BLM 2007b) provides a description of the distribution, life history, and current threats for each federally-listed species, as well as species proposed for listing. The BA also discusses the risks to special status fish and aquatic invertebrates associated with vegetation treatments proposed by the BLM.

In general, the potential effects to special status fish and aquatic invertebrate species from the proposed vegetation treatments would be similar to those described for fish and aquatic vertebrates as a whole in the previous section. However, the rarity and sensitivity of special status species and their habitats make them more likely to be affected by disturbances associated with treatments. For many species, additional mitigation is required. In addition, populations of special status species may in some cases benefit more from fuels reduction and control of non-native species than aquatic animals with secure populations.

Standard Operating Procedures

The BLM would implement SOPs to minimize the risks to special status fish and other aquatic organisms from vegetation treatments (see Table 2-5). Examples of SOPs include surveying for species of concern if the project may impact federally-listed species; minimizing direct impacts to species of concern from fire treatments, unless studies show that these species will benefit from fire; minimizing the use of ground-disturbing equipment near species of concern; and using temporary roads when long-term access to treatment sites is not required.

Adverse Effects of Treatments

A general reduction in the plant biomass of riparian areas, which could occur by any of the treatment methods proposed for use on public lands, can have multiple consequences for aquatic species, including an increase in water temperature and sedimentation, and a decrease in water storage capacity. Riparian cover provides shade to aquatic habitats, which cools water temperatures, and reduces the extent of water temperature fluctuation. In addition, riparian vegetation stabilizes the soil on banks, preventing erosion and sedimentation into streams and other aquatic habitats, and intercepts rainfall to reduce overland flow. Riparian vegetation also increases habitat quality by buffering streams from incoming sediments and other pollutants, building a sod of herbaceous plants to form undercut banks, increasing habitat complexity, and increasing terrestrial invertebrate prey for fish species (Platts 1991).

Increased sedimentation entering aquatic habitats as a result of destabilized streambanks and increased erosion can cover spawning/rearing areas, thereby reducing the survival of fish embryos and juveniles. Sedimentation can also fill pool habitats, making them unusable by fish and other aquatic organisms. A number of sublethal effects to aquatic species may also occur as a result of sedimentation, including avoidance behavior, reduced feeding and growth, and physiological stress (Waters 1995). Over the long-term, increased sediment loads reduce primary production in streams. Reduced instream plant growth, combined with the reductions in riparian vegetation, can limit populations of terrestrial and aquatic insects, which also serve as food sources for many special status fish species.

Removal of large amounts of riparian vegetation, while potentially causing a surge of nutrients into streams, can alter the nutrient dynamics of the aquatic habitat. In areas where riparian vegetation has been lost to fire, a shift in energy inputs from riparian organic matter to primary production by algae and vascular plants have been predicted (Minshall et al. 1989) and observed (Spencer et al. 2003). This change in a stream's food web could alter the composition of food and thus energy sources that are available to special status fish and other aquatic organisms.

The increased solar radiation that results from the loss of streamside or poolside vegetation causes temperatures, light levels, and autotrophic production (plants and algae) to increase. The resulting effects on some special status species, and particularly salmonids, may include reduced growth efficiency, an increased likelihood of succumbing to disease, and an increase in food production.

Numerous special status aquatic animals are most threatened by changes in water levels and quality associated with development, upslope land use practices, and groundwater pumping, and the expansion of non-native fish populations. For most of the special status aquatic animals discussed in the BA, invasions of non-native plant species into riparian and aquatic habitats were not listed as threats to the species' survival. For these animals, health risks and effects to aquatic habitats associated with vegetation treatments could outweigh any habitat improvements resulting from minimized weed infestations. In addition, some treatments could have short-term adverse effects on special status fish and aquatic invertebrates by reducing the overall cover of riparian vegetation that regulates water temperature through shading. It is also likely, however, that the weed infestations (if present) in or near the aquatic habitats that support some of these species do not currently require treatments under the BLM's vegetation management programs.

Effects of Fire

The effects of fire on water conditions, such as heating and chemical changes, would be short term in duration. However, a temporary impairment of water quality in habitat occupied by special status fish and other aquatic organisms could have lasting population-level effects if individual animals were killed or became more susceptible to predation as a result.

Other short-term effects on water quality as a result of fire treatments would be expected to pose a greater risk to special status fish and other aquatic organisms than species with more secure and extensive populations. The potential increase in water temperature and influx of sediments, ash, and chemicals (e.g., those associated with foam lines) resulting from removal of vegetation in riparian areas could reduce the vigor of special status species populations, particularly if all of a species' limited habitat were affected.

Furthermore, use of water from aquatic habitats that support special status species for creating wet lines and extinguishing hot spots could adversely affect those habitats, particularly in arid climates or during dry seasons, when water is limited. Taking water from aquatic habitats with special status species could also result in inadvertent entrainment and/or harassment of those species, which could have lasting effects on sensitive populations.

Effects of Mechanical Treatments

As discussed for aquatic animals in general, use of heavy equipment in riparian areas could physically degrade aquatic habitats through bank collapse, use of heavy vehicles directly in the water, and leaking of equipment fuel or lubricants into the water. For some special status species, loss of even a few individuals, or destruction of even a small area of habitat could substantially increase the susceptibility of the population to future extirpation. Risks would be greatest if the treatments occurred over the entire area occupied by a population.

As discussed previously, aquatic habitats would likely be altered by mechanical treatments in adjacent riparian and upland habitats. The degree of alteration would depend on the size and intensity of the treatment, as well as site conditions and other factors. Treatments resulting in sedimentation into aquatic habitats through soil disturbance and removal of stabilizing vegetation would be expected to affect populations of special status species, especially those that require clear water. Although most effects would be short term in duration, lasting effects to species with sensitive populations could occur. Furthermore, removal of plants and woody material from riparian areas could result in a future loss of coarse woody debris, which would have a lasting effect on special status species that use such debris for rearing habitat, substrate (in the case of aquatic invertebrates), and to hide from predators. These effects to habitats would be greatest if woody vegetation within the distance of one tree height away from the channel was removed (National Fire Plan Technical Team 2002).

Effects of Manual Treatments

Although some removal of vegetation would occur during manual treatments, it is unlikely that loss of riparian vegetation would be as extensive as that occurring during fire or mechanical treatments, since manual treatments are economically feasible only for limited weed infestations. Manual treatment methods are typically associated with minimal environmental effects, and as such are often appropriate for sensitive habitats, such as riparian areas. Some soil disturbance would occur during the removal of plants from the soil, but it would not be widespread and should not have a major effect on aquatic habitats. Provided manual methods are used appropriately (e.g., for small infestations and where native vegetation will replace the pulled weeds), effects of this treatment method should be beneficial to special status fish and aquatic invertebrates.

Effects of Biological Control Treatments

Containment by Domestic Animals. As discussed previously, the potential for weed containment by domestic animals to affect fish and other aquatic organisms is dependent on the size of the treatment area, the number of animals involved, the duration of the treatment, and how close to the water animals are allowed. Special status species would likely be more sensitive to water quality degradation from associated sedimentation or inputs of feces into the water than species with secure populations. Though most effects would be short term, they could have lasting effects on special status fish and aquatic invertebrates. If animals were allowed to enter the water occupied by special status species, some mortality or injury could occur, primarily to eggs and pre-emergent fry, but also adults of smaller fishes and other aquatic organisms. For species with small, isolated populations, increased risks of extirpation could result.

Special status fish and other aquatic organisms could also experience long-term effects from any structural changes to habitat resulting from intensive or repeated weed containment scenarios occurring in or near their habitats (e.g., widened or incised stream channels, streambank collapse, lowered water table, or loss of pools or undercut banks). Special status species often have very particular habitat requirements that contribute to their limited distribution. Loss of any of these habitat features could lead to extirpation of a population, with risks increasing the greater the portion of habitat affected.

Other Biological Control Agents. Use of biological control agents in aquatic and riparian habitats would result in the loss of some vegetation, so the general effects discussed above could potentially occur. Unlike under other treatment methods, however, the loss of vegetation resulting from biocontrol agents would be gradual, and therefore less likely to have a noticeable effect on aquatic systems. Some soil disturbance resulting from workers releasing agents in riparian areas could occur, but would be unlikely to have substantial effects on aquatic habitats.

Biological control agents would be thoroughly tested, and permitted by the USDA Animal and Plant Health Inspection Service prior to release. Despite these safeguards, there is always a risk that the release of an organism into a habitat in which it does not normally occur can result in unforeseen ecological repercussions. These unanticipated effects of biological control agents would be impossible to predict, although the appropriate precautions would be taken to prevent their occurrence.

Effects of Chemical Treatments

Risks to special status aquatic animals from herbicide treatments could be greater than risks to aquatic species with more secure populations. Diquat could affect special status fish and aquatic invertebrates during a normal application to an aquatic habitat. Normal applications of 2,4-D and imazapyr would not pose a risk to special status fish or aquatic invertebrates.

Terrestrial herbicides with the greatest likelihood of affecting special status aquatic animals as a result of a spill, drift, accidental direct spray into an aquatic habitat, or surface runoff are diuron and picloram. According to ERAs, there would be no risks to fish or aquatic invertebrates associated with chlorsulfuron, dicamba, diflufenzopyr, imazapic, Overdrive®, or sulfometuron methyl.

Beneficial Effects of Treatments

The invasion and spread of non-native plant species into aquatic and riparian habitats may affect certain populations of special status fish and other aquatic organisms. An overview of the ways in which non-native aquatic and riparian plants may affect aquatic habitats is presented earlier in this section. As discussed in the BA, numerous special status fish species are threatened by changes in water quality and flow, which may result from weed infestations. Salmon, for example, require a high level of dissolved oxygen, which is reduced when aquatic weeds such as Eurasian watermilfoil and water-thyme invade an aquatic system. A decrease in dissolved oxygen associated with the encroachment/excessive growth of vegetation has also been listed as a threat to the Foskett speckled dace in south-central Oregon (USFWS 1985) and the unarmored threespine stickleback in southern California (NatureServe Explorer 2001). For species such as these, treatments to reduce coverage of non-native plant species in aquatic and riparian habitats would likely improve habitat over the long term.

Provided short-term adverse effects to special status aquatic animals were avoided, a well-managed prescribed fire could have a beneficial effect on special status aquatic species over the long term, as a result of improved and rejuvenated habitat, as well as increased productivity (Minshall and Brock 1991, Burton 2000). Over the long term, there could also be an increase in populations of special status species as a result of a more healthily functioning ecosystem. This benefit would especially be true for riparian habitats that were historically subject to frequent, low intensity burns. Both the condition of the site prior to burning and the intensity of the burn would influence whether the end result of the fire was beneficial. Even a high intensity burn could eventually have a beneficial effect on riparian/aquatic habitats, especially if site restoration measures were followed post-burn.

Treatments would help to restore natural fire regimes and reduce the risk of wildfire. Wildfires influence aquatic systems by heating water or changing its water chemistry. Indirect effects include changes in hydrologic regime, erosion, debris flows, woody debris loading, and riparian cover. Wildfires kill fish and have caused local extinctions. A study of bull trout and redband trout on the Boise National Forest showed that wildland fires resulted in extensive direct mortality, as well as increased erosion, debris torrents, and other habitat effects. Treatments that minimize the threat of wildfire would reduce these types of risks to fish.

Interestingly, the numbers of fish on the affected stream reaches returned to near normal within 3 years after the fire (Rieman et al. 1997). This may be because large disturbances have been common in these systems in the past (Meyer and Pierce 2003 *in* Rieman et al. 2005). Fire can contribute coarse woody debris and sediment to streams that provide structure (Bisson et al. 2003 *in* Rieman et al. 2005). Although it opens the canopy, resprouting and increased growth of riparian vegetation can offset shade losses because of canopy reduction, and provide a source of insects into the stream.

Wildlife Resources

Wildlife occupies widely diverse habitats in the western U.S., and serves many different roles (e.g., herbivore, predator, scavenger). Many wildlife species can be found in several environments, but others are limited to one or two habitats. Species that are wide ranging and use several habitats are usually better able to adapt to change than species with narrow habitat requirements. As conditions worsen in one area, perhaps due to a large fire, they move to other areas. However, as animals move to a new area, the amount of food and other resources available to wildlife decreases per animal as the population in the area increases. Thus, a major habitat change in one area can indirectly cause a reduction in wildlife health and productivity, and potentially reduced habitat quality, in another area.

Species that depend on one or a few habitats are vulnerable to disturbance, and can become extinct as a result of extirpation from catastrophic wildfire or other major natural or man-made effects to habitats. Many of the species listed in the BA, which accompanies this PER, are restricted to small patches of habitat. Species with limited mobility are also susceptible to change.

Mobile species and animals that can use a variety of habitats usually move into other habitat types when change occurs. However, if change occurs across a broad area, as has occurred in sagebrush habitat in the Great Basin, even relatively adaptable and mobile species may decline in numbers. In addition, if habitats become fragmented, species populations may become isolated and unable to breed with other populations and exchange genetic material, which is often necessary to maintain small populations.

As a result of changes that have occurred on public lands and throughout the western U.S. from altered fire regimes, the spread of weeds and other invasive vegetation, and other human causes, habitat has declined for many wildlife species. Declines in habitat extent and quality during the past century are largely responsible for the listing of many species as threatened or endangered.

Scoping Comments and Other Issues Evaluated in Assessment

Respondents felt that the BLM should manage for biodiversity and identify specific sites that have high wildlife value. Other respondents wanted the BLM to address the habitat requirements of different wildlife species and the ways in which vegetation treatments would influence these habitats. The potential effects of treatments on ground-nesting birds were also mentioned as an important issue to consider. It was noted that burning may remove desirable habitat, and protecting biodiversity before and after fire was suggested. Some respondents felt that spring burning would harm wildlife, and that it is not consistent with natural fire regimes. Some concern was expressed that firelines might be used as vehicle routes and cause degradation of vegetation and wildlife habitat.

Numerous comments also promoted the idea that wildlife habitat improvement efforts should be directed at restoring habitat and natural ecological processes. Several respondents suggested that the role of keystone species, such as the prairie dog, pronghorn, and American bison, are important considerations. Respondents were also concerned about the impacts of treatments on habitat of wildlife used for subsistence (e.g., reindeer).

The protection of greater sage-grouse and their habitat was advised. It was noted that carefully applied herbicides may improve greater sage-grouse habitat. Comments also suggested that impacts to northern spotted owl habitat should be identified and addressed. It was noted that the maintenance of early-successional deciduous vegetation and a mosaic of vegetation types is important for most wildlife. One respondent suggested that the treatment of critical habitat areas would force wildlife to other areas, and wondered whether the BLM would also manage those areas. One respondent noted that aggressive tamarisk removal efforts in the Mojave River have killed wildlife in the past. Respondents also felt that impacts of treatments on soil and litter organisms, insects, and snag habitat should be analyzed.

Numerous comments encouraged the BLM to use this process as an opportunity for the recovery of the full range of native species and ecosystems across the western states, including the greater sage-grouse, white-tailed and black-tailed prairie dogs, black-footed ferret, Columbia spotted frog, Washington ground squirrel, and wolves.

Resource Program Goals

The Wildlife Management program, a subprogram under the Wildlife and Fisheries Management program, is responsible for wildlife habitat management on public lands. The purpose of the program is to maintain and restore wildlife and their habitats by conserving and monitoring habitat conditions, conducting wildlife resource inventories, and developing cooperative management plans, while providing for environmentally responsible recreation and commercial uses. Management actions emphasize on-the-ground and in-the-water actions that measurably increase the health of wildlife populations and reduce the need to federally list species of wildlife. The program supports the BLM's strategic plan by improving the health of watersheds and sustaining biological communities. The overall goal is to restore and maintain proper functioning conditions in aquatic, wetland, riparian, and upland systems (USDI BLM 2006c).

Standard Operating Procedures

This assessment of treatment effects assumes that SOPs listed in Table 2-5 for vegetation and wildlife would be used to reduce potential unintended effects to non-target vegetation and to minimize harm and disturbance to wildlife. Effort would be made to protect beneficial habitat characteristics and to protect special status species and their habitats. These SOPs include minimizing treatments during nesting and other important periods for birds and other wildlife; minimizing burns immediately prior to important use periods, unless the burn is designed to stimulate forage growth; retaining wildlife trees and other unique habitat features, where practical; and designing chaining activities to provide the maximum mosaic of treated and nontreated sites. For biological treatments with domestic animals, grazing would be minimized where/when it could impact nesting and/or other important periods for wildlife, and where it would be likely to result in removal or physical damage to vegetation that provides critical sources of food or cover for wildlife. SOPs for herbicide treatments, which are summarized in Table 2-8 of the PEIS, include using herbicides of low toxicity to wildlife, where feasible, and conducting pre-treatment surveys for sensitive habitat and wildlife species of concern. To minimize the potential for adverse effects to amphibians, the BLM would limit the use of herbicides in areas occupied by amphibians; and would avoid using glyphosate formulations that include R-11, and either avoid using formulations with POEA or use the formulation with the lowest amount of POEA available.

Adverse Effects of Treatments

The extent of these disturbances would vary by the extent and type of treatment, as discussed in the sections that follow. Over the short term, fire and other treatments could make habitats less suitable for some wildlife species, requiring displaced wildlife to find suitable habitat elsewhere. If these habitats were already at or near capacity in the number of wildlife they could support, displaced animals might perish or suffer lower productivity. In many cases, the treatments would return all or a portion of the treated area to an early successional stage, favoring early successional wildlife species. In areas where fire suppression has historically occurred, vegetation treatments could benefit native plant communities by mimicking a natural disturbance component that has been missing from these communities. Treatments would also restore native vegetation in areas where weeds and other invasive vegetation have displaced native plant species. Wildlife that occurred historically in these areas would likely increase in numbers, while species that have adapted to the disturbed conditions would decline.

Approximately 15% of treatments would be specifically designed to benefit wildlife habitat, although nearly all treatments would provide some benefit to wildlife habitat. Most treatments would occur in the Temperate Desert (50% of all treatments), Temperate Steppe (28%), and Mediterranean (8%) ecoregions.

Effects of Fire Treatments

Approximately 63% of fire treatments would occur in the Temperate Desert Ecoregion to benefit greater sage-grouse and other sagebrush-dependent species. Twelve and 9% of treatments would occur in the Subarctic and Subtropical Steppe ecoregions, respectively. Nearly half (48%) of all fire treatments would occur in evergreen shrublands and 19% would occur in evergreen woodlands. Six percent of treatments would occur in evergreen forests and perennial graminoid communities.

The effects of fire on wildlife and other fauna have received considerable attention in recent years, and there is an increasing literature base available documenting fire-wildlife relationships. Several references were used as primary sources to prepare this section: *Fire: Its Effects on Plant Succession and Wildlife in the Southwest* (Wagle 1981); *Final Environmental Impact Statement Vegetation Treatment on BLM Lands in Thirteen Western States* (USDI BLM 1991a); *Wildlife Habitat Management of Forestlands, Rangelands, and Farmlands* (Payne and Bryant 1998); *Wildland Fire in Ecosystems: Effects of Fire on Fauna* (Smith 2000); and *Terrestrial Wildlife and Habitat* (Anderson 2001).

Fire has influenced the composition, structure, and landscape patterns of animal habitat for millions of years, so it can be assumed that wildlife have coexisted and adapted to perturbations from fire (Lyon et al. 2000b). Fire is irreplaceable for many organisms, and aside from using livestock as a tool to enhance habitat, it is more practical to use, ecologically and economically, than other treatment methods (Payne and Bryant 1998). Fire has an ecological role in the development of most habitats. Fire changes the composition and distribution of vegetation, and generally improves the palatability and nutritional value of forbs, grasses, and some shrubs. Fire also promotes early-spring greenup, which is important to the nutrition of pregnant animals and young, and can remove dead and dying material that may limit access by wildlife to living vegetation (USDA Forest Service and USDI BLM 2000b).

Fire can kill and injure animals, although the number of wildlife killed by fires is probably a small proportion of most animal populations (Lyon et al. 2000a). Animals with limited mobility that live above ground are most vulnerable, but at times even large mammals are killed by fire, as evidenced by the Greater Yellowstone Area fires in 1988 that killed about 1% of the elk population (Singer and Schullery 1989). Fire may threaten a population if it is limited in size, range, or mobility, such as the extinct heath hen, whose demise might have been accelerated by scrub fires (Lloyd 1938).

Time of year of fire is an important variable in wildlife mortality. The eggs and young of birds are susceptible to fire, especially ground-nesting birds. The nesting season often coincides with the active period of plant growth, when moisture conditions are too wet to sustain prescribed fires. If a fire burns in a mosaic pattern, leaving some areas of vegetation relatively unscathed, some young may survive. The young of small mammals that build dens or nests near the ground, such as small rodents and hares, are susceptible to fire. Woodrats are particularly susceptible to fire mortality because of their reluctance to leave their houses even when a fire is actively burning (Simons 1991). Small mammals can often escape fire by going into burrows or hiding in rock crevices, under stumps or roots, or in large dead wood (Ford et al. 1999).

Fire regime and microsite characteristics can influence wildlife mortality from fire. Many desert and semi-desert habitats burned infrequently in the past because of sparse fuels. In these areas, patchy fire spread may have provided areas of unburned habitat where reptiles and small mammals could escape fire. Some amphibians and reptiles, in addition to small mammals, escape fire by burrowing into the soil or hiding under moist duff or leaves that burn less readily than drier forest or rangeland materials (Ford et al. 1999).

Wildlife that leaves an area due to fire may return soon thereafter if food or cover is available in unburned areas, or even in burned areas. For example, scavengers and predators will often return to a burned area to feed upon insects or other dead or dying animals harmed by fire. Geese often move into burned marshes while plants are still smoldering to feed on plant roots, while deer and other herbivores may return to a burned area after greenup. Other wildlife may emigrate until more suitable conditions return. A number of bird species show declines in numbers for several years after a burn, while numbers of other species increase. Caribou may avoid burned areas for 50 years or more until lichens, a preferred food, become reestablished in the new forest (Thomas et al. 1995).

Fire creates a mosaic of different kinds of vegetation (Mushinsky and Gibson 1991), with variability in size, composition, and structure of patches, as well as connectivity among patches. Within a large fire, there can be substantial variation in fire severity and many patches of vegetation may not burn, resulting in variation in plant mortality and perpetuation of the mosaic nature of the landscape (Gasaway and DuBois 1985, Smith 2000). Some areas will burn more intensely than others, influencing the nature of the vegetation that remains. When fire increases the heterogeneity of the landscape, some species of wildlife benefit from having increased opportunities to select from a variety of habitat conditions and successional stages.

Fire Effects by Ecoregion

Tundra Ecoregion. Fire use is not planned for the Tundra Ecoregion (Table 4-9), and prescribed burning is generally not recommended. If fire were to occur it would consist of wildland fire use for resource benefit.

As stated in the *Alaska Interagency Wildland Fire Management Plan* (Alaska Wildland Fire Coordinating Group 1998), "lightning caused wildland fires are an important component of the boreal forest and Arctic tundra ecosystems, and the complete exclusion of these fires is neither ecologically sound nor economically feasible."

The effects of fire on northern ecosystems were discussed under Vegetation in this Chapter. Enhancement of grasses and sedges using fire would benefit nesting shorebirds and waterfowl, and their young. Fire would also reduce cover and may make birds and small mammals more visible for snowy owl and other raptors, Arctic foxes, and other predators.

Subarctic Ecoregion. About 12% of proposed fire treatments would occur in this ecoregion. In the Subarctic Ecoregion, deciduous shrublands would receive most of the fire treatments, but spruce and aspen stands could also be treated.

Stand replacing fires in the black spruce forest could cause a shift from canopy dwelling to ground- and shrub-dwelling bird species. In some cases, over 70% of birds found in a burned area were not present in the preburn area. Numbers of black-backed woodpeckers could increase in the post-burn community, while ovenbirds may avoid burned areas. Fire can also cause a substantial reduction in the number of nesting territories the first few years after fire (Apfelbaum and Haney 1981).

Stand replacing fires in the boreal forest may skip as much as 15% to 20% of the area within their perimeters, providing a variety of habitats for wildlife and allowing resident species to find habitat even after the burn (Smith 2000). Stand-replacing fires can reduce the lichens that caribou use as forage in winter. For winter use, caribou prefer open forests in which preferred lichen species have reestablished, which usually takes at least 50 years after a fire. Their preference is related to abundance of food, snow cover, visibility from predators, and nearness to traditional travel routes. Lichens decline in old stands (over 200 years); thus fires of moderate to high severity may be needed to maintain forage for caribou in the long term (Klein 1982; Auclair 1983; Schaefer and Pruitt 1991; Thomas et al. 1995).

Temperate Desert Ecoregion. Nearly 60% of fire treatments would occur in the Temperate Desert Ecoregion, where the main vegetation types that would be treated are evergreen shrubland (e.g., sagebrush) and evergreen woodland (e.g., pinyon-juniper).

Evergreen Shrubland. Fire kills big sagebrush, little sagebrush, and black sagebrush. Fire can stimulate bitterbrush in a mountain big sagebrush community, but damage bitterbrush in a basin big sagebrush community (Bunting et al. 1985). Autumn burns are most harmful to sagebrush, while summer burns are most damaging to bitterbrush (Britton and Clark 1985, Vallentine 1989).

Several species of birds, including greater sage-grouse, sage thrasher, sage sparrow, and Brewer's sparrow are sagebrush obligates. Although the number of bird species in sagebrush habitats is far less than in forest habitats, some species, such as the greater sage-grouse, live nowhere else (Paige and Ritter 1999). Site selection by these species is positively correlated with sagebrush cover; greater sage-grouse require mature sagebrush as part of their habitat (Benson et al. 1991). Thus, burning must be done with caution to ensure that sufficient and suitable habitat remains for these species.

Fewer birds were observed after a fire in big sagebrush in Montana killed nearly 100% of the sagebrush (Bock and Bock 1978b). Sagebrush obligates avoided burned areas and used areas with sagebrush, although western meadowlark, a grassland bird, was attracted to the burn site (Huff and Smith 2000). Male attendance at sage-grouse leks in prescribed burn areas in Idaho were greater than untreated areas (Connelly et al. 2000a) Burning can create a long-term negative effect on greater sage-grouse nesting habitat because it can take sagebrush 20 or more years of postburn growth to develop sufficient canopy cover needed for greater sage-grouse nesting. Thus, prescribed fire should be used sparingly, or not at all, in sagebrush habitats. Prescribed fire can also harm shrews and other small mammals if patches of unburned vegetation are not provided in the burn area (Klebenow and Beall 1977, USDI BLM 1991a).

Fire can be used to create a mosaic of sagebrush and grassy patches, as long as key habitats are protected (e.g., greater sage-grouse nesting and brooding habitat). Increased grass production benefits mule deer and bighorn sheep (Lauer and Peek 1976; Willms et al. 1981; Payne and Bryant 1998). Neither extensive dense sagebrush nor extensive open space constitute optimal habitat for greater sage-grouse. While burning may restore the balance of plant community components in greater sage-grouse habitat, it also raises the risk of increasing downy brome productivity, which may cause the area to reburn before the sagebrush can recover. In a literature review, Connelly et al. (2000b) noted that prescribed burning has led to declines in greater sage-grouse breeding populations and has had long-term negative impacts on nesting and brood-rearing habitats. They also cited studies that showed that forb populations held steady, while insect populations declined, when an area was burned, as compared to nonburned areas. Baker (2006) noted that a mosaic of burned and unburned areas may be tolerated by certain wildlife, but can be detrimental to sagebrush obligates.

Burning large areas to eradicate sagebrush is detrimental to birds in sagebrush habitats because it removes shrub cover (Paige and Ritter 1999). More importantly, it can promote the conversion of shrubland to non-native annuals such as downy brome. Wildfire suppression should be encouraged in areas prone to downy brome infestations. Restoring native plants is crucial before fire is reintroduced or allowed to continue if further conversion to downy brome is to be avoided.

Evergreen Woodland. Under natural fire cycles, the successional stages following fire are typically annuals; mixed annuals and perennials; perennial forb; grass and shrub; shrub and pinyon-juniper; and climax pinyon-juniper. Young pinyon and juniper trees are readily killed by fires, but older trees may be less susceptible due to thicker bark and more open crowns.

Treatments would focus on reducing the encroachment of pinyon-juniper woodlands into sagebrush-grass and grassland habitats. However, there is limited information on the effects of these treatments on wildlife species, even though over 70 species of birds nest in pinyon-juniper woodlands, and mule deer and elk are also important inhabitants. Birds, including pinyon jays, and other wildlife often initiate the reestablishment of woodland by transporting pinyon and juniper seeds and berries to burned areas. Pinyon-juniper woodlands also provide habitat structure that would be lost if woodlands were converted to grasslands (Maser and Gashwiler 1978). Reduction of pinyon-juniper habitat would adversely affect species that favor pinyon-juniper habitat, but should benefit species that favor habitat, such as grasslands, that result from pinyon-juniper treatments. Creation of a mosaic of pinyon-juniper, and different ages of recovering sagebrush-grass, would provide the widest diversity of habitat for wildlife.

Large burns create more homogenous conditions that are less favored by wildlife, and remove thermal and hiding cover needed by deer and elk (USDI BLM 1991a). Large burns can also damage large, older trees that provide mast of juniper berries and pinyon nuts (Balda and Masters 1980). Often, fire may not have much effect unless combined with other treatments, including mechanical treatments such as chaining. Burns conducted during spring are often more successful in promoting grass development, while burns during drier periods can reduce herbaceous yields and increase erosion (Wink and Wright 1973).

Subtropical Desert Ecoregion. About 1% of fire treatments would occur in the Subtropical Desert Ecoregion, and fire treatments would predominately occur in evergreen shrubland and perennial grassland communities.

In many areas of the Mojave and Sonoran deserts, plant communities are too sparse during most years to adequately carry a prescribed burn. Therefore, this type of treatment would not be suitable for these areas. In areas that have increased fuel loading as a result of invasive annuals like red brome, prescribed fire would negatively affect plant communities by encouraging the further spread of these invasive species. In the denser desert shrublands, where there is an adequate amount of fuel to support a fire, many shrubs, trees, and cacti could be severely affected by burning, as these species are not adapted to fire. Paloverde, burroweed, bursage, broom snakeweed, ocotillo, and creosote bush are examples of desert species that can suffer high mortality rates from burning (Wright and Bailey 1980).

Fire in desert grasslands may benefit scaled quail, but harm Gambel's quail (Wright and Bailey 1982). Fire suppression in some desert areas has allowed mule deer and white-tailed deer to expand their range and increase in numbers, thus prescribed fire could reduce habitat for these species.

Temperate Steppe Ecoregion. Seven percent of fire treatments would occur in the Temperate Steppe Ecoregion. Vegetation types that would likely receive fire treatments include evergreen forests, evergreen shrubland, and perennial graminoid communities.

Perennial Graminoid. Prescribed fire could have either positive or negative effects on plains grasslands of the Temperate Steppe Ecoregion, depending on its timing and severity. In some areas, use of infrequent, low intensity fires could benefit grasslands by preventing the encroachment of woody species. Some shrubs, however, would be difficult to control using fire. Honey mesquite and sand shinnery oak, for example, both have the ability to resprout vigorously after fire (Wright and Bailey 1980). In addition, fires may not reach high enough to kill taller shrubs that are encroaching into shortgrass habitats. Fire can kill seedlings of these shrubs, and topkill taller plants. Resizing them can reduce their dominance on the site and improve water availability for grasses, forbs, and smaller shrubs.

Some butterfly species require forbs found in fire-dependent grasslands. The larvae, however, are usually very sensitive to fire. To protect butterflies, managers will often divide the landscape so every burn area contains patches that are not burned so that the butterfly can repopulate after the burn (Kwilosz and Knutson 1999).

In mountain grassland communities, where fire has been actively suppressed, prescribed fires could be beneficial to wildlife that favor grasslands by preventing the encroachment of woody species such as ponderosa pine, Douglas-fir, lodgepole pine, and sagebrush. However, bird species abundance is often higher in areas with shrubs.

Evergreen Forests. Open forest types (e.g., ponderosa pine, Douglas-fir, and western larch) would likely benefit from low-intensity prescribed fires, which would reduce the density of understory shrubs and tree seedlings, and encourage vigorous and abundant herbaceous vegetation and resprouting shrubs. Thinning, and sometimes removal of thinning slash, can be required in some of the dense stands before fire can be reintroduced. If thinning slash is not removed, the stand can still be susceptible to mortality from surface fires, even though the likelihood of crown fires has been significantly reduced.

Stand replacing fires typically result in many or most of the bird species present before the fire being replaced by new species (Finch et al. 1997). In the Grand Teton-Yellowstone region, more bird species were unique to the postburn community than to later stages of succession (100+ years; Taylor and Barmore 1980). In ponderosa pine forests in Arizona, stand-replacing fire also resulted in many bird species that were unique to the postburn community, while birds present before the burn left for other habitats (Lowe et al. 1978).

In ponderosa pine forests, granivores, tree drilling species, and some aerial insectivores usually increase after fires, while tree- and foliage-gleaning species usually decrease. Birds closely tied to foliage availability, such as hermit thrush, begin recovering as foliage volumes increase in subsequent years. Woodpecker abundance may peak in the first decade after fire, but then gradually decline (Finch et al. 1997).

A study of thinning and wildfire on small mammal populations in ponderosa pine forests found that several species, and total small mammal biomass, increased following thinnings and wildfire. The authors hypothesized that fuel reduction treatments would have the largest positive impact on small mammal populations in areas where tree densities are especially high (Converse et al. 2006).

Subtropical Steppe Ecoregion. Approximately 9% of fire treatments would occur in this ecoregion. Vegetation types that are proposed for vegetation treatments include perennial graminoid communities, evergreen shrublands, and evergreen woodlands. Treatments would focus on reducing hazardous fuels.

Perennial Graminoid. The xerophytic grasslands of the Subtropical Steppe Ecoregion support sparse shrubs and low trees, and exist on a continuum with evergreen woodlands (described below). The common plant species of grasslands would show a variety of responses to fire.

Prescribed fire treatments in the arid perennial grasslands of this ecoregion would potentially benefit these communities, and the wildlife they support, by controlling the invasion of shrubs such as mesquite, creosote bush, and tarbush. As is true for all of the plant communities discussed in this section, the benefits of fire would be dependent on the frequency of fire and the condition of the site prior to the burn, as well as the timing of the burn. Fires would maintain perennial bunchgrass communities at 5 to 40 year intervals. Fires would displace wildlife that depend upon shrub communities.

The effects of prescribed burns in winter on the relative abundance and species richness of breeding and wintering birds in mesquite grassland showed that relative abundance was greater in burned areas, but species richness was not different. Thus, unburned areas should be maintained next to burned areas to provide habitat for bird species that favor both habitat types (Reynolds and Krausman 1998).

Evergreen Shrubland. Chaparral shrub species in the Subtropical Steppe Ecoregion are fire-dependent, are comprised of highly flammable species, and grow rapidly after fire, taking about 25 years to mature and senesce (Brown and Smith 2000). The production of dead fuels in chaparral stands is not well understood, but it probably increases with age and after a drought. Fuels in chaparral communities are not as easily ignited as grass fuels, but will burn readily under hot, dry conditions.

In Arizona, fire is the main management tool used to open dense shrub canopies for edge wildlife. Although chaparral sprout vigorously within a few years after a burn, repeated burns can harm plants. Fire plus herbicides eliminates birchleaf mountain mahogany, a preferred deer food (Severson and Medina 1983). Burns during the warmer and drier periods of the year can also be harmful to vegetation used by wildlife.

Fire and herbicide treatments have been used to control chaparral in Oklahoma. Herbicide applications without fire do not benefit most reptiles, while herbicide applications with fire can adversely affect amphibians. Where eastern red cedar has invaded grassland habitats and now dominates, reptile and amphibian populations are reduced from historic levels. Maintenance of a mosaic of habitats is needed to maintain a diversity of reptiles and amphibians in chaparral.

Mediterranean Ecoregion. Fire treatments in the Mediterranean Ecoregion would be directed at evergreen forest and evergreen woodland. About 4% of fire use would occur in this ecoregion, and treatments would support efforts to improve forest health and reduce hazardous fuels. Evergreen forests in this region historically had an understory fire regime or a mixed severity fire regime, and are presently at risk for high-intensity, stand-replacing crown fires due to large fuel accumulations.

Changes in avian communities were studied in evergreen forests in the Sierra Nevada range. Changes in the avian community were related to changes in vegetation structure with succession. In the first 8 years after the burn, bird abundance on burned plots was similar to that on unburned plots, but species that were characteristic of low shrub and ground habitats predominated in burned areas. Woodpeckers were also more common on the burn area after the burn than before. By year 15 after the burn, bird diversity had decreased, as fewer snags were present and the shrub cover became denser. As the shrub community continued to develop from years 15 to 25, birds that fed and nested in shrubs also increased (Bock et al. 1978).

Frequent, low intensity fires help to maintain open oak stands with a grassy understory in the Mediterranean and the Marine ecoregions (Agee 1993). More intense fires can kill oaks. Some oaks do not produce mast until they are a certain size, and if fire kills trees before they become large enough, mast production for birds and squirrels can be limited (McCulloch et al. 1965).

Marine Ecoregion. Approximately 2% of fire treatments would occur in the Marine Ecoregion, primarily in evergreen woodlands and forests.

These humid maritime forests are extensive at lower and middle elevations west of the Cascades and the British Columbia Coast Range. The cooler, wetter, and more northerly portions of the coastal Douglas-fir type (generally associated with the mountains of western Washington and southwestern British Columbia) burned in stand-replacement fires at long intervals, averaging 200 to several hundred years (Agee 1993).

In Washington, stand-replacing fires in western hemlock forests resulted in the bird community shifting from one dominated by canopy-dwelling species to one dominated by species that nested and foraged near the ground (Huff et al. 1985). Once a full canopy develops in a hemlock forest, few changes occur in bird species composition. Since fire return intervals are long in hemlock forests, bird species composition may remain relatively stable for centuries. Long fire return intervals and large forest stands would benefit forest-interior dwelling species, while forest-edge species and species that favor early successional plant communities would be found in recently-burned areas.

Effects of Mechanical and Manual Treatments

Approximately 80% of mechanical treatments would occur in the Temperate Desert Ecoregion, and 7% and 5% would occur in the Temperate Steppe and Mediterranean ecoregions, respectively. Forty percent of treatments would occur in evergreen shrubland and 20% in evergreen woodland communities.

Mechanical treatments would injure or kill plants by removing some or all of the plant material on the treatment site. Mechanical methods are effective in restoring wildlife habitat and are the primary means of reseeding a site. However, equipment is often noisy, and noise may alter animal behavior or cause wildlife to leave an area during the disturbance period.

Manual treatments can be expensive, but they allow for more precise vegetation control than other methods and are often suitable in areas with sensitive wildlife species. Hand-held equipment, including chainsaws, create noise that can disturb animals and cause them to flee or alter their behavior or habitat use. These effects would be short-term and not likely to have much effect on the long-term health and habitat use of wildlife in the treatment area.

Mechanical Effects by Ecoregion

Tundra Ecoregion. No mechanical treatments are scheduled to occur in this ecoregion. If treatments were to occur, they would be designed to minimize damage to tundra by scheduling them during the appropriate season and/or using the appropriate equipment.

Subarctic Ecoregion. No mechanical treatments are scheduled to occur in this ecoregion. If treatments were to occur, they would occur predominantly in mixed evergreen/deciduous forests and evergreen forests. Treatments could be used to create a mosaic of habitats for wildlife. Mechanical treatments would be favored in areas where habitat management was required, but where use of fire or chemicals would provide less control or could result in harm to human life or property or to species of concern and their habitats.

Temperate Desert Ecoregion. An overwhelming majority of the proposed mechanical treatments would occur in the Temperate Desert Ecoregion, in evergreen shrubland communities.

<u>Evergreen Shrubland</u>. Most of the mechanical treatments in evergreen shrubland would involve tilling or plowing of sagebrush, followed by seeding or drilling. Other mechanical treatments, such as mowing, chopping, and chaining, would also be used, but to a lesser extent. Treatments would target woody species (e.g., big sagebrush, rabbitbrush, and greasewood), with the goal of encouraging certain species of perennial bunchgrasses, forbs, and shrubs. Plowing would be used in areas with little herbaceous understory, where soil disturbance would help prepare the seedbed for revegetation.

Mechanical treatments can be used to create openings in sagebrush habitats for use as foraging habitat and greater sage-grouse leks. Mechanical treatments also eliminate the uncertainty of size and shape of treatment that is common with prescribed burning (Urness 1979). Mechanical treatments can be designed to avoid more important sagebrush species or patches of habitat.

Mechanical methods to treat sagebrush include plowing, disking, rotobeating, chaining, and shredding. Chaining is often favored because it does not kill all of the sagebrush and retains native grasses and forbs important to wildlife and their young. Chaining can further benefit wildlife if chaining is done in strips, rather than blocks, and by using natural terrain features to maximize edge effect (Autenrieth et al. 1982).

Mechanical treatments should leave at least 70% of sagebrush habitat intact and treatments should be made in alternating strips of treated and untreated vegetation. Disturbed strips should be no wider than 350 feet to maintain bird species diversity and satisfies greater sage-grouse needs (Castrale 1982).

<u>Evergreen Woodlands</u>. Mechanical treatments in pinyon-juniper woodlands would primarily consist of thinning and machine piling of debris, as well as chipping/shredding and chaining to reduce the occurrence of pinyon and juniper species on sites in which they have invaded. As a result of tree removal, many native perennial grass species, forbs, and shrubs would increase on the site (Clary 1971, Jacobs and Gatewood 1999).

Various mechanical methods, including chaining, cabling, and bulldozing, are used to treat pinyon-juniper woodlands. Extensive modifications over large areas should be avoided, however, as these woodlands provide habitat for numerous birds, small mammals, and other wildlife.

Treatments that remove large amounts of pinyon-juniper woodlands can adversely affect interior species of wildlife and species that feed upon insects found on the plant surface and under the bark. If possible, large 1,000-acre or larger blocks of pinyon-juniper should be retained. Effort should also be made to retain trees for cavity-nesting birds and as perches (Payne and Bryant 1998).

Mule deer use pinyon-juniper woodlands, and about 54% of mule deer winter habitat in Utah is pinyon-juniper. Removal of pinyon-juniper would reduce the amount of food and cover for these animals (Terrell and Spillet 1975). In Oregon, pinyon-juniper woodlands support a greater diversity of bird species than many forest communities. Reptiles, rodents, rabbits, and other small and large mammals depend upon these communities (Maser and Gashwiler 1978).

Subtropical Desert Ecoregion. In the Subtropical Desert Ecoregion, some mechanical treatments are likely to occur in evergreen and deciduous shrublands. Mechanical treatments could benefit native communities by controlling woody shrub species, which have invaded desert grasslands and now occur in much greater densities than they have historically.

Land managers should be careful when modifying shrub habitats. They are used by a variety of small mammals and birds, and some species, such as Gambel's quail, prefer dense stands of desert shrub where shrub cover is more than 50% and shrubs are over 6 feet tall (Cooperrider et al. 1986). Shrub removal should be avoided in riparian areas and in draws, where shrubs provide important cover and forage for wildlife in an ecoregion where food and cover can be limiting (Short 1983). Short (1983) observed that several bird guilds used the creosote bush-bursage, Joshua tree-creosote bush, and saguaro-paloverde communities and that removing these plant communities would have adverse effects on many species of birds. In addition, management should strive to protect mature cactus, since they provide foraging sites, nest cavities, and perches for birds.

Temperate Steppe Ecoregion. In the Temperate Steppe Ecoregion, mechanical treatments would likely occur in evergreen forest, evergreen shrubland, and evergreen woodland communities. Mechanical treatments in forest communities would largely consist of thinning treatments to reduce the density of trees and the accumulation of understory fuels. Treatments would primarily be focused on reducing hazardous fuels in the WUI; improvement of wildlife habitat would be a secondary benefit.

Treatments would be used to reduce the extent of woodland communities, especially in areas where they are encroaching into grassland communities. Treatments include using chaining, blading, or similar methods to create openings, and then using fire to maintain openings (Payne and Bryant 1998). Livestock grazing can also be used to maintain openings. These openings interspersed with woodlands stands provide a good mosaic of habitat for wildlife. However, these treatments adversely affect interior species that depend on large, continuous stands of woodland.

Chaining, rootplowing, and disking have been used to control mesquite and juniper that invade prairies. Rootplowing kills plants, but also disturbs soil. Removal of woodland stands in bottomland sites and along drainages may reduce the amount of forage and cover for deer. Turkeys also avoid cleared areas. Treatments that open small patches or strips of woodland should provide the greatest benefits to species that use these habitats.

Subtropical Steppe Ecoregion. In the Subtropical Steppe Ecoregion, mechanical treatments would likely occur in evergreen woodland and evergreen forest communities.

The general effects of mechanical treatments on pinyon-juniper woodlands in this ecoregion would be largely the same as the effects on pinyon-juniper in the Temperate Desert Ecoregion. The warmer and wetter conditions in the Subtropical Steppe Ecoregion would likely result in more favorable vegetation response following treatment compared to similar vegetation types in the Temperate Desert Ecoregion.

Dense stands of chaparral could be treated mechanically to create openings. Rootplowing tends to be unfavorable for deer because it removes too much cover, and treatments that eliminate much of the midstory can negatively affect birds that forage and nest in these habitats (Urness 1974, Short 1983).

Mediterranean Ecoregion. In the Mediterranean Ecoregion, mechanical treatments would likely occur in evergreen woodland, evergreen forest, and evergreen shrubland communities.

Modification of oak woodlands can harm bird species if it reduces the number of niches or alters forage and cover habitat. Mechanical treatments in oak woodlands would benefit wildlife by removing conifers and other encroaching woody species that have increased the density of these communities, and by stimulating the growth of understory forbs and grasses.

The BLM could conduct treatments on juniper woodlands in northern California to reduce the spread of this species. Removal of junipers would reduce habitat for species that use the berries and structure of junipers for food and cover. However, removal would improve habitat for species that prefer herbaceous and shrub vegetation that would dominate the site after junipers were removed.

Marine Ecoregion. In the Marine Ecoregion, mechanical treatments would likely occur in evergreen woodland and evergreen forest communities.

The general effects of mechanical treatments on oak woodlands habitats would be similar to treatments in oak woodlands in the Mediterranean Ecoregion.

Thinnings and other woody biomass removal would be used in evergreen forests to maintain forests and improve forest health, and to reduce the amount of hazardous fuels present. Where thinnings promote development of the understory, wildlife species that favor more open understories would be harmed. If treatments were conducted to reduce understory vegetation to reduce the risk of fire, ground- and shrub-nesting birds would be harmed and less browse would be available for deer, elk, and other herbivores. If treatments were used to promote mid-seral stages characteristic of most timber management, little habitat would be provided for old-growth species, such as northern spotted owl and black-tailed deer. In particular, removal of decayed and malformed trees would tend to reduce the number of tree cavities for owls, while fewer large trees would be available to intercept snow to improve conditions for deer during winter (Hunter 1990).

Effects of Biological Treatments

Nearly 90% of biological control treatments would occur in the Temperate Steppe (48%) and Mediterranean (40%) ecoregions. Over half of treatments would control annual grasses or forbs (e.g. diffuse knapweed, medusahead, yellow starthistle) and perennial forbs (e.g., some knapweeds, some thistles, leafy spurge, purple loosestrife, dalmatian toadflax).

Containment by Domestic Animals

Domestic livestock can be used to reduce or contain undesirable vegetation in some situations. These treatments would generally occur in herbaceous communities (annual and perennial grassland and perennial forb communities) that have significant weed infestations.

Herbivores, whether wild or domestic, influence vegetation development. Improper grazing can 1) remove residual cover needed for ground-nesting birds; 2) create undesirable shifts in successions that can cause significant and difficult-to-reverse impacts to wildlife habitat; 3) reduce wildlife food and cover; and 5) reduce plant species diversity. Livestock can directly harm wildlife by trampling on animals or their nests, and grazing can alter grassland structure, to the detriment of birds and small mammals (Wiens and Dyer 1975).

In some cases, using prescribed grazing by domestic animals is not an effective tool for managing vegetation. When grazing is used for management, care should be taken to ensure that livestock do not substantially alter habitat structure. Certain habitats may be more sensitive to impacts caused by the use of livestock to control vegetation and therefore would require extra planning and management to be successful. The use of livestock in wetland and riparian areas not only has the potential to directly impact non-targeted vegetation, but there could also be unintended impacts to soils, streambanks, and stream morphology. Hot desert environments are fragile and recover slowly even after grazing exclusion. Tundra and subarctic environments are additional examples of habitat where livestock grazing is probably impractical and less likely to achieve desired results.

Significant biological control treatments are proposed for the annual graminoid/forb communities of the Mediterranean Ecoregion. Of note is a single large proposed grazing project. Because annual grasslands in California evolved in conjunction with heavy grazing regimes, grazing treatments would be unlikely to cause major changes to the vegetation communities that currently exist (Sims 1988). In addition, domestic animals would benefit these open communities by helping to prevent the encroachment of woody species.

Biological Control Agents

The effects of biological treatment using insects and pathogens would be minor. In most cases, the target plants would remain standing, although weakened or unable to reproduce. Insects are often used to control weeds because many species exhibit high host-specificity (Wilson and McCaffrey 1999). However, the success of biological control programs often depends on the presence of a more desirable plant community that can fill in the spaces opened by the removal of the weed. Thus, biological control would not be effective where large stands of annual grasses, such as downy brome, are present and have displaced native vegetation. If the weed is controlled, the space is often filled by another weed, or the plant community reverts to the weed annual grass understory. Because control using biological agents would take time, wildlife might be better able to respond to changes in habitat than after treatments that modify habitat over a short period of time, such as fire and herbicide use.

Effects of Chemical Treatments

Approximately 16% of treatments would involve the use of herbicides; a similar percentage of acres are currently treated using herbicides. Over 70% of acres would be treated in the Temperate Desert Ecoregion, a much greater proportion than is currently treated in this ecoregion. Fifteen percent of treatments would occur in the Temperate Steppe Ecoregion. Treatments in the Temperate Desert Ecoregion would be targeted primarily toward sagebrush, rabbitbrush, and other evergreen shrubland species, and annual grass and perennial forb weeds, while those in the Temperate Steppe Ecoregion would focus on control of invasive annual and perennial grasses and forbs.

While some field studies suggest that appropriate herbicide use is not likely to directly affect wildlife (Cole et al. 1997; Sullivan et al. 1998), herbicides (used properly or improperly) can potentially harm wildlife individuals, populations, or species (USDA Forest Service 2005). Harm at the population or species level is unlikely for non-special status species because of the size and distribution of treatment areas relative to the dispersal of wildlife populations and the foraging area and behavior of individual animals.

Possible adverse direct effects to individual animals include death, damage to vital organs, change in body weight, decrease in healthy offspring, and increased susceptibility to predation. Adverse indirect effects include reduction in plant species diversity and consequent availability of preferred food, habitat, and breeding areas; decrease in wildlife population densities within the first year following application as a result of limited regeneration; habitat and range disruption (as wildlife may avoid sprayed areas for several years following treatment), resulting in changes to territorial boundaries and breeding and nesting behaviors; and increase in predation of small mammals due to loss of ground cover (USEPA 1998b).

In the absence of prominent direct effects, the main risk to wildlife from herbicide use is habitat modification. In forests, for example, herbicide use may result in minor and temporary effects on plant communities and wildlife habitats, including some beneficial effects, but usually result in a significant drop in forage the season following treatment. However, forage species and wildlife use of treated areas are likely to recover within 2 to several years after treatment (Escholz et al. 1996; McNabb 1997; Miller and Miller 2004).

The extent of direct and indirect effects to wildlife would vary by the effectiveness of herbicide treatments in controlling target plants and promoting the growth of native vegetation, as well as by the extent and method of treatment (e.g., aerial vs. ground) and chemical used (e.g., toxic vs. non-toxic; selective vs. non-selective), the physical features of the terrain (e.g., soil type, slope), and weather conditions (e.g., wind speed) at the time of application. The effects of herbicide use on wildlife would depend directly on the sensitivity of each species to the particular herbicides used (and the pathway by which the individual animal was exposed to the herbicide), and indirectly on the degree to which a species or individual was positively or negatively affected by changes in habitat. Species that reside in an area year round and have a small home range (e.g., amphibians, small mammals), would have a greater chance of being directly adversely affected if their home range was partially or completely sprayed because they would have greater exposure to herbicides—either via direct contact upon application or indirect contact as a result of touching or ingesting treated vegetation.

In addition, species feeding on animals that have been exposed to high levels of herbicide would be more likely to be affected, particularly if the herbicide bioaccumulated in their systems. Although these scenarios were not modeled for the PEIS, wildlife could also experience greater effects in systems where herbicide transport is more likely, such as areas where herbicides are aerially sprayed, dry areas with high winds, or areas where rainfall is high and soils are porous. Wildlife that inhabit subsurface areas (e.g., insects, burrowing mammals) may also be at higher risk if soils are non-porous and herbicides have high soil-residence times. The degree of vegetation interception, which depends on site and application characteristics, would also affect direct spray effects. The effects of herbicide use on wildlife would be site- and application-specific, and as such, site assessments would have to be performed, using available information to determine an herbicide-use strategy that would minimize impacts to wildlife, particularly in habitat that supports special status species.

The BLM and Forest Service risk assessments suggested several common effects of herbicides to wildlife. Birds or mammals that eat grass that has been sprayed with herbicides have relatively greater risk for harm than animals that eat other vegetation or seeds, because herbicide residue is higher on grass (Fletcher et al. 1994; Pfleeger et al. 1996); this phenomenon is apparent in risks predicted for large mammalian herbivores by the BLM risk assessments. Grass foragers might include deer, elk, rabbit and hare, chukar, quail, and geese (USDA Forest Service 2005). However, harmful doses of herbicide are not likely unless the animal forages exclusively within the treatment area for an entire day. For example, studies of white-tailed deer have reported an average home range of about 400 acres (Fowler 2005), which would be about the size of the typical application area (two-thirds of herbicide treatments would be 400 acres or less), and less than half the size of a large application area of 1,000 acres (20% of treatments would be 1,000 acres or larger). Scenarios of chronic consumption of contaminated vegetation would also be unlikely if vegetation were to show signs of damage (these signs may not occur immediately after spraying). In addition, insect foragers (e.g., bats, shrews, and numerous bird species) would be at risk from herbicide applications because of the small size of insects and their correspondingly large surface area.

The PEIS includes additional information on the risks of using herbicides for wildlife habitat improvement. The reader is encouraged to review the PEIS and its Appendix C for more information.

Beneficial Effects of Treatments

Treatments that remove hazardous fuels from public lands, reduce the spread of weeds and other invasive vegetation, and restore native vegetation in areas that have been degraded by human-related activities would benefit wildlife habitat. Treatments would help to restore natural succession and disturbance processes to which native wildlife have adapted. In addition, treatments would increase plant diversity across landscapes, and in turn increase the number and types of wildlife that can be supported.

Traditional forestry and fire management has resulted in the loss of large shade-intolerant trees and favored the development of dense mid-seral forests. These practices have also reduced the number of dead and dying trees that can be used by cavity nesting species, and by other species, such as amphibians and burrowing small mammals, that used dead and rotting wood for shelter and food. Overall, there has been a loss of habitat diversity and complexity in managed forests; the number and types of animals that can be supported by these forests has also declined (Hunter 1990, USDA Forest Service and USDI BLM 2000b). Forests are more susceptible to catastrophic wildfire, with its inherent negative effects to wildlife survivorship and habitat. Forest management that restores natural succession and disturbance regimes would improve the health of forests on public lands and ability of forests to support a diversity and abundance of wildlife.

Weeds and other invasive species provide forage and cover for wildlife, such as chukar, and treatments to reduce the spread of weeds and other invasive vegetation would be harmful to these wildlife. However, if invasive species management increased plant species diversity and fostered healthy ecosystems that were more resilient to fire and invasive species encroachment, greater numbers and types of wildlife should be supported by the area, and risks to special status species and other species found in low numbers in treated ecosystems should be reduced.

Wildland fire, spread of weeds, and other factors have caused habitat fragmentation and the loss of connectivity between blocks of habitat, especially in lower elevation forests, shrub steppe, and riparian areas. Fragmentation has isolated some animal populations and reduced the ability of populations to disperse across the landscape. Treatments that restore native vegetation in disturbed areas should reduce fragmentation and restore connectivity among blocks of similar habitat.

Effects of Fire Treatments

Habitat structure follows successional trends in most communities. Short fire intervals tend to maintain or promote early successional plant communities characterized by herbaceous species and limited structural diversity (Anderson 2001). Long fire intervals and a typical successional pathway normally results in more woody species and greater structural diversity. Fires that set back succession tend to benefit herbivores and species that depend on herbaceous vegetation for cover. Red fox, gray fox, and weasel prey upon herbivores and are also associated with early to mid-successional habitats (Allen 1987). Older forests provide suitable prey, nest cavities, and more open flight corridors for owls than younger, denser forests. In the Pacific Northwest in areas of high snowfall, deer seek out more mature forests in winter for their snow-intercept thermal cover. In these forests, large branches capture much of the snowfall, keeping snowfall amounts at ground level much less than in younger forests, making it easier for deer to travel in snow and find shrubs and other forage.

Replacement of fire-adapted vegetation by fire-intolerant associations generally leads to overall declines in herpetofauna abundance and diversity. Prescribed fire is an appropriate management tool that can be used with other tools to benefit herpetofauna by restoring a historical mosaic of successional stages, habitat structures, and plant species composition. However, prescribed fire may not be appropriate for herpetofauna species that depend upon late-successional or climax vegetation (see review in Russell et al. 1999).

Fire generally leads to increases in plant nutrient density, palatability, and earlier “greenup.” However, this phenomenon normally only lasts for a few growing seasons. Hobbs and Spowart (1984) observed that winter diet quality for deer and bighorn sheep improved as a result of burning. Although the quality of individual forage items did not change substantially, forage items were more readily available. Beneficial treatments include those that target encroaching conifers that are reducing the acreage of bighorn winter range.

Tundra and Subarctic Ecoregions

Burning is not generally recommended on tundra. However, burning to remove lichens that smother more desirable plants has been used to improve habitat for willow ptarmigan (Payne and Bryant 1998).

Mixed-severity fires stimulate growth of most herbaceous and shrub cover. Stand replacing fires improve woody browse for moose. Aspen and spruce stands that are replaced by stand-replacing fires produce more browse in the first few years after burns than older stands. The benefits of these fires to moose may peak at about 25 years after a fire and last less than 50 years (Oldemeyer et al 1977; Wolff 1978; MacCracken and Viereck 1990).

Temperate Desert Ecoregion

Prescribed fire could reduce sagebrush cover and promote grass species that would be attractive to horned larks and meadowlarks. As burned areas recovered, sage and Brewer's sparrows would become more common (Rotenberry and Wiens 1978). It could take 4 or more years before bird populations reached pre-burn levels (Smith 2000). Pronghorn also benefit from a combination of grassland and shrubland, perhaps because dense stands of sagebrush can hinder pronghorn movement (Anderson 2001).

In shrublands where invasion by downy brome is not a factor, a mosaic-patterned fire is recommended in sagebrush as long as 50% to 60% of the sagebrush survives. Openings created in dense sagebrush stands were used as new leks for greater sage-grouse in Idaho (Connelly et al. 1981).

Forb and insect availability are important factors in sage-grouse productivity, and fire increases openings in sagebrush, increasing forb production. Fire may also increase the nutritional value of the browse and provide new lekking sites (Martin 1990; Benson et al. 1991; Pyle and Crawford 1996). However, intact stands of sagebrush are required as wintering habitat and to provide cover during all seasons. Prescribed burns should be conducted every 15 to 20 years or more (Payne and Bryant 1998). Extensive areas of higher elevation big sagebrush stands have been invaded, and in some places replaced, by pinyon and/or juniper. Treating these areas and allowing the reestablishment of grasses, forbs, and eventually big sage, can be beneficial to greater sage-grouse, especially as summer habitat.

A mosaic of pinyon-juniper woodland, grassland, and intermediate seral communities would optimize wildlife diversity (Belsky 1996). When conditions are favorable for stand-replacing fire, burning kills most of the pinyon-juniper overstory and increases plant diversity. However, some large, older trees should be maintained for mast and berry production for birds and other wildlife (Balda and Masters 1980). While loss of pinyon-juniper can reduce thermal and hiding cover for ungulates, an increase in plant species diversity after fire, particularly of forbs and grasses, can benefit deer and elk, as well as ground-nesting birds.

Burning can be used to create openings and early successional stages and to promote forage production (Payne and Bryant 1998). Small burns are favored because they create a greater variety of food and cover conditions than do larger burned or unburned areas (Short and McCulloch 1977).

Subtropical Desert Ecoregion

Fuel accumulations in the Mojave, Sonoran, and Chihuahuan deserts are generally too sparse to carry a fire, except after wet winters and springs. Fires can affect grass and shrub cover and productivity, and thus must be used carefully, if at all, to modify wildlife habitat. Fire can be beneficial if it stimulates grass and forb production (Bock and Bock 1990, Payne and Bryant 1998). If burning creates a mosaic of habitats, with extensive unfragmented habitats, wildlife would benefit.

Fire has been used to control mesquite to the benefit of wildlife. Fire can also be used with mechanical and chemical methods to maintain openings to the benefit of mourning doves and other species than need a mix of openings and shrub cover (Payne and Bryant 1998). Mosaic sites with varying densities of mesquite support high reptilian diversity, while sites with scattered mesquite benefit doves and quail (Germano and Hungerford 1981, Bock and Bock 1990).

Fire has been used to increase forb production in mixed prairie and oak communities. Deer forage and density are often greater in burned than unburned areas, and burns can also benefit quail and other birds (Jackson 1965; Hutchenson et al. 1989). In some cases, oak habitats become so dense that deer and other animals cannot penetrate them, or trees grow beyond the reach of ungulates.

Temperate Steppe Ecoregion

Patchy or irregular burns can enhance habitat diversity in grasslands that have little structural diversity. Heterogeneous mosaics of grasses and forbs are a more suitable habitat for some nongame birds than uniform stands of either (Verner 1975). Burning at 3- to 5-year intervals restores vigor and retards succession to optimize foraging habitat for prairie chickens (Kirsch 1974), although the quality of nesting habitat and availability of thermal and escape cover for prairie chickens may be reduced for several years following a burn (Boyd and Bidwell 2001).

Periodic burning also enhances small mammal populations in grasslands, although burns should be kept small and effort should be made to create a mosaic of habitats (Kaufman et al. 1990). For species that require protective cover, fall or early winter burns would be best. Wild ungulates also seek out burned areas. When conducting burns in grasslands, some shrub species should be protected to provide habitat for nesting and perching birds.

Fire should be limited to small, localized burns in prairie, as recovery of grass biomass can take several years. This type of management can benefit pronghorn and birds (Payne and Bryant 1998). Fire has been used to enhance waterfowl and shorebird nesting habitat (Kirsch and Kruse 1972). Fire can also help maintain prairie chicken habitat, but burned areas may not be used by sharp-tailed grouse for several years.

Understory fire regimes are needed to support northern goshawk populations in ponderosa pine forests. Management that increases the predominance of early-seral and mid-seral species, increases the number of large trees on the landscape, and maintains connectivity between patches benefits goshawks (Graham et al. 1999).

In Douglas-fir forests in Montana, small stand-replacing fires often leave many unburned patches. The burn areas attract wood-boring insects, woodpeckers, and warblers. The unburned areas attract Swainson's thrush. In ponderosa pine and Douglas-fir forest, patches of old-growth trees attract flammulated owls, but only if the patches of old growth are accompanied by grassy openings and some dense thickets of Douglas-fir. Stands embedded within a landscape of closed, mature forest do not support many owls. Thus, understory fire can be used to create openings and enhance habitat for the owls (Wright 1996).

In prairies, fires eliminate trees and increase the amount of forage available for grassland species. Grassland fires can cause early green-up of warm-season grasses, and increase grass forage production. Fire also increases the percentage of protein and minerals in prairie grasses and shrubs (Daubenmire 1969).

Burning produces positive results for deer and elk forage in evergreen forests by increasing grass and forb production after fires. These benefits generally last less than 30 years. However, if weeds and other invasive species predominate as a result of fire, the benefits to wildlife from fire in these forests would be few (Smith 2000). Mixed-severity and stand-replacement fires also stimulate berry-producing shrubs and their productivity for 20 to 60 years after fire, to the benefit of birds, small mammals, and bears.

Stand-replacement fires improve the protein content and other nutritional components of forage species in aspen, ponderosa pine, western larch, and Douglas-fir stands. Burning can also improve access to forage for elk and other wildlife. In one study, burns in mountain shrub and grassland habitats increased the level of protein and in vitro digestible organic matter in winter diets of bighorn sheep and mule deer, but had no detectable effects on spring diets (Hobbs and Spowart 1984).

Subtropical Steppe Ecoregion

Fire has been used in evergreen woodlands in Arizona. Fire stimulates shrub browse and creates openings where grasses and forbs can thrive. Birds are often more abundant in burned areas than unburned areas, but rodent populations sometimes decline in burn areas. In dense chaparral, fire is used to create openings and increase edge habitat for wildlife. Fire can also improve forage quality. Burning chaparral can shift rodent populations from chaparral to grassland-dominant areas (Wright and Bailey 1982).

Most shrubs in chaparral sprout vigorously from the crown and can recover within 5 to 10 years after fire. Small burns conducted on a 10- to 20-year rotation are beneficial to wildlife (Severson and Medina 1983, Bock and Bock 1988). Rotational burning can greatly improve deer browse in chaparral communities (Wright and Bailey 1982).

Fire may enhance grassland communities. Bock and Bock (1978a) found more raptors and game birds in burned grasslands than unburned grasslands. Lark sparrow and mourning dove nest densities are also greater in burned than unburned grasslands (Sontiere and Bolen 1976, Renwald 1977).

Mediterranean Ecoregion

In coastal sage scrub, a stand replacing fire would initially reduce the number of birds that use the scrub. However, by the end of the first year, species richness should be 70% to 90% of preburn levels, with species favoring more open areas being most abundant (Moriarty et al. 1985).

Burning has been used to create habitat for black-tailed deer in chamise chaparral. Taber and Dasmann (1958) found a 300% to 400% increase in deer use after a wildfire, and deer reproduction improved. Mechanical methods can be used along with fire to create openings for deer in chaparral (Biswell 1969). However, at least 30% of the area should be maintained to provide cover. Large burns are not good for deer or birds in chaparral habitats, as there is too much habitat fragmentation (Buttery and Shields 1975). Thus, small openings and brush islands within larger burns can increase bird species diversity.

Forage of deerbrush and other chaparral species is abundant after fire because it reproduces from seed that is stimulated to germinate by burning. Chaparral plants provide forage for many ungulate species (Burcham 1974).

Marine Ecoregion

Fire has been used to increase plant diversity and structural complexity in evergreen forestlands. Huff et al. (1985) found the greatest bird diversity in forests about 20 years after a burn.

Salmonberry provides fruit for birds and bears and leafy vegetation and twigs for deer, elk, mountain goats, and moose. Salmonberry sprouts prolifically after fire, although severe fire could reduce sprouting (Tappeiner et al. 1988; Zasada et al. 1989).

Effects of Mechanical and Manual Treatments

Mechanical treatments are often preferred to fire and herbicide use because they allow for more precise control of the vegetation treated. Fire and large scale herbicide treatments have the potential to modify or eradicate large areas of vegetation, to the detriment of obligate species and species needing structural and floral diversity or hiding or thermal cover. Prudent, well-designed mechanical treatments can result in a mosaic of habitats in different stages of disturbance and successional recovery (Payne and Bryant 1998).

Manual and mechanical treatments are especially effective in sensitive areas, such as wetland and riparian habitat, or near habitats of plant and animal species of concern, where greater control over treatment effects is required or effects to non-target species are a concern.

Killing big sagebrush by mechanical methods can release rabbitbrush, a generally undesirable plant. Mechanical methods are favored to thin sagebrush stands, while leaving other shrubs, grasses, and forbs, to benefit big game winter range (Payne and Bryant 1998). Mechanical methods have been used to control the encroachment of pinyon and juniper into sagebrush sites. These woodland species can be removed or thinned, while still retaining some patches for wildlife.

Pronghorn, mule deer, and elk benefit from mechanical treatments by foraging on strips of grasses and forbs that are created. Similar treatments should be considered for greasewood and shadscale saltbush communities to provide suitable habitat for black-tailed jackrabbits, and kit fox that prey upon jackrabbits (Spowart and Samson 1986).

Opening dense stands of pinyon and juniper benefits edge species, ground-feeding and ground-nesting birds, and small mammals. Openings of 250 acres or less by mechanical means benefit deer, small mammals, and turkeys and other birds. Breeding bird densities differ in treated and untreated areas, with ground-nesting birds being more prevalent in chained versus unchained pinyon-juniper stands. Thus, treatments that create patches of treated and untreated pinyon and juniper should promote species diversity (Scott and Boeker 1977; O'Meara et al. 1981; Payne and Bryant 1998).

Leaving slash, debris, and downed trees provides microhabitat for rabbits and songbirds. For deer, slash and debris should cover 20% or less of the treated site (Terrell and Spillet 1975). Treatment costs can be reduced by using harvested material as biofuel.

Mechanical treatments in the Temperate Steppe Ecoregion would primarily occur in evergreen forests and woodlands. Thinning of trees using mechanical harvesting equipment would create openings and increase light penetration to the understory, improving forb and shrub production to the benefit of deer and other wildlife. Trees that are removed could be used in biofuel production to reduce treatment costs.

Disking and chaining to thin and remove woodland vegetation and create openings with forbs and grasses benefits birds and small mammals. When treating forestlands and woodlands, managers should create openings within the forest/woodland stand; leave slash and downed trees for rabbits and other ground-residing wildlife; maintain shrub canopies for vireos, thrushes, and other birds; create edge habitat while also maintaining large patches of woodland/forestland habitat for interior species; and use burning to maintain habitat (Payne and Bryant 1998).

Gambel and other oak woodlands are important to wildlife in the Subtropical Steppe Ecoregion. Over 40 species of birds and 20 species of mammals use Gambel oak communities (Harper et al. 1985). Mechanical treatments can benefit oak woodlands by increasing oak sprouts for ungulate forage, reducing oak dominance to promote the development of forbs and grasses as forage and cover, and protecting oak stands from ponderosa pine and other tree encroachment to ensure future mast production (Payne and Bryant 1998). Lack of disturbance can limit the distribution, vigor, and growth of Gambel oak (Vallentine 1989). Bulldozing generally results in more oak sprouting than hand cutting, and increases forage production for deer and other wildlife compared to untreated areas (Rutherford and Snyder 1983). However, mast producing trees should be protected by limiting bulldozing to trees less than 3 inches diameter at breast height to avoid loss of mast-producing trees. Chaining has been done in Utah to reduce Gambel oak and increase herbaceous forage (Plummer et al. 1968).

Where shinnery oak is too thick or has expanded distribution, shredding or mowing oak thickets while leaving about 10% of the area untreated would provide good habitat for quail while still protecting some mast trees (Payne and Bryant 1998). Groups of shinnery oak trees should be retained to provide habitat for quail, deer, and lesser prairie chicken.

Mechanical treatment has been used to increase grass production by creating openings in chaparral (Severson and Medina 1983). Treatments that are limited to about 50% or less of the chaparral, and leave undisturbed corridors and buffer zones, are more successful than smaller or larger clearings or clearings that alter natural travel routes. Rollerchopping is the preferred method in the mesquite-acacia woodland, as forb density and diversity can be enhanced while encouraging sprouting by shrubs (Everitt 1983, Fulbright and Beasom 1987). Leaving woody plant cover in strips, rather than clumps, can benefit quail and turkey. Maintaining old stands of brush, interspersed with younger, treated stands, maintains cover while stimulating browse for deer (Guthery 1986). However, no more than 40% of the area should be cleared, and clearing should be no more than 250 feet from shrub cover. Trees and shrubs should also be maintained near permanent water and in riparian areas to provide cover to species that use these aquatic bodies, such as turkey, quail, and deer, and to maintain travel corridors (Hauke 1975, Payne and Bryant 1998).

In California, mechanical treatments are used to create openings in chaparral to stimulate growth of grasses and forbs. Treatments also create new edge habitat, although this may be detrimental to birds and other wildlife that need larger patches of chaparral (Soule et al. 1988). Greater bird use has been observed in areas where treatments have left islands of untreated chaparral than areas where large patches of chaparral have been removed and no islands provided (Buttery and Shields 1975). Small, irregular shaped openings are recommended over large blocks. Cutting can be used to stimulate new growth. Disking can be used to open up areas, and bulldozing, chaining, and rollerchopping are sometimes used to prepare sites for burning (Taber and Dasmann 1958, Vallentine 1989).

Mechanical treatments that thin vegetation to reduce hazardous fuels could create openings in dense forest stands that would promote development of understory vegetation, to the benefit of ground- and shrub-dwelling birds and other wildlife in the Marine Ecoregion (Zeedyk and Evans 1975). Thinnings would also increase browse in the understory to benefit deer and elk. Thinnings remove the poor vigor and damaged trees that are most prone to develop cavities that can be used by cavity nesting birds, and bats and other small mammals (Zeedyk and Evans 1975). If some snags and other dead and dying trees were retained, suitable habitat would be provided for species that require cavities.

If harvested material were windrowed or piled, it would provide hiding cover for small mammals and rotting vegetation that could be used by reptiles and amphibians for cover; these species could also forage upon insects and other invertebrates found under this debris.

Effects of Biological Treatments

Containment by Domestic Animals

The grazing discussed in this section refers to "prescribed grazing," which can be defined as the careful application of grazing or browsing prescriptions (i.e., specified grazing intensities, seasons, frequencies, livestock species, and degrees of selectivity) to achieve natural resource objectives. Livestock production is a secondary objective when using prescribed livestock grazing as a natural resource management tool.

The use of domestic livestock to contain vegetation has a greater likelihood of affecting non-target vegetation than insects and pathogens, but also allows for treatment of larger areas and may stimulate new growth of desirable species. Although grazing animals such as goats, sheep, and cattle are often looked upon negatively in terms of effects on vegetation, they can alter the appearance, productivity, and composition of plant communities to the benefit of wildlife if used in moderation and at appropriate stocking densities (Payne and Bryant 1998). Goats are effective in controlling shrubs such as oaks, mesquite, chamise, and sumac on desert shrublands and chaparral (USDI BLM 1991a). Goats are also effective in controlling vegetation in sensitive areas where use of fire or herbicides is undesirable, such as near residential areas or near streams and wetlands.

Use of domestic livestock in wildlife management must be used carefully, but it is an invaluable and cost-effective management tool if used wisely. Some species, such as black-tailed prairie dogs, and the black-footed ferret that feeds upon these prairie dogs, tend to be more abundant in heavily grazed areas (Koford 1958). Thus, efforts to promote ferret populations include grazing management of prairie dog towns. Livestock can be used strategically to benefit some wildlife by 1) promoting weedy patches for feeding sites for upland birds; 2) promoting grass cover when used in conjunction with rest-rotation grazing; 3) removing dead material; 4) encouraging sprouting by shrubs; and 5) removing competitive vegetation (Urness 1990). Grazing systems that include planned grazing and deferment periods are most successful.

Moderate to heavy grazing can open up shrub and herb layers and make it easier for raptors to locate prey, and can maintain shrub dominance on sites used by mule deer (Smith 1949; Olendorff et al. 1980). Livestock can also be used to maintain residual grass cover, and to create openings in sagebrush cover to benefit greater sage-grouse and their chicks (Crawford et al. 1992).

Other Biological Control Agents

The BLM would use insects and pathogens to control vegetation. The effects of biological treatments using insects and pathogens would be minor. In most cases, the target plants would remain standing, although weakened or unable to reproduce. Over time, the composition of the plant community could change as treated plants died out and native vegetation returned to the area. This would benefit species that favor the native vegetation, but harm species that have adapted to the plant species being treated. Strict controls would be used to ensure that insects and pathogens used in treatments are specific to the target vegetation and do not harm non-target species, as discussed in Chapter 2.

Effects of Chemical Control Treatments

Herbicides are an effective means of controlling weeds and other invasive vegetation. Herbicide treatments and fire use may be the only effective ways to control large areas of annual weeds and other invasive vegetation Sagebrush rangelands are often treated with herbicides to increase herbaceous plants, with herbicides that remove broad-leaved plants without harming grasses being the most widely used. Olson et al. (1994) used low rates of tebuthiuron to thin big sagebrush stands and enhance wildlife habitat in Wyoming. Herbicides such as 2,4-D, picloram, tebuthiuron, and dicamba are used to control woody species such as mesquite, creosote bush, and snakeweed in desert habitats. Where dense canopies are a problem, treatment with triclopyr and clopyralid might be needed to thin woody vegetation. Germano (1978 *cited in* USDI BLM 1991a) observed that jackrabbits, antelope, quail, and lizards favored openings in mesquite stands.

Over three-quarters of herbicide treatments in the Temperate Steppe Ecoregion would be focused on annual and perennial grasses and forbs, including downy brome, leafy spurge, and several species of knapweeds and thistles. Much of this work would be done in support of the BLM's Conservation of Prairie Grasslands initiative to improve grassland habitat for wildlife. Over three-quarters of treatments in the Subtropical Steppe Ecoregion would be focused on sagebrush and other evergreen shrublands, while 12% of treatments would focus on pinyon, juniper, and other evergreen woodland species. Healthy pinyon-juniper woodlands, with a full complement of understory grasses, forbs, and shrubs, provide excellent wildlife habitat. However, in many areas, pinions and junipers have increased in density to the point that understory vegetation is excluded, to the detriment of wildlife

(USDA Forest Service and USDI BLM 2000b). Studies of wildlife use of treated pinyon-juniper habitats have shown that mule deer use was greater in a chemically treated plot than on a mechanically treated plot because herbicide treatment resulted in more openings in the woodlands and a greater retention of screening cover (Severson and Medina 1983).

Herbicides are an important tool for improving forest productivity in the Mediterranean and Marine ecoregions, and studies suggest that the range of wood volume gains from effectively managing forest vegetation (primarily using herbicides) is 30% to 450% for Pacific Northwest forests (Wagner et al. 2004). Herbicides can be effective in improving forest wildlife habitat by 1) reducing populations of invasive exotic plants, 2) creating snags and downed woody material, 3) maintaining patches of early-successional vegetation within late-successional communities, and 4) maintaining woody and herbaceous plant communities for browsing species (Wagner et al. 2004).

The benefits of using herbicides in each ecoregion are described in more detail in the PEIS.

Effects to Special Status Wildlife Species

Public lands in the western U.S. support over 200 species of terrestrial wildlife (including birds, mammals, amphibians, reptiles, mollusks, and arthropods) that have been given a special status based on their rarity or sensitivity. Included are more than 75 species that are federally listed as threatened or endangered, or are proposed for federal listing. Some of these species have habitat requirements that have been or are being altered or reduced by invasions of non-native plant species. The *Final Programmatic Biological Assessment Vegetation Treatments on Bureau of Land Management Lands in 17 Western States* (USDI BLM 2007b) provides a description of the distribution, life history, and current threats for federally-listed animal species, as well as species proposed for listing. The BA also discusses the risks to listed and proposed terrestrial wildlife species associated with vegetation treatments proposed by the BLM.

In general, the potential effects to special status wildlife species from the proposed vegetation treatments would be similar to those described for wildlife as a whole in the previous section. However, the rarity and sensitivity of special status species and their habitats make them more likely to be affected by disturbances associated with treatments. In addition, populations of special status species may in some cases benefit more from fuels reduction and control of non-native species than wildlife species with secure populations.

Standard Operating Procedures

The BLM would implement SOPs to minimize the risks to special status wildlife species from vegetation treatments (see Table 2-5). Examples of SOPs include surveying for species of concern if the project may impact federally and/or state-listed species; minimizing direct impacts to species of concern from fire treatments, unless studies show that these species will benefit from fire; minimizing the use of ground-disturbing equipment near species of concern; and using temporary roads when long-term access to treatment sites is not required. Additional SOPs would be implemented based on the species or habitat present on the treatment site. For example, in western greater sage-grouse habitat, the BLM would minimize off-road vehicle use, minimize fire use, and use treatments to create small openings in continuous or dense sagebrush.

Adverse Effects of Treatments

Fire use and herbicide treatments could harm or kill special status wildlife, especially slow moving species and the eggs and young of ground-nesting or breeding species. Mechanical treatments that disturb soil could also harm burrowing and fossorial species found near the soil surface. All treatments would remove or alter vegetation and could affect the availability and quality of food, cover, and special habitat features needed by wildlife. Treatments could alter other resource conditions (e.g., air quality, soil, water), making them harmful or less suitable for use by special status wildlife. Treatments could also fragment habitats and isolate populations of special status species, especially those unable or unwilling to travel over disturbed ground.

Some special status wildlife species occupy a wide variety of plant community types, as long as they provide adequate food, cover, and breeding habitat. These species tend to be large animals that cover a large geographic area and eat a wide variety of food items, such as gray wolf, grizzly bear, and bald eagle. Although these species could potentially benefit to some degree from weed control, and are typically at low risk for impacts from exposure to herbicide, they could be affected through disturbances associated with vegetation treatments (e.g., presence of workers, trucks/ATVs, and other equipment in their habitat).

Effects of Fire Treatments

The potential for a fire treatment to directly harm special status wildlife would depend on the animal's ability to escape the treatment area. Slow-moving wildlife, such as insects and other arthropods, desert tortoise, and several species of small mammals would be more at risk than species that would be able to flee the area.

Indirect effects to special status species as a result of habitat alteration would depend on the habitat needs of the species. Species that require dense vegetation for cover, such as the southwestern willow flycatcher, riparian woodrat, and Preble's meadow jumping mouse would likely be adversely affected by prescribed burns. For other species, such as the Sonoran pronghorn, fire could potentially reduce the availability of forage in the treatment area, although the new growth after fire would likely be of increased forage quality. Although habitats would quickly recover from fire treatments, the effects of habitat loss to species with non-secure populations could persist over the long term and make populations more susceptible to extirpation. In addition, if a fire treatment were to burn through the entire habitat of a small, isolated population, extirpation of that population could potentially occur. For example, frequent fires were important in maintaining grassland habitat for the Oregon silverspot butterfly, and fire suppression and urbanization have reduced grasslands historically used by this species to a few small remnants. Prescribed fire can help to restore the historic fire regime, but fires also kill the eggs and larvae of the butterfly (Pickering 1997).

Special status species with large home ranges and more general habitat requirements would be unlikely to be affected by fire treatments, provided they did not occur near denning or breeding areas, and human contact was avoided. These species are typically large enough to avoid a treatment area during a burn, and are not specifically dependent on the type or structure of vegetation in their habitat. Examples include gray wolf, grizzly bear, and ocelot.

Effects of Mechanical Treatments

As discussed for wildlife in general, use of mechanical treatments to remove vegetation would run the risk of crushing small animals, including arthropods, reptiles and amphibians, the young and eggs of ground nesting birds, and small mammals. For some special status species, loss of even a few individuals as a result of crushing could substantially increase the susceptibility of the population to future disturbances. Risks would be greatest if treatments occurred over the entire area occupied by a population.

Disturbances associated with mechanical treatments would be substantial, though short in duration. Many mobile animals, such as large adult birds and mammals, could simply leave the area temporarily to avoid the disturbance. Less mobile animals might not be able to leave, particularly if the treatment area was relatively large. In addition, the noise and human presence associated with mechanical treatments would likely cause some animals to temporarily abandon nests. For particularly sensitive species, these disturbances could result in reduced breeding success, which could in turn have population-level effects.

Removal of large stands of vegetation during mechanical treatments could substantially alter the habitat of some special status wildlife species. Although the ultimate result of these treatments would likely be an improvement in habitat quality, the short term stresses on some special status species would outweigh the benefits. If the entire habitat of a special status species was removed during a treatment, extirpation of that population could occur. There would be substantially less risk associated with treatments in a portion of the habitat, provided the untreated habitat was large enough to provide a temporary refuge for the population, and animals and their nests or burrows were not destroyed during the treatment.

Effects of Manual Treatments

Manual treatments would be unlikely to affect mobile animals that could temporarily leave the treatment area. Because manual treatments are not cost-effective for treating large areas, it is unlikely that special status wildlife would have to move far to avoid workers in their habitat. Less mobile animals might not be able to leave the area, resulting in disturbance and stress. These effects should be short term in nature, provided treatments did not require repeated entry into habitat. Some special status wildlife species would be forced to leave nests or young behind temporarily, resulting in a risk of reduced reproductive success to an already sensitive population.

Effects of Biological Treatments

Containment by Domestic Animals. The effects of undesirable vegetation containment by domestic animals on special status wildlife species would depend on numerous factors, including the size and mobility of the species, the length of the grazing treatment, and whether the domestic animals used would be likely to graze on important forage plants or other required habitat components.

Larger, mobile animals, and birds that nest out of reach of domestic animals should be able to avoid contact with grazers. Less mobile species and young animals, including the eggs of ground nesting birds and butterfly eggs and larvae, would be more susceptible to injury or mortality through trampling and crushing. For special status species with small, at-risk populations, loss of any animals or eggs could reduce the viability of the population, making it more susceptible to extirpation in the future.

Species that originally coexisted with grazers, or that prefer habitats dominated by low, sparsely growing grasses, could potentially benefit from containment of undesirable vegetation by domestic animals, provided nests and burrows were not damaged during treatments. Examples include the blunt-nosed leopard lizard, kangaroo rats, the Utah prairie dog, and the black-footed ferret. In the case of the giant kangaroo rat, moderate levels of grazing by domestic animals have maintained nearly optimum conditions for the species (USFWS 1998).

Special status species that are themselves grazers could be adversely affected by containment treatments by competing with domestic animals for prime forage plants. Effects would be greatest in areas where forage is already limited. Although the ultimate effect could be an increased quantity of preferred forage plants in subsequent years, loss of forage during a single year could have lasting effects on already small and sensitive populations. Effects would be greatest if the treatments occurred over a large area of existing habitat.

Other Biological Control Agents. Use of biological control agents to control weeds could result in minor disturbances to some species from the presence of workers in sensitive habitats (e.g., nesting areas during the breeding season). For most species, these effects would be minor and short term, and would not have lasting effects on populations. Certain special status species, such as piping plovers, are extremely sensitive to human disturbance, and can experience reduced population vigor if disturbed sufficiently. Provided workers did not return repeatedly to the habitats of these species during the breeding season, long-term effects to populations should not occur.

It is not anticipated that use of biological control agents would result in adverse effects to the habitats of special status species. Gradual reduction in weed cover would improve many habitats without causing sudden losses of vegetation or structural changes. There would be some risk associated with using agents that attack plant species that are closely related to species required by special status wildlife for survival (e.g., butterfly host plants). Biological control agents undergo an extensive screening and testing process prior to being permitted by the USDA APHIS program and released. Despite these safeguards, there is always a risk that the release of an agent into a habitat in which it does not normally occur could result in unforeseen ecological harm.

Effects of Chemical Treatments

Terrestrial herbicides with the greatest likelihood of affecting special status wildlife species, via any exposure pathway, include 2,4-D, bromacil, diuron, and hexazinone, which pose moderate to high risks to special status terrestrial wildlife under one or more exposure scenarios involving the typical application rate (see PEIS Tables 4-23 and 4-24). Terrestrial herbicides with the least likelihood of affecting special status wildlife species include chlorsulfuron, diflufenzopyr, imazapic, and sulfometuron methyl, for which no risks to special status wildlife were predicted via any exposure pathway.

Aquatic herbicides with the greatest likelihood of affecting special status amphibian species during a normal application to an aquatic habitat are diquat and some formulations of glyphosate. Normal applications of 2,4-D and imazapyr would not pose a risk to aquatic amphibians. Terrestrial herbicides with the greatest likelihood of affecting special status amphibian species as a result of a spill, drift, accidental direct spray into an aquatic habitat, or surface runoff are bromacil, diuron, and picloram. The following herbicides would pose no risk to aquatic amphibians, according to the ERAs: chlorsulfuron, diflufenzopyr, imazapic, Overdrive®, and sulfometuron methyl.

Beneficial Effects of Treatments

Removal of non-native species and fuels from habitats that support special status wildlife populations would likely provide some degree of benefit to most special status species that occur on public lands by creating more native habitat conditions and reducing the likelihood of a future catastrophic wildfire. The degree of benefit to special status wildlife would depend, in large part, on the habitat needs of the species and its ability to avoid a fire.

Non-native plant species reduce the suitability of some habitats to support special status wildlife species. For some species, particularly butterflies and moths, certain plant species must be present on a site to serve as larval host plants. Other species require, or at the very least prefer, certain plants as food sources. For example, lesser and Mexican long-nosed bats meet most of their dietary needs from agave and cactus (USFWS 1994, 1995a), and the northern Idaho ground squirrel feeds on native bunchgrasses to fulfill a large portion of its dietary needs (USFWS 2000). Encroachment of non-native plant species, and displacement of native plant species that serve as important sources of food, reduces the suitability of the habitat for these wildlife species. For these species, vegetation treatments would likely provide a long-term benefit to habitat, and could improve the suitability of other areas, potentially creating additional habitat into which the population could expand.

For some special status wildlife species, it is the structure, rather than the species composition of the habitat that makes it suitable. For example, the western snowy plover nests in areas where vegetation is sparse, the Yuma clapper rail is associated with dense marsh vegetation (USFWS 1997), the southwestern willow flycatcher occurs in riparian areas with dense growths of deciduous shrubs and trees (USFWS 1995b), and kangaroo rats require open, grassland conditions. In some cases, invasive plant species alter the structure of habitats, making them less suitable for supporting sensitive wildlife species (e.g., the encroachment of European beachgrass into western snowy plover habitat, or the exclusion of marsh vegetation by saltcedar and arrowweed in Yuma clapper rail habitat). For these species, treatments to control weed infestations would likely provide a long-term benefit. In other cases, non-native plant species may invade an area without making drastic structural changes, and the suitability of the habitat, though not ideal, is maintained (e.g., thickets of saltcedar and Russian olive providing nesting habitat for the southwestern willow flycatcher, or kangaroo rats thriving in annual grasslands dominated by non-native plant species such as red brome). For these species, vegetation treatments may result in some improvement of habitat, but the long-term benefits may not outweigh the short-term risks to the species associated with certain treatment methods.

Some special status wildlife species are more at risk from wildfires than others, particularly species that are not exceptionally mobile and are unable to flee the area or hide in protected refuges such as underground burrows, or are unable to find suitable habitat outside of burned areas. For example, wildfires have burned thousands of acres of northern spotted owl habitat in the Cascade Range (Boroja et al. 1997). Given the limited amount of suitable habitat for this species, it is possible that displaced birds were unable to find suitable habitat nearby and may have perished or suffered reduced productivity, although owls will continue to use traditional use areas where low intensity burns do not kill the overstory and the canopy remains mostly intact (Bevis et al. 1997). These species would receive the greatest long-term benefits from fuels reduction treatments, particularly those with small or fragmented populations, which could be extirpated by a fire.

Fires are often needed to maintain a mosaic of forest habitat types. Northern goshawk habitat in the Southwest is maintained by frequent surface fires that regenerate, clean, and kill forest vegetation. The uneven-age forest structure contains mostly large old trees. Prescribed fires are appropriate for maintaining this type of fire regime. However, forests maintained by catastrophic wildfire result in even-age stand structure and large openings that are not favored by goshawks (Graham et al. 1997). California gnatcatchers require coastal sage-scrub with a shrub canopy cover of 50% or more and average shrub height of 3 feet or more, and avoid recently burned areas. However, this habitat is conducive to wildfire, and use of prescribed fire is an appropriate management tool to control this vegetation, especially when it is found near developed areas. However, if patches of unburned shrubs are left within burned areas, California gnatcatchers will continue to use the burned area (Beyers and Wirtz 1997).

Livestock

Public lands provide an important source of forage for many ranches and help to support the agricultural component of many communities scattered throughout the west. Approximately 165 million acres of public lands are open to livestock grazing, with use levels established by the Secretary of the Interior and administered through the issuance of grazing permits/leases. The majority of the grazing permits issued by the BLM involve grazing by cattle, with fewer and smaller grazing permits for other kinds of livestock, primarily sheep and horses. Many allotments are managed according to an allotment management plan, which outlines how livestock grazing is managed to meet multiple use, sustained yield, and other needs and objectives, as determined through land use plans. Even if there is no allotment management plan, grazing is managed to ensure that 1) watersheds are in or are making significant progress towards properly functioning physical condition; 2) ecological processes including the hydrologic cycle, nutrient cycle, and energy flow are maintained; 3) water quality complies with state water quality standards; and 4) habitats are, or are making significant progress towards being, restored or maintained for proposed, candidate, or listed federal threatened and endangered species and other special status species.

Many noxious weeds and other invasive plants greatly reduce the land's carrying capacity for domestic livestock. In North Dakota, the value of lands infested with leafy spurge may be a third of that of uninfested lands. In Oregon, the value of a ranch dropped over 80% after it became infested with leafy spurge. Effects to livestock owners occur when weight gains of livestock are reduced, animals are poisoned, or capacity for cattle grazing decreases as a result of weeds. In addition, the costs of treating weeds must be subtracted from the income derived from the sale of animals or their products when figuring net return from a livestock operation (Sheley and Petroff 1998; Rees et al. 1999).

Healthy rangelands that support native grasses, forbs, and shrubs have the capacity to support domestic livestock in addition to wildlife. Altered fire regimes, past grazing practices, and other human-related activities have resulted in rangelands throughout the West that are dominated by invasive annual grasses, forbs, and shrubs, rather than the perennial grasses (with a minor component of forbs and shrubs) that were dominant historically. Even where livestock grazing contributed to the current situation, simply removing domestic livestock or reducing their numbers would not correct this situation. Passive treatments, where the underlying cause of the invasive species problem is identified and eliminated or moderated, and rapid response to weed invasion and spread on rangelands would help, but in many situations, more aggressive treatments are necessary to restore rangeland health (Olson 1999). In some situations, grazing can be used as part of the vegetation treatment program, especially when goats and sheep are used to control vegetation, in addition to domestic cattle.

Scoping Comments and Other Issues Evaluated in Assessment

Some comments suggested that the dangers to livestock from noxious weeds need to be addressed. One respondent inquired about how livestock grazing would be prevented on areas treated with picloram. It was suggested that the BLM provide alternative grazing areas if livestock are displaced for vegetation treatment.

Resource Program Goals

Livestock grazing is important to the economy and social fabric of many rural communities. The Rangeland Management program is primarily responsible for activities involving domestic livestock on public land. Activities within this program include range inventory and monitoring, rangeland health assessments and evaluations, rangeland improvement planning and implementation, and invasive vegetation management. The purpose of vegetation management is to restore native ecosystems that have the capacity to provide a steady source of forage for livestock while meeting the needs of native animals and other uses and resource values (USDI BLM 2006c).

Standard Operating Procedures

Vegetation treatments pose risks to livestock; however, these risks can be minimized by following certain SOPs, which can be implemented at the local level according to specific conditions (see Table 2-5). These SOPs include notifying permittees of proposed treatments and identifying any needed livestock grazing, feeding, and slaughter restrictions. Notifying permittees of the project would improve coordination and help avoid potential conflicts and safety concerns during implementation of the treatment. Scheduling of applications should take into account normal livestock behavior, grazing patterns, and resting periods to minimize impacts to grazing permits. Alternative forage sites for livestock would be provided, if possible.

For herbicide treatments, herbicides of low toxicity to livestock would be used, where feasible. If possible, livestock would be removed from treatment sites prior to herbicide applications. The different types of application equipment and methods would be taken into account to reduce the probability of contaminating non-target food and water sources. These procedures would help minimize effects to livestock and rangeland on public lands to the extent practical. As a result, long-term benefits to livestock from the management of invasive species would likely outweigh any short-term negative effects associated with herbicide use.

Adverse Effects of Treatments

The proposed vegetation treatments would cause disturbances to rangeland plant communities by killing both target and non-target plants. In areas that have been highly degraded, merely restoring disturbance to the ecosystem could adversely affect native plant communities by encouraging the spread of weeds or the persistence of an altered vegetation structure and species composition. Treatments could require temporary rest from livestock grazing, forcing livestock operators to graze animals elsewhere. Herbicide treatments have the potential to affect the health of livestock.

Downy brome and other annual brome species are the most significant non-native species affecting rangelands in the West due to the sheer number of acres they cover and their site tenacity. Downy brome has a profound effect on sagebrush-grass rangelands because it replaces perennial native species. Once it becomes established, downy brome allows hot fires to occur in spring when perennial grasses are most susceptible to burning, thereby creating conditions favorable for downy brome to achieve dominance. Because downy brome creates fuels for fires, repeated fires eventually occur, which in turn allows downy brome to dominate.

The abundance of downy brome has caused some livestock producers to rely on it as a source of early spring forage. The disadvantage for livestock producers is the narrow window of grazing opportunity and the wide variation of total forage production from year to year.

Effects of Fire Treatments

The effects of fire on livestock would depend largely on the timing of the fire and the pre-burn condition of the site. Over the short term, prescribed burning would likely reduce the cover of grass and forb species available to livestock. Livestock would also have to be relocated during the treatment. In addition, livestock would need to be kept off of treated areas for a short time after a prescribed fire to give forage ample time to recover. The length of time would vary by site, but would generally range from two to four growing seasons (Stinson 2001).

The burning of rangeland generally results in increased perennial grass production and grazing capacity as well as increased forage availability from the removal of physical obstructions posed by brush and small trees. Following fire, there may be greatly increased amounts of flowering and fruiting, including a significantly enhanced output of grass seed (Daubenmire 1975, Christenson and Muller 1975, Young 1986 *cited in* USDI BLM 1991a). The amount of flowering and fruiting may decrease over prefire levels for some time if plants are severely damaged by fire.

Effects of Mechanical Treatments

Use of mechanical treatments could temporarily reduce the amount of livestock forage on the treatment site. Treatments that rip up plants, such as bulldozing or chaining, would be more likely to reduce forage than treatments that cut plants off at the base. These effects would be short-term in nature, as forage species would regrow following treatments.

Mechanical methods that remove competition and overstory vegetation would be expected to enhance grass production if grasses are present on the site. However, mechanical removal could negatively affect plants by compacting soils, creating bare ground, and uprooting desirable species. Ground disturbance could provide increased opportunities for weeds and increase the need to reseed after treatment.

Effects of Manual Treatments

Manual treatments would have minimal effects on livestock and their forage. Manual treatments would target the removal of undesirable species, but would not affect desirable species. Therefore, any effects on livestock forage would be beneficial.

Effects of Biological Treatments

Containment by Domestic Animals

Use of domestic animals to manage undesirable vegetation could affect the livestock that regularly graze on public lands under a grazing permit or lease. When managed improperly, these animals could compete for the same forage resources as domestic livestock. Under proper conditions, it has been demonstrated that the use of sheep and goats to manage leafy spurge through prescribed grazing has improved the conditions of the range, opening up infested sites for grass regrowth, and thus providing additional forage for authorized livestock grazing.

Other Biological Control Agents

Insects and pathogens released to manage noxious weeds on rangelands would not be likely to affect livestock. These agents target undesirable species, and could result in a long-term increase in the quality of forage on a treatment site. However, it is possible that in some situations use of these agents could prohibit animals from using a pasture for short periods of time.

Effects of Chemical Treatments

The extent of direct and indirect effects to livestock from herbicide treatments are evaluated in the PEIS (USDI BLM 2007a). Several factors influence the effectiveness of the herbicide application, including timing and method of application, herbicide used, application site characteristics, and environmental conditions. The direct effects of herbicide use on livestock depend on the sensitivity of each species to the particular herbicide used. Indirect effects include the degree to which a species or individual is positively or negatively affected by changes in rangeland conditions.

Livestock would have a greater chance of being affected by herbicide use if their range extent was completely treated or areas frequented by the livestock were treated. However, livestock could be specifically removed from an area during vegetation treatment, as directed on the herbicide label, or treatments could be scheduled to occur when livestock were not present, adhering to the re-entry interval specified on the herbicide label. If livestock were removed from the area specifically to facilitate the vegetation treatment, the grazing permittee would be adversely affected as a result of the area being unavailable for grazing. The permittee would need to either find alternative grazing areas, or modify ranching operations to account for the unavailable forage. Even though large treatments would usually occur when livestock were not in the treated area, some risk of indirect contact and consumption of contaminated vegetation over a large area would still exist. The use of spot treatment applications, in accordance to label directions, would reduce the potential effect on livestock. The effects of herbicide use on livestock would be site and application specific, and as such, site assessments would have to be performed, using available information, to determine an herbicide-use strategy that would minimize effects to livestock.

The BLM and Forest Service risk assessments suggested several possible common effects of herbicides to livestock (ENSR 2005c-l; SERA 2005). Livestock, which likely consume large quantities of grass, have greater risk for harm than livestock or wildlife that feed on other herbaceous vegetation or seeds and fruits, because herbicide residue is higher on grass than it is on other plants (Fletcher et al. 1994; Pfleeger et al. 1996). However, exposure to harmful doses of herbicide would be unlikely, since animals would be removed from the area if there was a chance they could be harmed by an herbicide, as required by the label instructions.

In conjunction with the identified grazing restrictions listed on herbicide labels, additional restrictions may be identified that require the livestock owner to remove the livestock from the treated area for a specified period of time prior to slaughter. In reviewing the grazing and slaughter restrictions listed on herbicide labels, it is important to recognize that additional grazing restrictions may apply to grazing lactating dairy animals. As described for other vegetation treatment methods, some herbicide treatments may require additional rest from livestock to ensure that more desirable vegetation has the opportunity to increase and reestablish on those sites from which undesirable vegetation has been removed.

Beneficial Effects of Treatments

All treatments that successfully reduce the cover of noxious weeds on rangelands would benefit livestock by increasing the number of acres suitable for grazing and the quality of forage. Noxious weed infestations can greatly reduce the land's carrying capacity for domestic livestock, which tend to avoid most weeds (Olson 1999). Cattle, in particular, preferentially graze native plant species over weeds, which often have low palatability as a result of toxins, spines, and/or distasteful compounds (Young 1992, Beck 1999, Olson 1999). Although goats and sheep are more likely to consume alien weeds than cattle, they also tend to select native or introduced forage species over weeds (Walker et al. 1994; Olson and Wallander 1998; Olson 1999). In addition, some noxious weeds (e.g., common tansy, houndstongue, Russian knapweed, and St. Johnswort) are poisonous to livestock. The success of weed removal would determine the level of benefit of the treatments over the long term.

Treatments that reduce the risk of future catastrophic wildfire through fuels reduction would also benefit livestock. Uncontrolled, high intensity wildfires can damage large tracts of rangeland, reducing its suitability for livestock grazing. Wildfires typically occur during drought conditions, when burning rangeland magnifies the drought stress of forage species and hampers their recovery. Treatments that restore and maintain fire-adapted ecosystems, such as the appropriate use of mechanical thinning and fire, would decrease the effects from wildfire to rangeland plant communities and improve ecosystem resilience and sustainability.

Fire suppression causes a buildup of dead plant materials (e.g., litter), and often increases the density of flammable living fuels on a site. The resultant fires burn hotter, spread more quickly, and consume more plant materials than fires that historically occurred under conditions of lower fuel loading. Large fires in the Great Basin during the late 1990s burned grazing allotments, eliminating much of the forage for livestock. If burned sites are not restored, weeds invade damaged areas and displace grasses favored by livestock. Therefore, restoring rangeland after fire helps increase forage for livestock (USDI BLM 1999).

Treatments that control populations of non-native species on public lands would be expected to benefit native plant communities by reducing the importance of non-native species and aiding in the reestablishment of native species. The use of fire, herbicides, or other treatment methods to simply kill vegetation is often inadequate, especially for large infestations. Introducing and establishing competitive plants is also needed for successful management of weed infestations and the restoration of desirable plant communities (Jacobs et al. 1999). The degree of benefit would depend on the success of these treatments over both the short and long term. Some treatments are very successful at removing weeds over the short term, but are not successful at promoting the establishment of native species in their place. In such cases, seeding of native plant species would be beneficial. Weeds may resprout or reseed quickly, outcompeting native species, and in some cases increasing in vigor as a result of treatments. The success of treatments would depend on numerous factors, and could require the use of a combination of methods discussed below to combat undesirable species.

Effects of Fire Treatments

In many cases, fire would benefit livestock by reducing the cover of shrub species such as sagebrush and juniper, which can form dense stands that preclude the establishment of desirable forage species and create physical obstructions to forage. The effect of fire on forage would vary by site. Fires conducted during the dormant season, under moist conditions, would be likely to stimulate forage production (e.g., through increasing soil temperature and nutrient availability) and favor perennial grasses (Wright 1974). Cattle have been observed to preferentially graze burned areas over unburned areas, with greater weight gains observed in animals that graze on burned sites (McGinty et al. 1983). In contrast, burning during the early summer can kill bunchgrasses and favor undesirable annuals, such as downy brome. In addition, suitable forage must be present on the site prior to the burn in order for livestock to benefit from the fire. In sites that are in poor condition, a combination of treatments and/or reseeding may be required to benefit livestock.

Effects of Mechanical and Manual Treatments

Livestock could benefit from a reduction in woody species and other undesirable vegetation. The duration of these benefits would depend on the species' ability to resprout, which could be controlled by using a combination of treatments (e.g., mechanical treatments plus fire or herbicides). Where woody species do resprout quickly, their palatability could be improved in the form of new growth.

Effects of Biological Control Treatments

Insects and pathogens have been used to control rangeland weeds and other invasive plants that are poisonous to livestock and that displace more desirable forage species. For example, flea beetles have reduced leafy spurge stem densities by 90% or more, and over 80% of flea beetle introductions have become established (Team Leafy Spurge 1999). It is estimated that 60% to 70% of leafy spurge infestations will be controlled using biological control by 2025 (Bangsund et al. 1997). Beetles, moths, flies, and other insects and pathogens have been used to control knapweeds, yellow starthistle, St. Johnswort, tansy ragwort, thistles, and other weeds that make rangeland unsuitable for livestock and may be poisonous to animals.

Effects of Chemical Treatments

In cases where herbicide treatments are able to reduce the cover of noxious and unpalatable weeds on grazed lands, there would be short- and long-term benefits to livestock as a result of increased quality of forage. In some cases, herbicides are the most effective means of controlling or eradicating invasive plant species.

The extent of positive and negative effects to livestock would depend on the relative amount each herbicide was used, whether herbicides would be applied in rangeland environments, and the method of application. The risk of negative effects would be greatest if diuron, diquat, bromacil and/or 2,4-D were used extensively. However, diquat would be used by the BLM exclusively as an aquatic herbicide, and the non-selective herbicides bromacil and diuron are not likely to be used extensively in rangelands. If these herbicides were used in restricted scenarios, as is proposed, and other herbicides were used effectively to increase the abundance of native forage relative to unpalatable weeds, positive effects to livestock could outweigh negative effects. Furthermore, the ability to use the four new herbicides proposed for use (diquat, fluridone, imazapic, and Overdrive®), as well as future herbicides that become registered with the USEPA, would allow BLM managers more options in choosing herbicides that best match treatment goals and application conditions and that are less toxic. As a result, there could be an increase in per capita benefits and a reduction in overall per capita risks to livestock (three of the four new herbicides present little to no risk to livestock) and an increase in habitat and ecosystem benefits from treatment.

Wild Horses and Burros

The BLM, in conjunction with the Forest Service, manages wild horses and burros on BLM- and Forest Service-administered lands through the *Wild Free-Roaming Horse and Burro Act of 1971*. Animals are managed within 201 Wild Horse and Burro herd management areas, with the goal of managing self-sustaining populations of healthy animals in balance with other uses and the productive capacity of their habitat. Public lands inhabited by wild horses or burros are closed to grazing by domestic horses and burros under permit or lease. In February 2005, over 31,000 wild horses and burros lived on public lands, with nearly half of these animals living in Nevada. The population of wild horses and burros is currently 3,500 animals above the appropriate management level. The appropriate management level is the number of wild horses and burros that public lands can support while maintaining a thriving natural ecological balance.

Vegetation management activities could affect wild horses and burros by exposing them to fire and chemicals that could harm their health, or by causing changes in vegetation that could positively or negatively alter the carrying capacity of the herd management areas. Alternately, vegetation management activities could improve the amount and quality of forage, potentially increasing the carrying capacity of the herd management areas.

Scoping Comments and Other Issues Evaluated in Assessment

Numerous respondents indicated that evaluation of the direct effects of herbicides to wild horses and burros would help in the selection of less-toxic herbicides, where feasible. Respondents were also concerned about how treatments would improve ecosystem health to benefit wild horses and burros.

Resource Program Goals

The goal of the Wild Horse and Burro Management program is to manage for self-sustaining populations of healthy animals in balance with other uses and the productive capacity of their habitat. The BLM manages populations by monitoring the animals, establishing appropriate population levels, and removing animals when appropriate population levels are exceeded. Given that populations increase by 15 to 20% annually, it is necessary to remove animals to maintain populations at a level that does not adversely affect rangeland vegetation (USDI BLM 2006c). This helps to promote healthy rangelands for all users. Vegetation treatments that improve rangeland would ensure healthier herds and could allow for an increase in the numbers of animals that could be maintained on public lands without harming ecosystem health.

Standard Operating Procedures

There are potential risks to wild horses and burros associated with herbicide use. However, these risks can be minimized by following certain SOPs, which can be implemented at the local level according to specific conditions: 1) minimizing potential hazards to wild horses and burros by ensuring adequate escape opportunities; 2) minimizing use of herbicides in areas actively grazed by wild horses and burros and/or using herbicides of low toxicity to horses and burros to reduce potential impacts; 3) removing wild horses and burros from identified treatment areas prior to herbicide application, in accordance with label directions for livestock; and 5) taking into account the different types of application equipment and methods to limit the probability of contaminating non-target food and water sources.

In addition the BLM should minimize potential hazards to horses and burros from all treatment methods by ensuring adequate escape opportunities, and 2) avoid critical periods and minimize impacts to critical habitat that could adversely affect wild horse or burro populations (see Table 2-5).

These procedures would help to minimize effects to wild horses and burros and rangeland to the extent practical. As a result, long-term benefits to wild horses and burros from the control of invasive species would likely outweigh any short-term negative effects to these animals associated with vegetation treatments.

Adverse Effects of Treatments

The proposed vegetation treatments would cause disturbances to rangeland plant communities by killing both target and non-target plants. In areas that have been highly degraded, merely restoring disturbance to the ecosystem could adversely affect native plant communities in some cases by encouraging the spread of weeds or the persistence of altered vegetation structure and species composition. Treatments also have the potential to adversely affect the health of wild horses and burros.

Effects of Fire Treatments

Fire treatments occurring in herd management areas would have the potential to affect wild horse and burro herds in those areas. Direct effects to animals from fires would be unlikely, as they would be able to flee the burn area. With large fires, wild horses or burros may be forced onto areas that are not legally designated for wild horse and burro management.

Over the short term, fire could reduce the suitability of the treatment site to support wild horses and burros. The degree of effects would be dependent on the size and severity of the fire, the climatic conditions, and any other animals (i.e., domestic livestock or wildlife) using the site for grazing purposes. A large fire that consumed much of a herd management area could potentially result in a loss of animals, unless herds were temporarily relocated prior to treatment. In the case of a small, low severity fire, wild horses and burros would be likely to find suitable forage in the area. Wild horses are accustomed to migrating in search of food and shelter in response to climatic variation and natural disturbances that alter food supplies (Nevada Commission for the Preservation of Wild Horses 1999). Food stresses to populations following prescribed fire would be the greatest on sites occupied by large populations of other domestic animals, or during harsh climatic conditions, such as drought.

Effects of Mechanical Treatments

Use of mechanical treatments could temporarily reduce the amount of forage on the treatment site, as discussed for livestock in the previous section. Long-term benefits to forage production could also occur. In addition, wild horses and burros could experience short-term disturbances associated with mechanical noise and the presence of humans. However, since animals could leave the area during treatments, effects would be minor.

Effects of Manual Treatments

Manual treatments would have minimal effects on wild horses/burros or their forage, as they would occur over a very small area and target undesirable forage species.

Effects of Biological Treatments

Containment by Domestic Animals

The use of domestic animals to control vegetation could result in minor competition with wild horses and burros. However, these effects would be localized and short-term in duration, and should not adversely affect wild horse and burro populations. Wild horses and burros are more generalists in regards to their feeding behavior than domestic livestock, and would graze over a larger area than animals brought in for treatments.

Other Biological Control Agents

Insects and pathogens that target noxious weed species would be unlikely to affect populations of wild horses and burros. These treatments target undesirable forage species, would generally not harm desired non-target species, and are slow-acting.

Effects of Chemical Treatments

The extent of direct and indirect impacts to wild horses and burros would be influenced by several factors, including the herbicide selected for treatment, the species composition of the site to be treated, the type of application, the physical characteristics of the treatment area, environmental conditions, and the timing of the application in relation to the behavior of the wild horses and burros. The impacts of herbicide use on wild horses and burros would depend directly on the sensitivity of each species to the particular herbicide used and indirectly on the degree to which a species or individual is positively or negatively affected by changes in herd management area conditions.

Adverse indirect effects could include reduction in forage amount and preferred forage type. If their range extent was partially or completely sprayed, wild horses and burros would be at risk for exposure to herbicides directly via contact with the herbicide upon application, or indirectly via dermal contact with or ingestion of sprayed vegetation. It is unlikely that an animal's entire range would be sprayed, as these animals are wide ranging; herd management areas are often larger than 10,000 acres, while most (77%) of treatments would be less than 1,000 acres. On average, wild horses and burros use about 360 acres per animal, or about 3,600 acres for a herd of 10 animals.

The BLM and Forest Service risk assessments assessed the risks of herbicides to wild horses and burros (ENSR 2005c-l; SERA 2005). Wild horses and burros, which likely consume large quantities of grass, have relatively greater risk for harm than smaller wildlife or wildlife that feed on other herbaceous vegetation or seeds and fruits because herbicide residue is higher on grass than it is on other plants (Fletcher et al. 1994; Pfleeger et al. 1996). However, exposure to harmful doses of herbicide would be unlikely since animals would cover a large area during their daily movements, and thus would likely be exposed only to small amounts of herbicide.

Beneficial Effects of Treatments

All treatments that successfully reduce the cover of noxious weeds on grazed lands would benefit wild horses and burros by increasing the acreage available for grazing and the quality of forage. In addition, some noxious weeds (e.g., common tansy, houndstongue, Russian knapweed, and St. Johnswort) are poisonous to wild horses and burros. The success of weed removal would determine the level of benefit of the treatments over the long term.

Treatments that reduce the risk of future catastrophic wildfire through fuels reduction would also benefit wild horses and burros. Weeds of concern that could be found in rangelands include downy brome, medusahead, halogeton, rabbitbrush, diffuse knapweed, Russian thistle, and perennial pepperweed. Much of the herd management area land for wild horses and burros occurs in drier habitats in Nevada. Uncontrolled, high intensity wildfires can damage large tracts of rangeland, reducing its suitability for wild horse and burro grazing. Wildfires typically occur during drought conditions, when burning rangeland magnifies the drought stress of forage species and hampers their recovery. Some herbicides are approved for use in BLM programs for rangeland as well as fuels management (e.g., glyphosate, imazapic, and sulfometuron methyl). Treatments that remove dominant woody vegetation, particularly pinyon and juniper that have invaded shrub-grass habitats, would enhance habitat for wild horses and burros as grasses and forbs establish.

Effects of Fire Use

In the growing seasons following fire treatments, wild horses and burros would be able to return to treated sites. The condition of forage on the site would depend on the condition of the site prior to treatment and the response of the vegetation type receiving fire treatments. Improved forage would be likely as a result of fires conducted during the dormant season and under moist conditions.

Effects of Mechanical and Manual Treatments

In some cases, wild horses and burros would benefit from the reduction in woody species and other undesirable vegetation. The duration of these benefits would depend on the species' ability to resprout, which could be controlled by using a combination of treatments (e.g., mechanical treatments plus fire or herbicides). Where woody species did resprout quickly, their palatability could be improved in the form of new growth. Shrubs are an important component of the diet of wild horses and burros, especially during winter (USDI BLM 2001a).

Effects of Biological Treatments

Insects and pathogens have been used to control rangeland weeds and other invasive plants that are poisonous to wild horses and burros and that displace more desirable forage species. Beetles, moths, flies and other insects and pathogens have been used to control knapweeds, yellow starthistle, St. Johnswort, tansy ragwort, and thistles; these unpalatable or poisonous plant species make rangeland less desirable for wild horses and burros.

Effects of Chemical Treatments

In cases where herbicide treatments reduce the cover of noxious and unpalatable weeds on grazed lands and replace them with more palatable native plants, there would be associated short- and long-term benefits to wild horses and burros from increased availability and quality of forage. If the forage amount was increased within a given herd management area, the carrying capacity of the herd management area would increase, thus benefiting those areas where wild horse and burro populations exceed the appropriate management level.

The use of herbicides, or a combination of herbicides in conjunction with another treatment method, may be the most effective means of controlling or eradicating some invasive plant species. Noxious weed infestations can greatly reduce the land's carrying capacity for wild horses and burros, which tend to avoid weeds that have low palatability as a result of defenses such as toxins, spines, and/or distasteful compounds (e.g., thistle [Olson 1999]). In addition, some noxious weeds (e.g., horsetail, wild mustard, poison hemlock, tansy ragwort, yellow starthistle, and St. Johnswort) are poisonous to horses. Grazing alone can be an effective means of managing invasive plants in herd management areas. However, if vegetation is overgrazed (e.g., as a result of herd management areas in excess of the appropriate management level) another method, such as herbicide treatment, is required to return vegetation to a more desirable composition, followed by grazing within the carrying capacity of the herd management area. The success of weed removal would determine the level of benefit of the treatments over the long term.

The ability to use the four new herbicides (diquat, fluridone, imazapic, and Overdrive®), as well as future herbicides that become registered with the USEPA, would allow BLM managers more options in choosing herbicides that best match treatment goals and application conditions and are the least toxic. As a result, there could be an increase in per capita benefits and a reduction in overall per capita risks to wild horses and burros (three of the four new herbicides present little to no risk to wild horses and burros), and an increase in habitat and ecosystem benefits from treatment.

Paleontological and Cultural Resources

As discussed below, wildfire has the potential to adversely affect paleontological, cultural, and traditional lifeway resources by destroying and altering resources. It is likely that invasive infestations have long-term negative effects on paleontological and cultural resource sites by altering native plant communities and increasing the potential for soil erosion, potentially leading to the loss of paleontological and cultural resources. Restoration of natural fire regimes and removal of invasive vegetation would limit these effects as well as contribute to the restoration and maintenance of historic and ethnographic cultural landscapes (USDI National Park Service 2003).

Scoping Comments and Other Issues Evaluated in Assessment

Some respondents felt that cultural preservation is an important issue, and encouraged addressing the effects to cultural and archaeological sites. Other respondents suggested that traditional cultural properties should be approached in a way that is sensitive to cultural resources, with plan revisions and, in some cases, by project cancellation. There was concern about the effects of herbicides on basket plants and the people who collect them, in particular Native peoples. Plant parts are sometimes placed in the mouth for cutting, splitting, or softening, which can result in ingestion of contaminants. Respondents noted that fire generally helps these basket plants, while herbicides are detrimental.

Resource Program Goals

The management of cultural and paleontological resources on public lands is overseen by the BLM's Cultural and Fossil Resources and Tribal Consultation programs. Goals of the programs include: 1) protection, study, management, and stabilization of the BLM's cultural and paleontological resources; 2) interpretation of these resources; 3) protection and curation of museum collections recovered from on-the-ground investigations; 4) consultation with Indian tribes and Alaska Native corporations; 5) development of partnerships with non-federal entities; and 6) repatriation of museum collections subject to the provisions of the Native American Graves Protection and Repatriation Act.

As discussed below, vegetation treatment activities could have substantial effects on paleontological and cultural resources and Native American traditional lifeway values. Thus, the program has a keen interest in ensuring that vegetation treatments are conducted in a manner that protects or enhances these resources while improving vegetation condition.

Standard Operating Procedures

Before proceeding with vegetation treatments, the effects of BLM actions on cultural resources would be addressed through compliance with the NHPA, as implemented through a 1997 national Programmatic Agreement (*Programmatic Agreement among the*

Bureau of Land Management, the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers Regarding the Manner in Which BLM Will Meet Its Responsibilities Under the National Historic Preservation Act) and state-specific protocol agreements with SHPOs. Effects on paleontological resources would be addressed as outlined in resource management plans developed under the authority of the FLPMA, and site specific NEPA documents developed for vegetative treatments. The BLM's responsibilities under these authorities would be addressed as early in the vegetation management project planning process as possible.

The processes for identifying and managing cultural resources are addressed in USDI BLM manuals 8100 *(The Foundations for Managing Cultural Resources*), 8110 *(Identifying and Evaluating Cultural Resources),* 8120 *(Tribal Consultation under Cultural Resource Authorities*), 8130 *(Planning for Uses of Cultural Resources)*, 8140 *(Protecting Cultural Resources)*, and Handbook H-8120-1 *(Guidelines for Conducting Tribal Consultation)*. Processes for identifying and managing paleontological resources are outlined in Manual 8720 (*Paleontological Resource Management*) and Handbook H-8720-1 *(General Procedural Guidance for Paleontological Resource Management)*. The BLM Cultural Resource Management program is responsible for the study, evaluation, protection, management, stabilization, and inventory of paleontological, historical, and archeological resources. The program also guides close consultation with American Indian tribal and Alaska Native group governments as required by law for the maintenance, preservation, and promotion of native cultural heritage and resources, including plant and animal subsistence resources and vegetation used for religious and ceremonial purposes. The BLM initiated consultation with American Indian tribes and Alaska Native groups to identify their cultural values, religious beliefs, traditional practices, and legal rights that could be affected by BLM actions. Consultation included sending out letters to all tribes and groups that could be directly affected by vegetation treatment activities, and requesting information on how the proposed activities could affect Native American and Alaska Native interests, including the use of vegetation and wildlife for subsistence, religious, and ceremonial purposes (see Appendix C).

Paleontological Resources

The processes for identifying paleontological resources would include consultation with BLM regional paleontologists, paleontology program contacts in BLM field offices, state geological survey agencies, local colleges, universities, or museums, or SHPOs (if individual SHPOs deal with fossil resources) as part of the planning process. Procedures would be developed for protecting significant fossil resources as outlined in BLM Handbook H-8270-1 (*General Procedural Guidance for Paleontological Resource Management)*. Resource management plans may be in place that have classified sensitivity levels for important fossil resources and management prescriptions associated with each sensitivity level. Specific protective measures for paleontological resources would be identified at the local level during project development. If management plans lack this classification scheme, project specific analysis would be necessary to assess the need to conduct paleontological resource inventories based on available information. If a project area contained documented locations of paleontological resources, or had geological or geomorphic characteristics likely to contain vertebrate fossils, a field inventory could be required to locate and report previously unrecorded paleontological resources. Site specific mitigation measures would be developed during the implementation stage of the vegetation treatments, if needed.

Cultural Resources

Treatments would follow standard procedures for identifying cultural resources in compliance with Section 106 of the NHPA, as implemented through the national programmatic agreement and state protocols. The process would include necessary consultations with SHPOs and interested tribes, at the state or local level, as projects were planned.

As part of the process of planning for vegetation treatments, cultural resource specialists would identify historic properties eligible for the NRHP. Historic properties may include any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP. Effects to National Register-eligible cultural resources could be avoided through project redesign or could be mitigated through recordation, data recovery, monitoring, or other appropriate measures. Should National Register-eligible cultural resources be inadvertently discovered during vegetation treatments, appropriate actions would be taken to protect these resources or recover data following appropriate consultation. An important concern regarding the presence of non-cultural resource personnel on the ground during any of the treatment processes is the unauthorized collection of artifactual material, especially from National Register-eligible properties. Procedures would be developed as part of an unanticipated discoveries plan that would include reporting previously unrecorded cultural resources to local BLM professionals. Ancestral tribal human remains and associated grave goods subject to the Native American Graves Protection and Repatriation Act would be further reported to appropriate American Indian tribes by local BLM officials.

Traditional Lifeway Values

Discussions would be held with American Indian tribes and Alaska Native groups to determine which plants with the potential to be affected by proposed project treatments have traditional lifeway values, and to identify any specific, traditional collecting areas. Target plants for vegetation treatments include oak, juniper, pinyon, lodgepole pine, cottonwood, mesquite, amaranth, cattail, and brackenfern, as well as many other plants identified in Native American ethnobotanical studies and pharmacopoeia. These plants are traditionally used for subsistence, clothing, basketry, shelter, utilitarian items, and possibly medicines by one or more tribes or groups in the western U.S. and Alaska. Since other target species have common names similar to those of some plants used traditionally, such as whorled milkweed or giant reeds, this should be made clear to Native Americans and Alaska Natives in areas where treatments are planned. Treatments that could adversely affect plants important for maintaining traditional lifeways could be modified or cancelled in certain areas, depending on the intensity of the effects as determined through NEPA analysis and if mitigation is required. On the other hand, there could be long-term benefits to traditional lifeways, since reducing or eliminating non-native or invasive plant competitors could allow traditionally used native species to proliferate, and possibly also improve access for tribal uses. Prescribed fire produces new growth that can benefit plant species desired for traditional tribal practices, such as basket weaving.

Adverse Effects of Treatments

Treatment activities that disturb the ground or alter the distribution, health, and welfare of plants and animals used by Native peoples would result in the greatest potential to harm paleontological, cultural, and traditional use resources. One third of acres would be treated using fire, which has both short- and long-term effects, including beneficial effects, on resources important to Native peoples. Another third of the acres would be treated using mechanical methods. Ground disturbance associated with mechanical treatments could affect artifacts located near the soil surface. Other treatment methods would have little effect on paleontological, cultural, and subsistence resources, although herbicide treatments could harm non-target vegetation and the health of Native Americans, and could alter cultural landscapes associated with historic properties.

Effects of Fire Treatments

There are several good sources of information on the effects of fire on cultural and paleontological resources, including the *Fire Effects Guide: Cultural Resources* (Hanes 2001), *Bibliographic Sources Regarding the Effects of Fire on Cultural Properties* (Halford 2001), and the *Bare Bones Guide to Fire Effects on Cultural Resources for Cultural Resource Specialists* (Winthrop 2004). These sources were used to prepare the following discussion on the effects of fire on cultural resources.

The effects of fire on cultural resources would vary depending on temperature and duration of exposure to heat. Generally, higher temperature and/or longer exposure to heat increases the potential for damage to cultural resources. As a general rule, fire does not affect buried cultural materials. Studies show that even a few inches of soil cover are sufficient to protect cultural materials (Oster n.d.). However, there are times when conditions do carry heat below the surface, with the potential to affect buried materials.

Stumps that smolder and burn have the potential to affect nearby buried materials. Heavy duff, surface logs, and roots that smolder and burn have the potential to expose subsurface materials to heat over a period of time, and hence have the potential to affect cultural materials. Fires that burn hot and fast through a site may have less of an effect on certain types of cultural materials than fires that smolder in the duff, or than logs that burn for a period of time.

Some effects of fire on certain cultural materials may be insubstantial. That is, the fire might not actually diminish characteristics that make a site eligible for the NRHP. For example, although high heat could destroy obsidian hydration bands on surface artifacts, the surface component of the affected site might not be of particular value in the site’s overall assessment. Fire could burn the solder out of a hole-in-cap can without diminishing the can’s ability to provide chronological information for a site.

Wildland fire is generally more destructive to cultural resources than prescribed fire, since it results in effects from both uncontrolled fire and fire suppression. Management decisions may need to balance the potential effects of a prescribed burn with the risk of damage from an uncontrolled wildfire. Because prescribed fire can be controlled, cultural resource specialists could work with fire managers to determine the predicted temperature and duration of a fire through an area, and possibly to modify burn plans to minimize effects to cultural resources. The emergency nature of wildland fires can lessen management ability and priority to conserve cultural resources.

Protecting cultural resources during fire would begin with fire management planning. During planning, the BLM would define vulnerable cultural resources by classes of site-types and specific sites, identify appropriate protection measures for them, and identify appropriate management responses with regard to cultural resources in the event of fire. Consultation with SHPO, Tribes, and other appropriate entities should be part of the project planning process, especially when designing fire-specific protocols for identification and protection of potentially affected cultural resources.

Fire Effects on Lithics

Fire can affect chipped and groundstone tools, primarily through changes in morphology rather than in chemistry. Residues on artifacts are not necessarily destroyed by fire. As a general rule of thumb, the hotter the temperature and the longer the exposure to fire, the greater the effect on lithic materials. When important artifacts are present in a treatment site, it could be necessary to take protective measures.

Obsidian. Fire can modify or destroy obsidian hydration rinds, but does not affect obsidian source analysis (Shackley and Dillian 2002). High temperatures, such as those experienced in a catastrophic wildfire, may be sufficient to cause obsidian to bubble and crack, losing shape as well as hydration capacity.

The exact temperature at which obsidian is affected varies, probably due to components of the field environment and/or differences in source materials. Duration of exposure increases the effect of heat on obsidian. High temperatures and smoldering fires can affect hydration bands, diminishing or obliterating them.

Chert. Fire can affect chert (including various silicates), through fracturing, pot-lidding, crazing, shattering, causing changes in color and internal luster, and other effects that might reduce an artifact's ability to render information about the past. Temperatures that affect chert vary and are possibly dependent on source or other variables such as prior heat-treatment for tool manufacture. Generally, the longer and hotter the fire, the more intense the effects on chert artifacts would be (Deal n.d.; Winthrop 2004). After a fire, it may be more difficult to distinguish whether chert artifacts were subjected to purposeful heat-treatment in the original manufacturing process.

Basalt. Fire can produce changes in basalt, including spalling, potlidding, crazing, and fracturing that possibly result from rapid cooling. There is little experimental data for fire effects on basalt. One study indicates that spalling or flaking may occur at temperatures around 662 ºF to 752 ºF (Deal n.d.). Peak production of combustible products from fire occurs above 600 ºF.

Groundstone. Rock types vary in their response to fire. Sandstone reportedly cracks or fractures at a lower temperature than basalt. Granites and quartzites withstand higher temperatures. Severe wildfire may cause portable groundstone to crack or fracture. Thermal shock, such as rapid heating or cooling, can cause fracturing and exfoliating of groundstone artifacts, including bedrock mortars. Burning or smoldering fuels on groundstone artifacts or features (e.g., a fallen tree on a bedrock mortar) may contribute to increased damage during a fire. As is true for other tool types, longer exposure to heat and/or hotter fires increases the potential for artifact damage (Deal n.d.; Buenger 2003).

Fire Effects on Ceramics

Because of the different types of clays, inclusions, and manufacturing techniques, the effects of fire are different for different distinct pottery types. Since all pottery—historic and prehistoric—has been fired to some degree, heat damage is not as significant a consideration for this artifact type as it is for others. Generally, structural damage does not occur until temperatures exceed the original firing temperature. Most damage noted is to the surface decoration or glaze. Archaeological ceramic manufacturing facilities, like archaeological hearths, may have characteristics that could be altered or damaged by fire; thus, fire can potentially damage their suitability for dating by thermo-luminescence techniques.

Prehistoric Ceramics. Temperatures do not exceed the original firing temperature for most prehistoric ceramics until about 1,112 ºF (Andrews 2004). Fire can, however, affect the appearance of pottery shards, possibly leading to misidentification. Effects from fire include surface spalling, alteration of painted decoration, blackening and sooting, and loss of appliqué designs, which may break off. In one experiment painted designs faded and changed color at temperatures greater than 1,472 ºF. However, sooting or blackening may be removed by cleaning in a lab, and discoloration does not necessarily prevent identification of pottery type (Rude n.d). Fire-altered ceramic fragments may make field location of actual ceramic manufacturing facilities or sites more difficult, as such processes are identified by the presence of "waste fragments," the by-products of pottery production.

Historic Ceramics. Historic ceramics consist of earthenwares, stonewares, and porcelain. These types of pottery are differentiated in part by the heat of firing. All of these pottery types may be glazed, and the glaze or other decoration is likely to be the most vulnerable characteristic. Some early glazes (e.g., majolica glaze) and glazes on "whiteware" (refined earthenware common at 19th and 20th century sites) may crackle or spall even in a low temperature fire.

Fire Effects on Organic Materials

Organics usually burn or alter at lower temperatures than inorganic items. Artifacts (e.g., basketry, digging sticks, clothing, textiles) and features (e.g., structures, bow-stave trees, wikiups, dendroglyphs) made of or containing organics such as wood, leather, hide, or cordage would require protection or treatment before allowing a fire to burn through a site containing such items. Bone and shell can sustain some degree of burning without complete destruction (Buenger 2003). Many historic structural elements are constructed of building materials that are highly flammable and severely affected by even low temperature fires.

Fire Effects on Inorganic Architectural Materials

Fire damages architectural stone. Above about 572 ºF, sandstone begins to oxidize, and at higher temperatures (1,292 ºF), it spalls and fractures. These effects can significantly alter features constructed of this material and may constitute a significant effect to sites with these features (Buenger 2003).

Adobe bricks and mortar and rammed earth walls are created from non-flammable sand, silt, and clay. These materials are sometimes mixed with straw, however, and adobe structures are often constructed with wooden poles and posts, which may burn. Walls may be smoothed with adobe plaster. When intact, an adobe structure resists fire. Plaster that is made with gypsum spalls when exposed to sufficient heat, which may expose the more flammable parts of a structure. If the straw used in the adobe burns, the structure may also be weakened (Haecker n.d.). Sometimes roofing and flooring of adobe structures incorporate organic materials, although tile may be used. Mastic sealants may be weakened by fire.

Cement-mortared fieldstone, firebrick, cinder block, and cement aggregate are generally resistant to fire. Low-fired, non-commercial, locally made brick may weaken and crumble in a hot fire. Hot fires also calcinate lime-based mortar, causing it to crumble and eventually causing the wall to collapse. Masonry and cinder block may spall, resulting in damage to the surface of the structure (Haecker n.d.). These materials can also be discolored from soot.

Fire Effects on Rock Art

Fire has a high potential to damage rock art. Though there are no specific temperature guidelines for rock art, fire effects include soot smudging and discoloration from smoke, which obscure the rock art images; degradation of the rock surface from spalling, exfoliation, and increased weathering; changes in organic paints due to heat; and damage to rock varnish, which may destroy its potential to date the art (Tratebas 2004, Kelly and McCarthy 2001 *cited in* Winthrop 2004).

Effects of Fire Suppression on Cultural Resources and Archaeological Sites

Fire suppression activities have a considerable potential to damage archaeological and historic sites. Effects to cultural materials can occur from many activities, including fireline construction (hand line and bulldozer line), establishment of helicopter bases and fire camps, and related activities. Application of fire retardant and other chemical products has the potential to affect cultural resources, although use of fire retardants on historic structures may protect them from destruction during a fire. Cultural resource specialists might need to consider the effects of fire itself versus the effects of retardant use or the possibility of other protection options during a fire. Foam-lines or wetlines would not affect cultural resources in general, however they might affect Native American traditional plant gathering areas. Fire camps and staging areas in or near known or unidentified archaeological or historic sites may subject the associated surface artifacts to removal or displacement.

Other Effects of Fire

Fire use increases visibility of cultural sites as a result of vegetation burn-off, and consequently increases the potential for vandalism. Fire can cause physical damage to sites from snags/trees falling on them, and can indirectly lead to loss of archaeological data due to increased damage from rain, changes in drainage patterns, soil erosion, and flooding after a fire. Field procedures for identifying cultural sites for protection and avoidance from fire-related activities (e.g., flagging site perimeters, etc.) attract local illegal artifact collectors to vulnerable site localities.

Effects of Mechanical and Manual Treatments

Approximately 2.2 million acres would be treated annually using mechanical methods. Chaining, root plowing, tilling and drill seeding, mowing, roller chopping and cutting, blading, grubbing, and feller-bunching would damage surface and subsurface cultural resources if the sites were not avoided. Treatments involving surface and shallow subsurface disturbance would likely introduce organic materials to lower soil layers, thereby contaminating surface or shallow subsurface cultural resource sites containing early historic or prehistoric datable organics, such as charcoal, wood, or preserved plant materials. Plant and pollen contamination would lead to incorrect or inaccurate analytical results by researchers studying such remains preserved at sites. Surface and shallow subsurface effects would also include horizontal and vertical displacement of the upper portion of soils in which archaeological resources are contained, compromising depositional context and integrity, and artifact damage or destruction.

During treatments, the BLM would have limited ability to avoid plants identified by Native peoples as being important in traditional subsistence, religious, or other cultural practices. Timing of treatments would be critical to avoid conflict with traditional cultural practices. Once concerns of Native peoples were identified, the BLM would take these concerns into consideration when treating vegetation in sensitive areas.

About 270,000 acres would be treated using manual methods. The use of hand tools and hand-operated power tools to cut or clear vegetation could disturb both surface and subsurface cultural resources. However, such manual treatments have the least potential to affect known identified cultural sites. Although dating sample cleaning and processing has improved over the past few years, mulching with organic materials would complicate radiometric dating of materials from cultural resource sites.

Effects of Biological Treatments

Biological treatments using grazing animals could damage surface artifacts and disrupt surface and shallow subsurface cultural materials. However, pretreatment site-specific investigations and development of measures to discourage livestock from using sensitive areas would decrease this possibility. Because of their small size and host-specific action, insects or pathogens would be unlikely to affect cultural resources, although organic site constituents (e.g., baskets, cordage, etc.) might be affected, if present.

Consultation with Indian tribes would be undertaken to locate any areas of vegetation of significance to tribes and that could be affected by biological treatments. The BLM would work with tribes to minimize effects to these resources from grazing or other biological treatments.

Effects of Chemical Treatments

Paleontological Resources

The effect of herbicide treatments on fossil material would vary with respect to: 1) fossil type, 2) minerals, 3) degree of fossilization, 4) whether the fossil was exposed or buried, and 5) method of herbicide application. Although chemicals found in herbicides could possibly affect unique fossil material, herbicide treatments would be more likely to affect researchers, students, or other field personnel conducting paleontological research than the paleontological resources. The most likely cause of damage to fossil materials would be the use of wheeled equipment to apply herbicides. Vehicles driving cross-country would potentially crush fossil material exposed on the surface. Erosion channels or fractured soil crusts that increase or accelerate erosive action may also result from such off-road vehicle use.

Cultural Resources

While herbicide treatments could affect buried organic cultural resources, they would be more likely to have a negative effect on traditional cultural practices of gathering plant foods or materials important to local tribes or groups. The effect of herbicide treatments on cultural resources would depend on the method of herbicide application and the herbicide type used. Some chemicals can cause soil acidity to increase, which would result in deterioration of artifacts—even some types of stone from which artifacts are made. Chemical treatments could also alter or obscure the surfaces of standing wall masonry structures, pictograph or petroglyph panels, and organic materials. While chemicals could affect the surface of exposed artifacts, they could also generally be removed without damage if the artifacts were treated soon after exposure. Organic substances used as inactive ingredients in herbicide formulations, such as diesel fuel or kerosene, could contaminate the surface soil and seep into the subsurface portions of a site. These organic substances could interfere with the radiocarbon or Carbon 14 (C-14) dating of site, and could be opposed by tribes for use near burials (USDI BLM 1991a).

Depending on the selected application method, herbicide applications would have limited ability to avoid plants identified by Native peoples as being important in traditional subsistence, religious, or other cultural practices. Consultation would be undertaken with tribes to locate any areas of vegetation of importance to the tribe that could be affected by herbicide treatments, which could then be subject to potential cancellation. Certain herbicides could also pose a possible health risk, through residues left on plants used as traditional foods or for ceremonial purposes, or by contaminating other food sources or drinking water, as discussed below. A study to assess the exposure of basketweavers to forestry herbicides showed that detectable residues of herbicides were found on 49% of plant materials used by Native Americans inside treatment areas, but only 3% outside of treatment areas, and that residues continued to be detected for several months (Segawa et al. 1997). Tribal basketweavers that gather wild vegetation often place plant parts into their mouths for processing (e.g., cutting, splitting, softening). However, a study of herbicide uptake by lomatium and bitteroot roots in rangeland treated with picloram and sulfometuron methyl showed that no herbicide residues were found in roots at 2, 6, and 45 weeks after treatment (ENSR 2001). Often tribally-gathered root crops occur on lithosols with little soil development and low forage value, such that vegetation treatments may rarely co-occur where traditional gathering takes place. Thus, risks would vary depending on the time of plant use and herbicide treatment, and the portions of the plants that are used.

Herbicide Effects on Native American Health

Exposure Characterization. The potential risks to Native Americans from exposure to herbicides used in BLM programs were evaluated separately from risks to other public receptors (see Human Health and Safety section in this chapter). Native Americans could be exposed to herbicides as a result of subsistence and cultural activities such as plant gathering and consumption of fish caught in local streams; therefore, risk levels determined for Native American receptors reflect unique exposure scenarios as well as typical scenarios for public receptors, but with higher levels of exposure than general public receptors.

Risk Characterization. Native American adults face the same risks that public receptors face, as well as some additional risks as a result of unique subsistence practices or increased time spent in treated areas. Native American adults face health risks from the following scenarios: exposure to diquat when accidentally spilled or applied at the maximum rate (low risk), and consumption of fish contaminated with 2,4-D (high risk), hexazinone (moderate to high risk), or picloram (low risk). Native American children face health risks under scenarios where diquat is applied at the typical rate or fluridone is accidentally spilled; as well as risk from berry picking in an area sprayed with diquat at the typical rate. Native Americans eat far more fish than the general population, and could be exposed to or to ingest fish impacted by herbicide applications. Traditional cultural practitioners, usually elders with greater health vulnerability, may use roadside access where herbicidal treatments have been applied, and may ingest chemicals that have been directly or indirectly (e.g., wind drift) applied to cultural plants.

Beneficial Effects of Treatments

The BLM proposes to treat up to 6 million acres annually. Although these treatments could have adverse effects on paleontological, archaeological, cultural, and traditional use resources and Native American health, effects should be short term, with the exception of loss or destruction of these resources and effects to health. In contrast, restoring natural fire regimes and native ecosystems would have long-term benefits to these resources and traditional lifeways. Many of these benefits are described in more detail in Appendixes D (Native American Resource Use) and E (Cultural Resources) of the PER.

Protection of Paleontological, Archaeological, and Cultural Resources

Efforts to reduce fire risk through the use of prescribed fire and other treatment methods should ensure the long-term protection of these resources and improve ecosystem health to benefit the plants and animals upon which Native peoples depend. Stabilization and restoration of riparian systems would reduce streambank erosion and ensure that cultural and paleontological resources buried near streams remained intact. Surveys would be conducted to identify the locations of cultural and traditional lifeway resource values prior to treatment activities to ensure that these resources would be protected.

Protection and Enhancement of Vegetation Used by Native Peoples

Although universally important, plant use by Native peoples is extremely varied, both by region and by group. Subsistence use of such plant products as roots and tubers, stalks, leaves, berries, and nuts is essential to Native peoples. Vegetation also provides habitat for fish and wildlife used by Native peoples.

Although modern materials may now replace materials traditionally used by Native Americans, a variety of residential shelters and other buildings, such as ceremonial lodges and sweat houses, may be constructed using a combination of traditional materials and typically employing a locally derived or imported hardwood as part of the structural frame. The frame may then be covered with other materials, such as planks, mats, brush, hides, and other materials that are available. Wood is burned to cook food, smoke cure game and fish, warm dwellings, and facilitate making of native arts, such as ceramics and tools. Trees are often fashioned into various types of watercraft, ceremonial objects, and other structural or non-structural uses. In many cases, an emphasis may be placed on using native and traditional materials for a variety of purposes to perpetuate native arts from generation to generation.

The use of plants for medicinal purposes is widespread. Plants such as tobacco, sweet grass, cedar, and sage, have seen important religious and other ceremonial uses. The use of grasses and other plant resources for basket, box, and tool making also can be observed in the cultures of numerous Native American and Alaska Native groups (Zimmerman and Molyneaux 1996, Bol 1998). Plant products also have been used to make textiles, cordage, and matting, as well as to tan hides. The use of plant dyes, paints, and soaps is widespread.

The BLM's highest priority is to use vegetation treatments to restore high priority subbasins within key watersheds to benefit wetland and riparian vegetation, as well as fish and other aquatic organisms. Over the short term, adverse effects to aquatic organisms from vegetation treatment activities proposed by the BLM would occur, but treatments would lead to improved conditions for aquatic species over the long term. The eventual growth of desirable vegetation in treated areas would moderate water temperatures, buffer the input of sediment and herbicides from runoff, promote bank stability, and contribute woody debris to aquatic bodies. Ongoing efforts by the BLM to enhance riparian vegetation would also help to increase the number of miles of BLM-administered streams that are classified as "Proper Functioning," and provide good habitat for anadromous and other fish that are harvested by Native peoples.

Treatments that remove hazardous fuels from public lands would be expected to benefit the health of plant and animal communities in which natural fire cycles have been altered, and to improve accessibility for tribal cultural practices. The suppression of fire results in the buildup of dead plant materials (e.g., litter and dead woody materials), and often increases the density of flammable living fuels on a site (e.g., dead branches on living shrubs or live plants, especially during dry periods). The resultant fires burn hotter, spread more quickly, and consume more plant materials than fires that historically occurred under conditions of lower fuel loading.

Changes in vegetation composition, distribution, and structure can affect the habitats of fish and wildlife. Fire is an important element in habitat condition. Fire improves the palatability and nutritional value of forbs, grasses, and some shrubs. Fire can improve or enhance wild plant stands used for tribal basketry, such as beargrass, as the new regrowth is more pliable and more abundant. Fire suppression and change in fire regimes due to exotic plant invasions have reduced the quality and availability of many game habitats (Lyon et al. 1995; USDA Forest Service and USDI BLM 2000b).

Treatments that restore and maintain fire-adapted ecosystems, through the appropriate use of mechanical thinning, fire use, and other vegetation treatment methods, would decrease the effects of future wildfires on communities and improve ecosystem resilience and sustainability. Treatments should also reduce the incidence and severity of wildfires across the West. Treatments that provide a mosaic of forbs, grasses, and shrubs, and reduce stand density in forests should benefit game species such as grouse, deer, and elk and many of the plant species used for traditional lifeway values.

Treatments that control populations of non-native species on public lands would be expected to aid in the reestablishment of native plant species. The use of fire, herbicides, or other treatment methods to simply kill vegetation is often inadequate, especially for large infestations. Thus, the BLM would introduce and establish competitive plants to successfully manage weed infestations and restore desirable plant communities (Jacobs et al. 1999). Treatments to control non-native species would benefit game species and plants used for traditional lifeway values, including species associated with shrubland habitats (e.g., greater sage-grouse, sharp-tailed grouse, quail), where most treatments would occur.

Use of herbicides would enhance the control of weeds and poisonous plants that adversely affect humans, especially weeds most effectively controlled by the four newly proposed herbicides. Herbicide treatments are especially effective in areas where there is insufficient fuel to carry a fire, or where the adverse effects of fire (e.g., erosion, loss of life and property) could be substantial, and where mechanical and other treatments would not be effective due to cost or location. Weeds and other invasive vegetation can displace native species that may be desirable to Native peoples, and may provide poorer quality forage and cover for wildlife used by Native peoples. Consultation between the BLM and affected tribes prior to treatment implementation should ensure that resources important to tribes are protected.

Three of the four new herbicides proposed in the PEIS (diflufenzopyr+dicamba [Overdrive®], diquat, fluridone, and imazapic) pose little risk to Native Americans and other human receptors. Of the 20 previously-approved herbicides, only four (clopyralid, imazapyr, metsulfuron methyl, and sulfometuron methyl) have negligible to low risks to humans. If available for use, the risk to humans per each herbicide application would be lower than under current treatment programs.

Visual Resources

Visual resources consist of land, water, vegetation, wildlife, and other natural or man-made features visible on public lands. Vast areas of grassland, shrubland, and mountain ranges on public lands provide scenic views. In addition, highways, rivers, and trails pass through a variety of characteristic landscapes where natural attractions can be seen and where cultural modifications exist.

For the purpose of planning management activities, public lands are assigned VRM classes according to scenic quality, sensitivity level, and distance zone criteria. Scenic quality, a measure of the visual appeal of the land, is rated based on landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. Sensitivity levels, which are measures of public concern for scenic quality, consider the types of users of the area, the amount of use, public interest in the area, adjacent land uses, and whether the area is classified as a special area. Distance zone criteria are based on relative visibility of the area from treatment routes or observation points. The VRM classes assist in minimizing and/or mitigating adverse effects of land management activities on scenic values (USDI BLM 1986a).

The proposed vegetation treatments would affect visual resources by changing the scenic quality of the landscape. Vegetation treatments would kill or harm vegetation in the applied area, resulting in a more open, "browned" or "blackened" landscape until new plants were to grow in the area. Treatment areas would vary in terms of their visual appeal prior to treatment and their distance from human activity, as well as the resulting public sensitivity to the pre- and post-treatment visual character of the area. Effects on visual resources would be of substantial concern if they 1) reduced the visual rating of the treatment site over the long term, or 2) resulted in short- or long-term degradation of high-sensitivity visual resources. The effects of vegetation treatments on the visual quality of the landscape would be most notable to public land visitors, sightseers, and residents for the first year to several years following treatment, particularly in affected areas found near major roads, residential areas, or recreation areas.

Scoping Comments and Other Issues Evaluated in Assessment

Scoping comments stressed that treatments should improve management of public lands for multiple use and maximum public benefit. The visual quality of the landscape is seen as one component of public benefit, particularly if lands are located in highly visible areas along roads.

Resource Program Goals

The BLM identifies and evaluates visual resource values through the VRM Inventory system (Handbook H-8410-1; BLM 1986a). The VRM system is a basic tool used by the BLM to inventory and manage visual resources on public land based on VRM classes describing scenic quality, sensitivity level, and distance zone criteria. Visual resource management objectives are established in resource management plans in conformance with land-use allocations (USDI BLM 1984c). These area-specific objectives provide the standards for planning, designing, and evaluating future management projects.

A Contrast Rating System (BLM Manual Handbook H-8431-1; *Visual Resource Contrast Rating*; USDI BLM 1986b) provides a systematic means to evaluate the approved VRM objectives, as well as to identify mitigation measures to minimize adverse visual effects. The Contrast Rating System is designed to compare the respective features of an existing landscape and a proposed project and to identify those parts that are not in harmony. These features include the basic design elements of form, line, color, and texture that characterize the landscape and the surrounding environment. Modifications to a landscape that repeat the natural landscape's basic elements are said to be in harmony with their surroundings, while those that differ markedly may be visually displeasing. The information generated is used as a guide for field managers to decide on the amount of visual change that is acceptable and to minimize potential visual effects. An evaluation should be made of what aspects of the current landscape are "natural," given the significant changes in vegetation caused by fire occurrences that are outside of normal fire regimes. Reference should be made to the fire regime condition classes when evaluating landscape qualities, as the classes help to assess the departure of landscapes from historical fire regimes.

The most dramatic effects would be seen in states and ecoregions with large total acreage treated, such as Nevada, Idaho, and Oregon, and in areas where fire or herbicides were used. Projects with the largest treatment acreage (those over 1,000 acres in size; 20% of all herbicide treatments) would be located in Idaho (22% of large-scale treatments), Wyoming/Nebraska (18%) and Oregon/Washington (16%). Although these states account for 56% of all large-scale treatments, only about 18% of public visitor days on public lands are associated with these states, suggesting that public exposure to treated areas would be less than expected based on size of treatment area and number of acres treated (USDI BLM 2006d). Fire use and herbicide treatments would comprise nearly 65% of these large-scale treatments. Treatments in drier states, such as New Mexico, Nevada, and Wyoming, could have fewer visual effects than comparable treatments in other states because visual color contrast between natural and browned or blackened treated areas would be less dramatic (versus wetter states with higher percentages of green vegetation, especially coniferous forests).

Standard Operating Procedures

There are several SOPs that would help reduce the effects of treatments on visual resources. The BLM would minimize the use of fire and broadcast foliar applications in sensitive watersheds to avoid creating large areas of blackened or browned vegetation. Similarly, the BLM would consider the surrounding land use before assigning fire or aerial spraying as a treatment method, and would avoid fire use and aerial spraying near agricultural or densely populated areas, where feasible. This would serve to reduce the visual effects of large treatments and resulting landscape changes, since treatments would be unlikely to be near areas of high visibility. Furthermore, at areas such as visual overlooks, the BLM would leave sufficient vegetation in place, where possible, to screen views of vegetation treatments. In addition, SOPs for minimizing off-site drift and mobility of herbicides (e.g., do not treat when winds exceed 10 mph; avoid treating areas where herbicide runoff is likely; establish appropriate buffer widths between treatment areas and residences) would also serve to contain the visual changes to the intended treatment area.

During mechanical and manual treatments, the BLM would minimize dust drift, especially near recreational or other public-use areas, and would minimize loss of desirable vegetation near high public use areas. Earthwork would be minimized and located away from prominent topographic features, and sites would be revegetated after mechanical treatments.

In Class I or II visual resource areas, the BLM would ensure that changes to the characteristic landscape were minor and would not attract attention (Class I), or if seen, would not attract the attention of the casual viewer

(Class II). Visual effects could be lessened by: 1) designing projects to blend in with topographic forms; 2) leaving some low-growing trees or planting some low-growing tree seedlings adjacent to the treatment area to screen short-term effects; 3) revegetating the site following treatment; 4) designing structures that fit in with the landscape; 5) minimizing ROW crossings; and 6) selecting colors that blend in with the land, and not the sky. When restoring treated areas, the BLM would design activities to repeat the form, line, color, and texture of the natural landscape character to meet established VRM objectives. A more detailed list of SOPs is found in BLM Manual Handbook H-8431-1 (*Visual Resource Contrast Rating*). All treatments should be evaluated with recognition that the most negative visual aspects would be short term. In the long term, treatments should increase plant species diversity and enhance visual characteristics of the landscape. The potential for extremely negative visual effects by wildfire should be weighed against short-term negative effects from vegetation treatments.

Adverse Effects of Treatments

The removal of vegetation would affect the visual qualities of treatment sites by creating openings and other vegetation-free areas that provide a noticeable visual contrast to the surrounding areas. The degree of these effects would depend on the amount of area treated, the appearance of the background vegetation and the vegetation being removed, the type of treatment method used, and the season of treatment. In general, treatments would have short-term negative effects and long-term positive effects on visual resources.

The greater the area of vegetation removal, the greater the resultant visual effect. Large treatments alter a larger portion of the landscape than small treatments, and the effects are more likely to be observed by people. However, the areas receiving large-scale treatments are most likely to be degraded lands of low to moderate scenic quality, minimizing the extent of these effects. Color contrasts caused by vegetation removal would be most apparent in areas dominated by green vegetation and large plants, such as coniferous forests. The contrast between a cleared area and the surrounding vegetation would be much less for much of the arid west, where low-growing shrubs, and browns, grays, and earth tones dominate the landscape. Exposed soil would not be as apparent. In addition, the brown colors associated with vegetation treatments would be the least noticeable during the late fall and the winter, when they would blend more naturally with surrounding colors than in the spring and summer, when the green colors of new growth are more likely to be present.

Effects of Fire Treatments

During fire treatments, there would be some effects to visual resources, with localized deterioration of air quality and reduced visibility caused by smoke. These effects would only persist as long as the fire itself. Prior to the 1930s, smoke was a common feature of the western landscape in summer (Barrett and Arno 1982). Since then, land managers have focused on controlling wildfires, and smoke has become increasingly viewed by the public and policymakers as undesirable and often avoidable (Schaaf 1994). In addition to affecting the visual characteristics of an area, smoke can also affect the health of humans, plants, and animals that come into contact with smoke.

Following a fire, the blackened appearance of the treated areas would create a color contrast, affecting visual resources. Darkened stumps and snags would be visible for many years following treatments. Although vegetation would begin to reappear in the growing season after the fire, softening the visual contrasts, there would be lasting evidence of the burn.

The total volume of smoke produced from a fire primarily depends on the amount of fuel consumed and the temperature of the burn. Factors influencing smoke production include fuel type, behavior, and moisture; fuel weight per unit area; and particle size and arrangement (see Air Quality section and Tables 4-1 and 4-2). Particulate matter is the most important air pollutant emitted from fire because of its far-reaching effects.

The quantity of emissions from wildfires, and thus the air quality effects from smoke, varies from fire to fire, depending on several factors. A fire’s size, duration, intensity, fuel type, surface fuel loading by size class, and fuel moisture content all affect its total fuel consumption and emission characteristics. The fire’s intensity and distance from receptors, as well as current meteorological conditions such as wind speed and atmospheric stability, affect the concentrations that arrive at downwind receptors. Regionally, visibility effects are roughly proportional to the total annual emissions from wildfires. The greater the emissions, the greater the expected effects on visibility.

Prescribed fire emissions can be reduced by 1) having clear smoke management objectives, 2) burning when conditions favor rapid combustion and dispersion, 3) burning under favorable moisture conditions, 4) using backfires when applicable, 5) burning smaller vegetation blocks when appropriate, and 6) coordinating with regional and local air pollution and fire control officials to ensure that the burn plan complies with federal, state, and local regulations.

Effects of Mechanical Treatments

Use of mechanical treatments to clear vegetation would be likely to remove large quantities of vegetation from a treatment site, in many cases exposing soil and leaving dead plant material on the ground to turn brown. Mechanical methods such as tilling, mowing, and chaining have the potential to scarify the landscape and leave bare soil and dead vegetation that contrast with the surrounding colors (BPA 2000). Mowing can also create an uneven, ragged appearance along roadsides and ROWs, but in other areas can result in a well-manicured, pleasing look.

Mechanical treatments on flat terrain, such as sagebrush communities, would have less effect on visual resources than treatments on steeper terrain, such as pinyon-juniper woodlands, which would be more visible on the landscape. The effects of mechanical treatments on visual resources would be temporary, and would only last until the reestablishment of vegetation on the treatment site, typically one or two growing seasons.

Effects of Manual Treatments

There would be some visual changes to the landscape as a result of manual treatments, but since this treatment method would be limited to small areas, these changes would be much less noticeable than the alterations caused by other treatment methods. In some cases, manual treatments would result in the extraction of weeds from a sensitive site, immediately resulting in an improvement in the quality of visual resources on the site. In other cases, such as the removal of vegetation with chainsaws, the effects would be negative, though minor, and would last until the treated areas were concealed through revegetation.

Effects of Biological Treatments

Containment by Domestic Animals

The use of domestic animals to contain undesirable vegetation would cause minimal effects to visual resources. The sight of domestic animals should not cause any adverse effects, as the presence of these animals is typically common and expected on public lands. Trampling and consumption of vegetation by livestock, as well as the presence of feces on the ground, would minimally reduce the quality of visual resources. However, these effects of grazing would not create sharp visual contrasts, and would be short term in nature, becoming largely unnoticeable after revegetation of the site.

Other Biological Control Agents

The use of insects and pathogens to control weeds would cause some visual alterations to the landscape. Plants attacked by these agents often show visual symptoms of disease or parasitism are regarded as visually unappealing. However, these changes would only be noticeable upon close examination of the site. The overall appearance of the treatment area would likely remain relatively unchanged. Because these agents kill target species gradually, the effects would be less visibly distinct than treatments that kill a large area of vegetation all at once.

Effects of Chemical Treatments

In general, herbicide treatments would have short-term negative effects and long-term positive effects on visual resources. The greater the area of vegetation treatment, the greater the visual effect is likely to be. Large treatments alter a larger portion of the landscape than small treatments, and the effects are more likely to be observed by people. However, areas receiving large-scale treatments are most likely to be degraded lands of low to moderate scenic quality, resulting in a smaller visual effect from treatment and likely an improvement in the scenic quality of the land over the long term. Color contrasts caused by vegetation removal would be most apparent in areas dominated by green and/or flowery vegetation and by large plants, such as coniferous forests. The visual effects would be heightened if the herbicides also prevented the manifestation of seasonal changes in vegetation, such as spring flowers and/or fall color. The contrast between a cleared area and the surrounding vegetation would be less for much of the arid west, where low-growing shrubs, and browns, grays, and earth tones dominate the landscape, than for areas with greater amounts of rainfall (e.g., Marine Ecoregion). Therefore, browned vegetation would not be as apparent. In addition, the brown colors associated with vegetation treatments would be the least noticeable during the late fall and the winter, when they would blend more naturally with surrounding colors than in the spring and summer, when the green colors of new growth are more likely to be present.

For all treatment methods, effects to visual resources would begin to disappear within one to two growing seasons after treatment in most landscapes. The regrowth of vegetation on the site would eliminate much of the stark appearance of a cleared area. Effects would last for the longest amount of time in forests and other areas where large trees and shrubs were removed.

Beneficial Effects of Treatments

The BLM proposes to treat 6 million acres annually. Thus, adverse and beneficial effects to visual resources should be about 3 times greater than current treatment effects. For all treatment methods, effects to visual resources would begin to disappear within one to two growing seasons after treatment. The regrowth of vegetation on the site would eliminate much of the stark appearance of a cleared area, and the area would develop a more natural appearance. Effects would last for the longest amount of time in forests and other areas where large trees and shrubs were removed.

Over the long term, vegetation treatments would likely improve visual resources on public lands. Treatments that aim to rehabilitate degraded ecosystems, if successful, would result in plant communities that are dominated by native species. Native-dominated communities tend to be more visually appealing than areas that have been overtaken by weeds (e.g., areas supporting a downy brome monoculture), or that have been invaded by woody species (e.g., grasslands experiencing encroachment by conifer seedlings). These improvements would be most evident in the Temperate Desert Ecoregion, where over half of all large-scale treatments would occur.

Fire use and other treatment methods that restore native fire regimes, vegetation, and ecosystem processes would reduce the spread of noxious weeds and other invasive vegetation that is less visually appealing than native vegetation. Catastrophic wildfires, which can affect thousands of acres, often occur in the WUI, or in close proximity to campgrounds and other recreational use areas, where their effects are visible to the public. In high visitor use areas or the WUI, non-fire treatments can be used to avoid the visual effects associated with smoke and to integrate treated and untreated areas into a more visually appealing mosaic of vegetation types.

The use of fire would allow the BLM to limit the size and duration of fires in areas of high public use to minimize visual contrasts between burned and unburned vegetation and effects of smoke. As discussed under Air Quality, an analysis of a vegetation management program in the Interior Columbia Basin showed that wildfire effects on air quality and visibility could be significantly greater in magnitude than effects from prescribed burning. Thus, vegetation treatment actions that improve ecosystem health and reduce hazardous fuels buildup, thereby reducing the risk of wildfire, should provide short- and long-term benefits to local and regional air quality.

The controlled use of domestic animals to contain undesirable vegetation may create a short-term visual impact associated with trampling and consumption of vegetation. These impacts would be dealt with on a case by case basis and mitigated as appropriate at the project level. The visual effects of containment by domestic animals would be short term in nature and would create a positive visual effect with the regrowth of desirable vegetation in a healthy, productive condition.

In general, herbicide treatments would have short-term negative effects and long-term positive effects on visual resources. The greater the area of vegetation treatment, the greater the visual effect is likely to be. Large treatments alter a larger portion of the landscape, and the effects are more likely to be observed by people. However, areas receiving large-scale treatments are most likely to be degraded lands of low to moderate scenic quality, where visual effects would be minimal and treatments would likely improve the scenic quality of the land over the long term. Color contrasts caused by vegetation removal would be most apparent in areas dominated by green and/or flowery vegetation and by large plants, such as coniferous forests. The visual effects would be heightened if the herbicides prevented the manifestation of seasonal changes in vegetation, such as spring flowers and/or fall color.

Wilderness and Special Areas

The invasion of noxious weeds and nonnative plant species into wilderness ecosystems and their effects on wilderness naturalness is of great concern to resource managers and the public. The presence of nonnative and nonindigenous species is significantly increasing in wilderness. Some species have been introduced to wilderness areas through pack stock feces, or by wild horses and burros that may migrate in and out of wilderness areas (Hendee and Dawson 2002). Hikers and wildlife may also bring in weed seeds on their clothing, fur, or droppings. In addition, efforts to control and remove invasive species can sometimes cause additional changes beyond restoring the preexisting "natural" conditions.

Because of their special status, wilderness and special areas have strict guidelines for vegetation treatments. These guidelines prohibit activities that degrade the quality, character, and integrity of these protected lands. Vegetation treatments used in wilderness areas follow the guidance contained in the BLM's *Interim Management Policy* (USDI BLM 1995) and the *Management of Designated Wilderness Areas* (USDI BLM 1988d). The guidance states:

- Prescribed burning would be used where necessary to maintain fire-dependent natural ecosystems.
- Noxious weeds may be controlled by grubbing or with chemicals when they threaten lands outside wilderness or are spreading within the wilderness, provided the control can be effected without serious impacts on wilderness values.
- Reseeding would be done by hand or aerial methods to restore natural vegetation.

There are no set restrictions on vegetation treatments in other types of special areas. However, the unique characteristics of these areas would be considered when preparing plans for treatment activities.

Scoping Comments and Other Issues Evaluated in Assessment

Respondents suggested that weeds should be stopped from spreading into wilderness areas by treating them outside of these areas, while others requested that treatments within wilderness areas be undertaken only after the spread of weeds outside of these areas has been effectively halted. Other respondents proposed that unique natural areas, including riparian zones, roadless areas, old growth areas, and areas of highest biological integrity, should be protected and that roadless areas should not be treated.

Resource Program Goals

The Wilderness Act of 1964 gave the Forest Service, National Park Service, and USFWS the authority to study, protect, and manage "legal" wilderness on lands under their jurisdiction; the Act failed to give the BLM comparable authority, even though the agency managed far more land than the other federal agencies (Hendee and Dawson 2002). In 1976, the FLPMA called on the BLM to study and manage legally designated wilderness, and to make recommendations to the president. The ANILCA of 1980 withdrew BLM roadless lands in Alaska from wilderness review, but stated that the Secretary of the Interior, at personal discretion, could periodically study and make wilderness recommendations to Congress. In 1981, the Secretary of the Interior issued a memorandum directing that no further wilderness inventory and review be done in Alaska; this memorandum remains in effect, except for a wilderness review of the Central Arctic Management Area specifically mandated by ANILCA legislation.

The primary activities of the Wilderness Management program are to inventory public lands for wilderness character, prepare activity plans, and monitor and manage wilderness and wilderness study areas. The BLM manages wilderness to provide the American people of present and future generations with the benefits of an enduring resource of wilderness (USDI BLM 2006c). Approximately 86% of wilderness acres administered by the BLM are achieving wilderness character as specified by statute, while about 73% of wilderness study areas are meeting their heritage resource objectives. Management of designated wilderness has included recent efforts to reclaim areas damaged by vehicles in California, and controlling saltcedar in the South Jackson Mountain Wilderness Area in Nevada.

Standard Operating Procedures

Actions that reduce the spread of noxious weeds, prevent the establishment of new invaders, and promote public awareness would be encouraged by the BLM in wilderness and other special areas and would provide long-term benefits to wilderness and other special areas and to the users of these areas. In particular, the BLM would encourage backcountry pack and saddle stock users to feed their livestock only weed-free feed for several days before entering a wilderness area. In addition, stock users would be encouraged to tie and/or hold stock in such a way as to minimize soil disturbance and loss of native vegetation. Disturbed sites would be reseeded with native vegetation, where feasible, to enhance the long-term development of native vegetation. Educational materials would be provided at trailheads and other wilderness entry points to make the public aware of the need to prevent the spread of weeds.

The BLM would use the "minimum tool" to treat noxious and invasive vegetation, relying primarily on use of ground-based tools, including backpack pumps, hand sprayers, and pumps mounted on pack and saddle stock. If mechanized equipment were used, the BLM would: 1) use the minimum amount of equipment needed; 2) time the work for weekdays or off-season; 3) require shut down of work before evening if work was located near campsites; and 4) if aircraft were used, plan flight paths to minimize disturbance to visitors and wildlife. In general, motorized equipment would only be used for emergency situations involving the health and safety of visitors, for administrative purposes, and in emergency situations involving criminal law. The BLM would give preference to those herbicides that have the least effect on non-target species and on the wilderness environment, and would implement herbicide treatments during periods of low human use, where feasible (USDI BLM 1988d). Other SOPs that would be followed by the BLM include addressing wilderness and special areas in management plans, maintaining adequate buffers for Wild and Scenic Rivers (¼ mile on either side of river; ½ mile in Alaska), and revegetating disturbed sites with native species if there is no reasonable expectation of natural regeneration.

Adverse Effects of Treatments

The overall effect of treatments on wilderness areas and wilderness study areas would depend on whether the end condition of the treatment site (considering both long-term benefits and short-term effects) was an improvement in wilderness characteristics. In many cases (e.g., an eradication of a small population of an incipient pest, a prescribed fire that mimicked historical fire), communities in the treatment area would quickly recover, and the overall effect would be positive. In other cases (e.g., treatments that require the creation of access roads to treatment sites, treatments that require repeated access to a site in order to meet a desired objective), the effects of the treatment to the wilderness character of the site would outweigh the potential long-term benefits.

The short-term effects of vegetation treatments in other special areas would typically be less than those in wilderness areas, as human activities and influences are not necessarily incompatible with their unique qualities. However, all treatments would have the potential to alter these unique qualities, as well as to provide long-term benefits by controlling weeds and reducing fire risks.

Effects of Fire Treatments

Periodic fires are a natural part of most wilderness ecosystems, and the goal of wilderness fire management is to restore fire as nearly as possible to its natural role (Hendee and Dawson 2002). Fire influences the species composition of plant communities, interrupts and alters plant succession, influences the scale of the vegetation mosaic, regulates fuel accumulations, and influences ecosystem productivity, all important factors determining the characteristics of wilderness.

The objectives of fire management in wilderness are to: 1) permit lightning-caused fires to play, as nearly as possible, their natural ecological role within wilderness, and 2) reduce, to an acceptable level, the risks and consequences of wildfire within wilderness or escaping from wilderness (USDI BLM 1988d). Fire caused by lightning will be permitted to burn or will be suppressed as prescribed in an approved burn plan. Prescribed fires ignited by people may be permitted to reduce unnatural buildup of fuels only if necessary to meet the above objectives. Although additional benefits may result from man-ignited prescribed fire, vegetative manipulation cannot be used to justify such fires.

Prescribed fire would be used in wilderness areas only as a means to meet the objectives of reducing the risks of wildfires and maintaining fire-dependent natural ecosystems within these areas (USDI BLM 1988d). The ability of a fire treatment to follow these guidelines would depend on a number of factors, including the amount of fuels accumulation and other conditions at the treatment site. Fires that were more intense than historical fires, or that were set more frequently than under historical regimes, would have the potential to alter the ecological characteristics of a wilderness area and endanger human life and property (Hendee and Dawson 2002). In areas where fire exclusion has changed an ecosystem's attributes (ponderosa pine forests, for instance), a well-planned controlled burn would likely benefit wilderness areas.

The effects of fire on other special areas would depend on a number of factors, such as the vegetation type of the site, the condition of the site, and the particular unique quality of the site that requires special management. In general, sites with special qualities that could be destroyed by fire would be the most likely to experience significant adverse effects from fire treatments. Sites at which natural fire cycles have been altered, and that do not contain attributes that would be susceptible to loss by burning, would be likely to benefit from these treatments.

Effects of Mechanical Treatments

Motorized equipment is allowed by the Wilderness Act to meet the minimum administration requirements of a wilderness area, as specified in Section 4(c) of the Act. However, very few activities and situations within wilderness justify or require the use of motorized equipment and/or mechanical transportation. The BLM State Director must approve or disapprove the use of motorized equipment and mechanical transport in writing by letter and a Decision Notice on a one time, case-by-case basis (USDI BLM 1988d). If mechanized equipment was allowed, effort would be made to: 1) use the minimum amount of equipment needed; 2) time the work for weekdays or off-season; 3) require shut down of work before evening if work was located near campsites; and 4) if aircraft were used, plan flight paths to minimize disturbance to visitors and wildlife.

For the most part, use of mechanical treatment methods would adversely affect wilderness areas and wilderness study areas because vehicles and heavy equipment are incompatible with the “unspoiled” nature of wilderness. For this reason, mechanical treatments would only be allowed on a very limited number of sites where no other method is feasible (e.g., tamarisk removal) and in the few areas where mechanical treatments have occurred in the past, and repeat treatments are required. Aerial reseeding would also be allowed to restore natural vegetation. In all of these cases, mechanical treatments would require special approval, and would be carefully planned to improve or maintain the quality of wilderness areas and wilderness study areas.

The effects of mechanical treatments on other special areas would be similar to the effects of fire, as discussed under Effects of Fire above, in that they would be highly dependent on the resources present at the site. In particular, the unique resources requiring special protection would be important factors to consider. Thinning treatments in areas that are managed primarily for recreational purposes, such as National Historic Trails, would not be likely to result in a loss of quality as long as their recreational assets were left intact. However, thinning treatments in forests with old-growth characteristics could have significant adverse effects.

Effects of Manual Treatments

Manual treatments would be the least obtrusive method for use in wilderness areas and the most appropriate. Because this method of vegetation removal is very selective, damage to non-target vegetation would be minimized.

Effects of Biological Treatments

In areas that did not historically support livestock grazing, and where grazing use does not currently occur, the use of domesticated grazing animals to control vegetation in wilderness areas and wilderness study areas would involve the introduction of a non-native domestic animal into these largely unaltered landscapes, thereby potentially introducing new effects. Domesticated grazing animals could alter plant communities, spread noxious weeds on their fur or through their feces, and potentially influence native wildlife movements and use patterns within wilderness areas.

Effects associated with the use of domestic grazing animals have the potential to affect wilderness areas and other types of special areas. However, in many cases, grazing would be compatible with the designated uses of these areas, and the use of grazing animals to control weeds would be less intrusive than other treatments, particularly mechanical methods.

The use of other biological control agents (e.g., insects, pathogens) to control vegetation in wilderness areas and wilderness study areas would involve the introduction of non-native organisms into these largely unaltered landscapes, thereby potentially introducing new effects. However, these other biological control agents would not be likely to adversely affect wilderness areas, wilderness study areas, or any other scenic resources or special areas managed by the BLM, provided that they were host-specific and only affected non-native plant species. Although the risks of its occurrence are slim, an inadvertent release of a biological control agent that affects native species could significantly degrade the ecological integrity of wilderness areas and make wilderness study areas unsuitable for wilderness designations.

Effects of Chemical Treatments

Use of herbicides to treat undesirable vegetation could potentially affect the “naturalness” of wilderness areas and wilderness study areas by killing non-target native vegetation through imprecise application and/or drift. The degree of effect would depend on the application method, with spot applications less likely to cause adverse effects than aerial applications. For the most part, vehicle-mounted sprayers would not be used to treat vegetation, given the existing restrictions on wilderness areas. However, vehicles could be used in extreme scenarios, if approved.

The potential effects of chemical treatments on other special areas would depend on numerous site-specific factors. Some special areas would support resources that are more sensitive to exposure to herbicides than the resources in other areas. There would also be human health risks involved with using certain types of herbicide application (e.g., aerial application) in special areas that are managed to support recreational activities. A more detailed discussion of these risks can be found in the Wilderness and Special Areas and Human Health and Safety sections of Chapter 4 of the PEIS.

Beneficial Effects of Treatments

In general, vegetation treatments in wilderness and special status areas would have short-term negative effects and long-term positive effects on these specially designated areas. In wilderness areas and wilderness study areas, treatments would only be allowed in order to improve the natural condition of these areas. Therefore, if treatments were successful, long-term effects would be beneficial by reducing noxious weed infestations and reducing the risk of future catastrophic wildfires.

The reduction of hazardous fuels and noxious weeds on lands adjacent to or near wilderness and special areas would provide long-term benefits by reducing the likelihood that noxious weeds would spread onto these unique areas, or that a catastrophic wildfire would burn through them, thus degrading their unique qualities. Because there would be fewer restrictions on the intensity of treatments on lands adjacent to wilderness and special areas than on lands in these areas, preventative treatments in areas adjacent lands would eliminate or reduce the need for intrusive treatments in wilderness and special areas in the future. The need for emergency fire suppression activities, which can be very damaging, would also be reduced.

Prescribed fire would be used in wilderness areas only as a means to meet the objectives of reducing the risks of wildfires and maintaining fire-dependent natural ecosystems within these areas (USDI BLM 1988d). Few activities and situations within wilderness and other special areas would justify or require the use of motorized equipment and/or mechanical transportation. Manual treatments would maintain or improve the wilderness qualities of an area without causing effects that are incompatible with established wilderness principles. Other special areas would also benefit from manual treatments, with low risks that their definitive qualities would be degraded. Insects and pathogens used a biological control agents would have minimal effect on wilderness values. The long-term effects of herbicide treatments on wilderness and other special areas would depend on the success of the treatment in controlling noxious weeds. In most cases, the benefits of eradicating noxious weeds from wilderness and other special areas would far outweigh the potential short-term negative effects of using chemical treatments.

Recreation

Approximately 40% of public lands are within a day's drive of 16 major urban areas in the west (USDI BLM 2006c). Outdoor recreation, nature, adventure, and heritage tourism are the fastest growing segments of the travel and tourism industry. In 2003, recreational use of public lands predominantly consisted of camping and picnicking, which represented 43% of all visitor days (USDI BLM 2006d). Other important recreational activities included non-motorized travel, such as hiking, horseback riding, and mountain biking; OHV travel; viewing public land resources, interpretation, and education; and hunting. Snow- and ice-based activities, such as cross-country skiing, snowmobiling, and snowshoeing represented less than 1% of visitor days. The BLM administers many acres of public lands and facilities, in part for these recreational pursuits. Many of these lands are managed for multiple uses, such that activities designed for one program or purpose (e.g., vegetation control/enhancement) must be compatible with other programs and purposes.

Intensively managed, developed recreation areas are near major urban centers in California, Arizona, and Utah. These areas include National Monuments and other National Conservation Areas (see Map 3-12). In recreation areas, the goals of vegetation treatments include maintaining the appearance of the area and protecting visitors from the adverse effects of contact with noxious weeds and other invasive or unwanted species. Treatments would likely be done using mechanical and manual methods, or with spot treatments using herbicides, and treatment effects on the public would be minimal. The likelihood of herbicide treatments would increase with increasing distance away from high-use visitor areas. Thus, hikers, hunters, campers, horsemen, livestock owners, and users of plant resources for cultural, social, and economic purposes would be at the greatest risk of coming into contact with herbicide treatment areas.

Scoping Comments and Other Issues Evaluated in Assessment

Several respondents remarked that treatments should not be used as an excuse to close OHV trails. Another commenter requested that areas not be treated solely to improve recreational use. If any travel or access routes would be closed, the effects on recreation and nearby areas that would handle the shift in use should be addressed. The effects of herbicides on recreational users should also be addressed.

Resource Program Goals

The long-term goal of the BLM's Recreation Management program is to provide opportunities to the public for environmentally responsible recreation. BLM-administered public lands host over 68 million visitors annually, and over 4,000 communities with a combined population of 23 million people are located within 25 miles of public lands. Although much of the focus of the program is on providing visitor services, the BLM's most daunting challenge is to manage travel on public lands. Technological advances in modes of transportation, coupled with the explosion of growth of this activity, have created a management challenge to meet these needs while protecting land resources (USDI BLM 2006c). As pointed out during scoping, the public recognizes the potential for travel access routes to spread weeds and for off-road travel activities to degrade land, leading to conditions that favor the establishment and spread of weeds and other unwanted vegetation.

Standard Operating Procedures

Recreation activities on public lands are guided by BLM Handbook H-1601-1 (*Land Use Planning Handbook*, *Appendix C*). There are several SOPs that could help reduce the negative effects of herbicide treatments on recreation:

- Schedule treatments to avoid peak recreational use times, where feasible. However, managers must also time treatments when they would be most effective, which may be during peak public visitation periods.
- Notify the public of treatment methods, hazards, times, and nearby alternative recreation areas.
- Adhere to entry restrictions identified on the herbicide label for public and worker access.
- After herbicide treatments, post signs noting exclusion areas and their duration.

In addition, SOPs identified in Table 2-5 and in the Human Health and Safety, Fish and Aquatic Resources, and Wildlife Resources sections should be implemented to further reduce risks to recreationists and the resources they use.

Adverse Effects of Treatments

Effects on recreation activities would likely be greatest in states with the most acres treated (Nevada, Idaho, Oregon, and Wyoming), or in which large-scale treatments are proposed to occur (Idaho, Oregon, Wyoming, and Montana; Table 4-14). However, based on visitor use days, the number of visitors to public lands in these states as a percentage of all visitors to public lands is small in relation to the number of acres treated in those states (USDI BLM 2006d), suggesting that effects to recreationists could be less than expected based on treatment acreage. Treatments that occur in states with a large number of visitors (Arizona, California, and Utah) could have a greater effect on recreationists. Over 85% of large-scale treatments would involve mechanical or chemical treatment methods, or use of fire, each in nearly equal proportion. These are also the methods most likely to have an adverse effect on the landscape and recreationists.

There would be some short-term scenic degradation, as well as distractions to users (e.g., noise from machinery), from treatments. In addition, there would be some human health risks to recreationists associated with exposure to herbicides or smoke from fire. These risks are discussed in more detail in the Human Health and Safety section. Finally, some areas would be off-limits to recreation activities as a result of treatments, for periods ranging from a few hours to days, or even one full growing season or longer, depending on the treatment. In most cases, recreationists would be able to find alternative sites offering the same amenities, although a lessened experience could result from more concentrated use in these alternative sites.

Dispersed recreation in non-developed areas would potentially be affected to a greater degree than recreation in developed sites because most of the 6 million acres of vegetation treatments would occur in these undeveloped, dispersed areas. Recreational activities in these areas are spread out across the landscape, and different types of recreational activities would be affected differently. For example, hikers or backpackers would likely avoid using an area treated with herbicides, but would probably continue to use a trail passing through a mowed or mulched area. Effects to recreation in areas with an abundance of recreational opportunities (e.g., Alaska) would not be as significant as effects in areas with less extensive recreational opportunities. Recreational use of motorized vehicles on public lands is typically limited to designated routes and trails. Trails located in treatment areas would be closed during treatments and for a period of time following treatments to allow vegetation to recover. Closures could last for several growing seasons following more intensive treatments where vegetation was completely removed, while less intensive treatments might not require site closures beyond what was recommended for safety.

The effects of herbicide treatments and fire use on fish and wildlife could have indirect negative effects on recreational activities such as fishing, hunting, and wildlife viewing. For example, aerial application of an herbicide over a large area could adversely affect these types of recreation activities by harming or displacing game and non-game fish and wildlife species.

Vegetation treatments could also affect scenic views, particularly large treatments next to roads, and smoke-producing fire treatments. The effects of vegetation management on the visual quality of the landscape are discussed further in the Visual Resources section.

Effects of Fire Treatments

Prescribed burns would require the closure of burn areas to visitors during burn activities. People recreating in nearby areas would be able to see and perhaps smell smoke. The potential for smoke inhalation could result in some health risks to these users (see Human Health and Safety), depending on their vicinity and position (i.e., upwind or downwind) in relation to the fire. Because smoke impairs visibility, views of the landscape could be blocked during burning. These effects would reduce the recreation experience, but would typically last only as long as the burn treatment itself. After a fire, the burned area would appear blackened, and some residual vegetation would be charred, making the area undesirable for most recreational uses for a period of 1 or more years. Four-wheel drive vehicles and OHVs could be excluded from areas treated with fire to minimize damage to these sites while they revegetated. Low impact uses such as camping and hiking would generally not be restricted, but it is likely that burned areas would be avoided by users engaging in these types of activities. Visitation to a prescribed burn area would decline drastically or cease altogether in the short term, but would likely increase in the long term as a result of habitat improvement. Some visitors would be attracted to recently-burned areas to view wildflower blooms that often follow wildland fire.

Effects of Mechanical Treatments

Mechanical equipment would primarily be limited to mowers, trenchers, and graders in developed recreational sites, and would have limited effect on recreation activities. In dispersed recreation areas, however, mechanical treatments such as chaining, tilling, and seeding could require the temporary closure of treatment sites to visitors. Low intensity treatments such as thinning would generally be less restrictive to recreational uses than treatments such as chaining or plowing. People recreating in nearby areas would be able to hear the motorized equipment and could be exposed to some exhaust smells, but these effects would last only as long as the treatment itself (BPA 2000). After the completion of treatments, vegetation would be absent from large portions of the landscape and bare soil would be exposed, making the site less desirable for recreation. The use of heavy machinery would disrupt the treatment area, breaking limbs and disturbing soil. It is also likely that some large debris would be left behind, creating obstacles for certain types of uses (BPA 2000). In addition, use of heavy machinery could create routes for unauthorized OHV use in some areas. This activity could interfere with other types of recreation and potentially add to scenic degradation by interfering with recovery of the site and contributing to the spread of weed seeds. Some treatments (e.g., mowing) would improve the visual appearance of a site, making it more pleasurable to visit and increasing its accessibility (e.g., clearing vegetation around a lake for fishing). The removal of woody vegetation could also improve access for some recreational activities, such as authorized use of off-road vehicles. The negative effects of mechanical treatments on recreation could last from a few days to several years or more, depending on how much vegetation was removed and the rate of site recovery (USDI BLM 1991a).

Effects of Manual Treatments

Manual treatments would have few effects on recreationists since they would not occur over extensive areas, cause significant habitat disruption, or require closures of large sites during treatment. The noise associated with power tools such as chainsaws could

TABLE 4-14
Percentage of Vegetation Treatments, Large-scale Vegetation Treatments, and Visitor Use Days for Each State/Region

State	All Treatments (%)[1]	Large-scale Treatments (%)[2]	Visitor Use Days (%)[3]
Alaska	2.4	0.4	1.7
Arizona	4.7	6.4	23.7
California	3.9	1.7	23.7
Colorado	4.1	4.7	5.9
Idaho	15.7	22.2	6.7
Montana, North Dakota, South Dakota	4.6	9.6	4.1
Nevada	30.5	8.2	8.1
New Mexico, Oklahoma, Texas	3.2	6.4	2.5
Oregon, Washington	14.5	15.9	9.0
Utah	5.9	4.3	12.2
Wyoming, Nebraska	10.6	17.8	2.5

[1] Acres treated in each state as a percentage of total acres treated on public lands.
[2] Percentage of large-scale treatments (treatments > 1,000 acres) on public lands in each state.
[3] Visitor use days as a percentage of total visitor use days on public lands.
Source: USDI BLM (2000d).

distract nearby users (BPA 2000). In some instances, the presence of workers could also cause a minor distraction. These effects would be limited in extent and last only as long as the treatments. There would be some visual changes to the landscape as a result of manual treatments, but they would only occur on small areas, and would be much less noticeable than the alterations caused by other treatment methods.

Effects of Biological Treatments

Containment by Domestic Animals

Domestic livestock would generally not be used in developed recreation sites, but are more likely to be used in dispersed recreation areas. There could be some adverse impacts to recreation as a result of biological control using domestic animals. Some recreational activities, particularly more intensive recreational events, may not be able to occur simultaneously with grazing treatments. If it was necessary to concentrate domestic livestock to provide intensive vegetation management, these areas may be off-limits to many recreational activities during grazing treatments, but restrictions would typically be short-term and would not be extensive. In many cases, recreationists would be able to bypass areas using concentrated livestock management and utilize alternative recreation sites. Other negative impacts during and following grazing treatment could include visual effects associated with the appearance of grazed and trampled vegetation and the presence of manure, but these effects would potentially be less noticeable than those associated with other methods that leave more dead, standing, piled, or burned vegetation on the treatment site.

Other Biological Control Agents

The use of biological control agents (e.g., insects and pathogens) would have few effects on recreation areas and visitors to public lands since they would specifically control undesirable species without disturbing desirable vegetation or the land. During the release of biological control agents, there would be some workers present that could cause a minor distraction to recreationists in the area. Death or injury to large numbers of plants could reduce the quality of the recreation experience. These effects would last until undesirable plant populations were reduced to the point where they no longer supported populations of these biological control agents.

Effects of Chemical Treatments

Chemical treatments would affect the availability of recreational opportunities because of site closures, changes to wildlife habitat, loss of edible plants and fruits on the treated site, and possible contamination of vegetation and water bodies off site (USDA Forest Service 1988). Site closures would generally last for a short time period following herbicide application, depending on the recommendations on the herbicide label. Usually the recommended exclosure periods would not exceed 24 hours; however, recreational access could be restricted for a season or more to allow vegetation to recover following treatment.

During site closures, signs stating the chemical used, the date of application, and a contact number for more information, and would be posted for a period of at least 2 weeks following treatment. Dead brown vegetation would temporarily reduce recreational potential until vegetation recovered. Herbicide treatments could also pose some health risks to recreational users, which would be greatest during aerial herbicide applications and when ingesting contaminated resources, such as berries or fish (see Human Health and Safety section of the PEIS). It is likely that herbicide use would negatively affect sightseeing recreational opportunities. Herbicide treatments would generally result in long-term benefits to recreationists by controlling noxious weeds and toxic plants.

Unintended effects of herbicides on non-target plants and animals could impact recreation activities (e.g., hiking, plant collecting, hunting, and fishing) in off-site areas. The longer an herbicide lingers in soil (depending on its ability to bind to soil [Koskinen et al. 2003]), the more likely it is to contaminate groundwater or run off into water bodies used by recreationists.

Beneficial Effects of Treatments

Treatments that restore native vegetation and natural fire regimes and ecosystem processes would be beneficial to recreationists. Treatments would improve the aesthetic and visual qualities of recreation areas for hikers, bikers, horseback riders, and other public land users; reduce the risk of recreationists coming into contact with noxious weeds and poisonous plants; increase the abundance and quality of plants harvested from public lands; and improve habitat for fish and wildlife sought after by fishermen and hunters.

Developed recreation sites with public facilities would be treated in order to maintain the appearance of the area and to protect visitors from the adverse effects of unwanted vegetation (e.g., thistles, ragweed, and poison ivy). Some mechanical activities, such as mowing in visitor use areas or along ROWs, would provide an immediate benefit in terms of improved appearance of vegetation.

Recreationists in these dispersed recreation areas would likely benefit from a reduction in invasive plants (especially thorny or poisonous noxious weeds) provided by vegetation treatments. Removal of weedy vegetation would return public lands to a more "natural" or desirable condition, which hikers and nature enthusiasts would likely value over that of degraded lands. In addition, the increased aesthetic value of treated sites would benefit most recreational users. In some instances, treated sites could become more desirable as destinations for outdoor activities, making them more popular to recreational users. Treatment of sites to restore native vegetation would enhance fish and wildlife habitat, to the benefit of hunters, birdwatchers, and other users of these resources.

Fuels reduction treatments would reduce the severity of future wildfires on public lands used for recreation. As a result, recreationists would be provided with safer conditions, and there would be less of a chance that a wildfire would destroy a large acreage of lands used for recreation. Severe wildfires are capable of causing damage to recreational resources over large areas that subsequently require long periods of time for recovery. In addition, treatments that reduce the risk of wildfire would reduce the likelihood of recreationists being displaced from their favorite hunting, fishing, and camping sites by wildfires. During the recent wildfires that swept through the Great Basin, not only were traditional recreation activities affected, but some special events were altered or cancelled. Signs were destroyed, hiking and camping areas burned over, wildlife and game displaced, and the scenery in the Great Basin marred (USDI BLM 1999).

Social and Economic Values

Vegetation treatments have the potential to affect people, communities, and economies in each of the 17 western states that could receive treatments. The susceptibility of these entities to social and economic effects stems from the importance of public lands to the lives of the people and communities in the West, especially in the states with the largest amounts of public land, either in total area or in percentage of the state. Public lands commonly provide a major portion of economic sustenance, especially in rural areas, by supporting ranching (grazing leases), mining, active and passive recreation opportunities, and a myriad of other activities that westerners rely on. The dollar value of the social sustenance may not be readily quantifiable, but it is important to the way of life of westerners. "Wide open spaces" are not just a cliché in western songs and novels, but a tangible part of the experience that attracts and/or retains people who live in western states. The large expanses of federal lands are a significant contributor to the open spaces that define the "sense of place" in many parts of the West. Through support of economies and the social context of the West, federal lands are highly important to the western states. Actions that affect federal lands, including vegetation treatments, have the potential to affect the economic and social environment of the region.

The extent of potential effects would vary from state to state because of the differing prevalence of federal lands and also because the treatment area in each state would vary, both in acreage and in percentage of land area treated, depending on local issues and needs. The most pervasive effects would likely occur in states with large amounts of public land. BLM field offices provided information on the general location of proposed treatment projects. Based on this information, over 70% of the acreage to be treated in the proposed program would occur in Idaho, Nevada, Oregon and Wyoming, all of which have large areas of public lands. The largest increase in treatment area from current levels would likely occur in Nevada, where more than 6 times the current treatment acreage is proposed for treatments using all five methods under consideration.

This PER is programmatic in nature and very broad in scale. A programmatic analysis at this scale does not permit the completion of a detailed, quantitative social and economic analysis. Therefore, only general effects and expected trends are addressed here. Concerned individuals should be assured that more detailed, site-specific analyses would be conducted during the development of specific treatment projects. Public participation in the development of the details of such proposals would be encouraged at appropriate times in those processes.

Scoping Comments and Other Issues Evaluated in Assessment

Among the major concerns identified during scoping were the ecological costs and benefits to local communities and residents from treatments. Some individuals proposed that the BLM's needs for people and fiscal resources should be addressed, as should costs to state and local governments and private individuals, including secondary costs from such things as loss of recreational opportunities. Environmental justice issues—disproportionate effects on minority, low-income, and child populations—and Indian Trust issues were raised. Several comments addressed potential economic effects on ranchers from grazing restrictions or changes to forage productivity, while others questioned whether grazing permittees would pay for a portion of the treatment costs. A few respondents questioned whether the BLM would perform the treatment work or contract it out, others proposed contracting to local vendors, and some were concerned about potential economic effects on local fire fighters. Beneficial and detrimental effects of the proposed treatment program that pertain to these issues are addressed in this PER, as limited by the scale of the potentially affected geographic area and the necessarily inexact nature of the program in advance of specific treatment project proposals.

There are numerous stakeholders throughout the U.S. with differing needs and perspectives; all of their interests must be taken into consideration when planning the overall treatment program and subsequent implementation plans. On a local level, stakeholders include people in communities located in the vicinity of public lands, such as adjacent landowners, local businesses, users of public lands (e.g., ranchers and recreationists), as well as the county and state governments that benefit from BLM revenues. On a national level, the stakeholders include all taxpayers, whose tax dollars support BLM programs and who have partial "ownership" of federal public lands. Given the wide range in stakeholders whose needs and interests must be considered, many different and often conflicting opinions must be considered. A balance of both national and local interests must be pursued.

Resource Program Goals

The BLM is required to manage public lands on the basis of multiple use and sustained yield and to meet the needs of present and future generations. As the human population continues to increase and social values evolve, resource conflicts are likely to increase. In addition, the American public is increasingly aware of the importance of public lands to its well-being, and is demanding a larger voice in resource management decisions. In this context, BLM program planning must take into account a constant balancing of competing needs, interests, and values.

By statute, regulation, and Executive Order, the BLM must address social and economic issues in the preparation of programs affecting planning decisions for public lands. Section 202(c)(2) of FLPMA requires the BLM to integrate physical, biological, economic, and other sciences in developing land-use plans (43 United States Code [USC] 1712(c)(2)). FLPMA regulations 43 CFR 1610.4-3 and 1610.4-6 also require the BLM to analyze social, economic, and institutional information. Section 102(2)(A) of NEPA requires federal agencies to "insure the integrated use of the natural and social sciences . . . in planning and decision making" (42 USC 4332(2)(A)). Federal agencies are also required to "identify and address . . . disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States" in accordance with Executive Order 12898 on Environmental Justice.

In the context of these issues and regulatory guidance, the overall goals of the vegetation treatment program are to sustain the condition of healthy lands and to restore degraded lands. From the perspective of social and economic issues, the objectives are to accomplish these goals while minimizing adverse effects and optimizing beneficial effects for affected communities. For example, reducing hazardous fuels in the WUI would, over the long term, reduce economic losses from wildland fire. Reducing the spread of invasive plant species would improve the productivity of grazing lands for both domestic livestock and wildlife, which would be economically beneficial to ranchers and advantageous for sightseeing, thus benefiting recreation-oriented businesses as well.

Standard Operating Procedures

Vegetation treatment projects would affect local social and economic resources; some effects would be beneficial while others could be adverse. Following certain SOPs would reduce adverse effects; Table 2-5 lists a number of SOPs designed to minimize unintended adverse effects of treatment projects. These SOPs include posting treatment areas; notifying adjacent landowners, grazing permittees, the public, and emergency personnel of treatments; controlling public access to treatment areas and observing restricted entry intervals given on herbicide labels; consulting with Native tribes that might be affected by the project; and, to the degree possible within the law, hiring local contractors and purchasing supplies locally.

Adverse Effects of Treatments

General Effects

It is expected that communities that are particularly dependent on a single industry would be more susceptible to the effects of vegetation treatment projects than other, more diverse, communities. In particular, ranching communities and recreation-dependent communities could be more affected than more diversified communities. However, it is not possible to identify effects on particular communities at this scale of analysis.

The vegetation treatment program would only apply to public lands; this PER does not attempt to predict possible decisions or actions by other agencies or private individuals. Also, it is not expected that any of the alternatives would significantly affect ongoing, long-term trends such as the increasing demand for outdoor recreation or the relatively high growth rates in urban, suburban, and rural populations, particularly in states from the Rocky Mountains to the Pacific.

It is assumed that vegetation treatment programs would meet, to varying degrees, the identified need for reducing the risk of wildland fire and improving ecosystem health. Vegetation treatments would reduce the amount and concentration of hazardous fuels, especially in the WUI, but also in the back country. As a result, the number, size, and severity of wildland fires would be reduced, as would the cost of wildland fire suppression and the risk of loss of life and property. Treatments that improve ecosystem health could increase or improve the amount and quality of commercial and casual uses of public lands, improve or maintain market and non-market values of public land resources, and reduce the cost of operations on public lands. However, it is not possible to quantify these benefits at this programmatic level of analysis since there is uncertainty as to when, where, and how specific treatments would occur.

Social effects of individual vegetation treatments are, for the most part, impossible to differentiate at the scale addressed by this PER. The potential for social effects would depend on people's perceptions about health and safety risks associated with different treatments. Data on such perceptions are not available, and could differ from one community to another, depending on the level of knowledge in the community about vegetation treatment methods and past experiences with these methods. The Human Health and Safety section in this chapter discusses health and safety issues related to the proposed treatments in more detail.

There is some potential for adverse effects on the social fabric of communities, depending on the success of vegetation treatment programs. Successful improvement in the productivity of rangeland, for example, would help sustain a ranching-dependent community, whereas lack of success could lead to additional economic pressure on the community, which would tend to encourage emigration. Successfully reducing hazardous fuels in the WUI could encourage people to remain in, or move to, a community, whereas major fire losses, particularly in smaller communities, could encourage some people to move away. These potential effects are somewhat speculative, but should be examined more closely at the project-specific level.

Economic effects of vegetation treatment on communities could be similar to social effects. Changes in range productivity, wildfire risk, and access to or attractiveness of recreation activities could potentially affect employment opportunities and income levels in a community, in either a positive or negative fashion. As with social effects, however, the broad scale of this PER and the lack of data preclude the ability to accurately predict whether and where such effects would occur, and to what degree they would be beneficial or adverse.

Population and Demography

None of the proposed treatment methods is likely to cause substantive changes to existing patterns and trends in population or demographic conditions in the western states. In particular, it is unlikely that vegetation treatments would either exacerbate or counteract the trend of out-migration from small rural communities.

Environmental Justice

Executive Order No. 12898, "*Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations*" (59 FR 7629), is "intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority communities and low-income communities access to public information on, and an opportunity for participation in, matters relating to human health and the environment." It requires each federal agency to achieve environmental justice as part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects, including social and economic effects, of its programs, policies, and activities on minority and low-income populations.

Environmental justice concerns are usually directly associated with effects on the natural and physical environment, but these effects are likely to be interrelated with social and economic effects as well. Native American and Alaska Native access to cultural and religious sites may fall under the umbrella of environmental justice concerns if the sites are on tribal lands or a treaty right has granted access to a specific location.

USEPA guidelines for evaluating potential adverse environmental effects of projects require specific identification of minority populations when either a minority population exceeds 50% of the population of the affected area, or a minority population represents a meaningfully greater increment of the affected population than of the population of some other appropriate geographic unit.

Public lands occur predominantly in rural areas. There are large minority populations in rural areas of the West and Alaska, particularly Hispanics and Native Americans. Approximately 63% of the nation's Hispanic population, 68% of the nation's American Indian population, and 50% of the nation's Asian/Pacific Islander population reside in the western U.S., which contains less than 32% of the nation's total population (Table 3-15). In addition, Hispanics represent a large percentage of the total population of some states, particularly New Mexico, California, Texas, and Arizona. Similarly, Alaska, New Mexico, and several other western states have disproportionately large percentages of Native Americans and Alaska Natives. Issues of concern might include the propensity of Native Americans and Alaska Natives to use native plants for cultural and traditional purposes, and the potential for vegetation treatments to damage some of these native plants if projects are not carefully planned and implemented. This combination of factors suggests the possibility that any significant effects associated with vegetation treatments could disproportionately affect these minority populations. Potential effects specific to the individual treatment methods are addressed in later sections.

It is not possible to determine whether minorities or low-income populations would actually be disproportionately affected at this broad scale of analysis, because it is not known if treatment areas would coincide with concentrations of minority or low-income populations, or with Native American and Alaska Native use areas. Specific evaluations of environmental justice effects would be conducted in concert with environmental analyses for site-specific treatment project proposals.

Issues specific to Native Americans (such as subsistence gathering of rangeland products) have been addressed in more detail in the Cultural and Paleontological

Resources section, but they, too, must be addressed in detail during project-specific analyses.

Protection of Children

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks,* instructs federal agencies to identify and assess environmental health risks and safety risks that may disproportionately affect children, and to ensure that their policies, programs, activities, and standards address disproportionate risks to children that result from environmental health or safety risks. Children could have a greater chance of being exposed to health and safety risks associated with vegetation treatments than adults because they typically spend more time outdoors, and because they tend to be more vulnerable to adverse effects from exposure to environmental contaminants. Although children may spend more time outdoors, they are not often on public land without adult supervision because of the remoteness of most of these areas. Thus, the increased opportunity for exposure would generally be negligible to minor. If there were potential risks for adverse effects to people who happen to be outside in the vicinity of vegetation treatments, a project could have a disproportionate effect on children.

Employment and Income

Most employment and income effects from vegetation treatment projects would be beneficial. However, there could be some temporary loss of jobs and income if access to treated areas was restricted for rehabilitation of vegetation. Most closures would be expected to last for no more than one growing season. Where vegetation was completely removed, however, it is possible that closures would last longer, particularly in areas with arid climates and relatively poor soils. If long-term closures occurred over large acreages and conflicted with important grazing or recreation areas, they could result in job losses and associated reductions in income. Employment and income losses would have the greatest effect on smaller communities, where alternative employment opportunities would be scarce, and where these losses would represent a larger portion of the economy than they would near larger, more diversified towns and cities.

Regardless of the local economic situation, employment and related income effects would normally be short-term in nature and geographically dispersed, primarily affecting specific communities rather than large regions of the 17-state study area.

Perceptions and Values

There would be a range of stakeholder perceptions and values associated with the various vegetation treatment methods. For example, individuals who have an aversion to chemical use in the environment could find herbicide treatments offensive. Alternatively, individuals with a much greater concern about wildfires or the effects of invasive species would likely favor the most efficient means of attacking vegetation problems. Westerners that are against government ownership and management of large land areas might be opposed to the substantial expansion of the BLM-administered vegetation treatment program, but somewhat encouraged by plans to employ private contractors for some of the treatment work. These individuals would presumably favor the most efficient means possible to reduce fire risk and improve range productivity. Some individuals place high values on the health and pristine nature of public lands, and would therefore prefer to see that the least intrusive methods be implemented. Generally, most of the treatment methods have similar negative and positive responses to these perceptions and values.

Economic Activity and Public Revenues Generated from BLM Lands

Commercial activities that occur on public lands could be adversely affected by vegetation treatments in the short term. Treatments would not directly affect mineral resources but could temporarily reduce access to such resources. Treatments would be unlikely to cause a significant reduction in BLM revenues generated from mineral leases. Most of the BLM's mineral lease revenues come from Alaska, Colorado, and Montana (see Table 3-18), where only about 11% of the proposed vegetation treatments would occur. Further, restrictions on access for these activities would likely be minimal in most places because durable road access is generally required for commercial mineral extraction ventures. Consequently, any adverse effects on employment and revenue from mineral production due to vegetation treatments would likely be very minor.

Historically, nearly all of the BLM's revenues from timber sales have come from Oregon. In 2004, timber sales amounted to $23.4 million and nearly all timber revenues were from Oregon ($23.3 million, Table 3-18), where about 14% of all vegetation treatments are proposed to occur. No adverse effects on timber sale activities are anticipated from implementation of the vegetation treatment program.

Effects on harvesting non-timber plant products would depend on the product and the design of specific vegetation treatment projects. Indiscriminate use of any treatment method could potentially damage resources or reduce their value. Public involvement in project planning and environmental review should be encouraged to minimize adverse effects and maximize benefits.

Vegetation treatments would necessitate that some sites be closed to grazing activities during treatments and for a suitable recovery period afterward, both for effectiveness of the treatment and, in some cases, for safety of the livestock. Treatments requiring temporary rest from grazing would result in a reduction in forage for livestock. Although alternative grazing sites might be available, the costs associated with grazing in a different area would likely be higher. The economic effects of temporarily reducing forage production and/or access would vary depending on the size and flexibility of the affected ranching operations. It is not possible to quantify the effects at the 17-state regional scale. As for other vegetation products, public involvement in project planning and site-specific environmental review should be encouraged to minimize adverse effects on grazing and maximize benefits.

Recreation-based businesses such as outfitters, bait shops, OHV sales and repair shops, fish and hunting shops, and outdoor gear and equipment rental shops are direct beneficiaries of recreation use of public lands. Other services such as gas stations, restaurants, and hotels that are frequented by recreationists also benefit. Temporary closure of a popular recreation site, either to protect public safety during vegetation treatments or to decrease user-related effects during a site's post-treatment recovery, would result in temporary losses of revenues to surrounding businesses. In most cases, these effects would be short term in nature, lasting only as long as the site closure. In general, most recreational activities would continue, but would shift to other locations. Depending on the location of the alternate use area, the economic benefits could shift from one community to another. If there were a suitable nearby alternative to the closed site, the effects on surrounding businesses would be minimal; if not, the businesses would be adversely affected for a period of time. It is not possible to quantify the potential effects at the 17-state regional scale, or to identify communities or specific businesses that would benefit or be harmed from potential shifts in recreational activities.

Recreation provides revenues to the BLM through fees and permits. Closure of a popular fee-based recreation site would result in a loss of revenues to the BLM. The severity of any such losses cannot be determined at this scale because no specific fee-based recreation sites have been identified for treatment. Detailed effects would be examined at the site-specific project level.

Expenditures by BLM

Vegetation treatments would require a large commitment of financial resources by the BLM, which would vary by treatment method, location, terrain and other factors. The most cost-effective treatment method would be the one that would produce the greatest benefits for the least amount of financial investment. However, the cheapest method, if it did not substantially improve the health of the land, could require indefinite repeat treatments, thus costing more money over the long term. Benefits to the health of public lands depend on the specific problem to be addressed in each specific area. Consequently, these benefits would be evaluated on a site-specific basis as project proposals were developed, and the costs for the preferred treatment method would be determined at that time.

Effects on Private Property

Vegetation treatments could affect private property in the vicinity of public lands, particularly parcels adjacent to treatment areas. Over the short term, there would be minor risks for property damage associated with the effects of treatments extending beyond public land boundaries onto private property. Under such a scenario, crops or forage could be lost. Generally, losses would be minor and short term in nature, although the relative size of the affected property would be a factor in the degree of damage accruing to the property owner.

Effects of Fire Treatments

Approximately 2.1 million acres are proposed for vegetation treatment with fire. Nevada (24%), Wyoming (20%), and Oregon (16%) would be the largest users of prescribed burn treatments. Adverse effects from use of fire include the risk that a prescribed burn would escape control. While the probability of such an occurrence is low, individual events in the past have occasionally been catastrophic, and public awareness is high because of the publicity major fires garner. Fires escaping control could have several adverse effects, including damage to private property, damage to recreational opportunities, loss of forage on public lands, potential loss of revenue to recreational businesses and ranchers, and increased costs to federal, state, and local public agencies to combat the fires.

They would also exacerbate concerns among a portion of the public about the advisability of using fire as a treatment method. Public concerns could cause conflict within communities near proposed burn areas or between concerned citizens and BLM personnel.

Although fires escaping control would cause the greatest adverse effects, they would not be common. Most prescribed fire treatments are relatively small and are successfully kept within planned boundaries. Adverse effects from controlled burns would include primarily smoke and aesthetic effects, both of which would be temporary in nature. Potential health risks from smoke are addressed in the Human Health and Safety section of this chapter. To the extent that fire treatments would be employed in low income and minority areas, health risks could cause environmental justice concerns. Similarly, if fire treatments were used near communities, they could raise concerns regarding the protection of children. Burn treatment areas would suffer from degraded aesthetic qualities both during the actual burning and for a period of a year or more afterward, which could adversely affect the quality and desirability of recreational opportunities in the area of the burn. Certain recreational features, such as trails and OHV routes, could be closed to the public for a period of time, pending successful revegetation of burn areas. In some areas, the loss or restriction of recreational opportunities would adversely affect businesses that either directly or indirectly depend on recreationists.

Effects of Mechanical Treatments

Mechanical vegetation treatments are proposed for over 2.2 million acres, with nearly half of the acreage (47%) in Nevada. Idaho would be a distant second with approximately 18% of the total. The type of mechanical treatment employed would be the major determinant of whether adverse effects would result. Mowing, for example, would have minimal effects, most of which would be considered beneficial by the public. Most mechanical methods involve use of heavy equipment, however, and are more disruptive. Chaining, for example, requires use of a pair of large crawler type tractors, which would generate noise and exhaust odors and would typically leave torn up soil and substantial amounts of debris in their wake. Some of the plant debris would remain for several years after the treatment and would degrade slowly, especially in arid and semiarid areas like Nevada, southern Idaho, eastern Oregon, and Utah. Adverse effects would be mainly aesthetic, but could physically disrupt certain recreation uses. In either case, the effects would be reduced desirability of a treated area for recreation, which could adversely affect recreation-dependent businesses as well. There would also be some potential for loss of grazing values until a disturbed area was successfully revegetated.

Effects of Manual Treatments

Slightly less than 271,000 acres are proposed for manual treatment. Manual treatments are particularly suited to small problem sites and areas, such as Oregon forestlands, where other treatment methods would be difficult to use or would be undesirable because their detrimental effects would outweigh their benefits. Adverse social or economic effects from manual treatments would be unlikely and would be minimal, at worst.

Effects of Biological Treatments

Biological treatments are proposed for approximately 454,000 acres of public land. Over 87% of the acreage would be in just three states: California (40%), Montana (35%), and Idaho (12%). Biological treatments could range from containment using domestic livestock to use of specific insects or pathogens to control unwanted plant species. Generally, there would be few, if any, adverse social or economic effects from use of domestic animals. There could be temporary, short-term interference with some recreation activities that would adversely affect recreation-dependent businesses, but the losses would likely be minor.

It is assumed that any insects or pathogens used for vegetation treatments would be properly tested and approved prior to use. There have been past occurrences, however, in which a species introduced for a positive purpose was later found to cause a different problem. For this reason, and because of the publicity such events have received, there could be public concerns about the use of insect or pathogen treatments. Efforts should be made to inform and educate the public in the vicinity of a proposed project to minimize adverse public perceptions about the use of these treatment methods.

Effects of Chemical Treatments

Chemical treatments are proposed for approximately 932,000 acres in 14 states. The largest application areas would be in Idaho (28%), Nevada (22%), and Wyoming (16%); no chemical treatments are proposed for Alaska, Nebraska, or Oklahoma. There is some potential that chemical treatments would disproportionately affect minority or low-income populations and children, depending on where the treatments were located, although it is not possible at the scale of the PER to determine if such effects would occur. The Human Health and Safety section of this chapter, Chapter 4 of the PEIS, and the HHRA (PEIS Appendix B) all address health and safety issues that could influence the likelihood of environmental justice effects.

Chemical treatments have the potential to adversely affect plants used for ceremonial purposes by Native Americans because herbicides can affect non-target species or plants outside the application area. Similarly, there is some potential for chemical sprays to migrate onto private land or into areas used for grazing or recreational activities on public lands, especially when applied from the air. Such effects could adversely affect ranching or recreation-dependent business revenues in certain localities, although specific locations cannot be identified at the 17-state regional scale of this PER.

As with other treatment methods, chemical treatments would require closure of some treatment areas to grazing and recreational activities. Such closures would be temporary and typically short term, but might be somewhat longer in duration than other methods because, in some cases, chemical residuals could be a more persistent concern for adverse human or animal health reactions. Closures could adversely affect ranching or recreational economic activity.

Use of chemicals is often controversial, due to public perceptions about risks associated with chemicals. Efforts to inform and educate the public on specific project proposals prior to implementation would be advisable to ensure that public perceptions are based on facts rather than fears.

Standard operating procedures noted above and in greater detail in Chapter 2 would serve to minimize the potential adverse effects of chemical treatments. Also, project-specific environmental reviews would identify specific locations where effects would accrue.

Both beneficial and adverse effects of chemical treatments are addressed in greater detail in Chapter 4 of the PEIS.

Beneficial Effects of Treatments

General Effects

As noted above, there is no site-specific information on which types of treatment would be used in any particular area. Consequently, there is little or no discussion of specific treatment parameters and it is not possible to identify effects on particular communities at this scale of analysis.

It is assumed that vegetation treatment programs would meet, to varying degrees, the identified need for reducing the risk of wildland fire and improving ecosystem health. Vegetation treatments would reduce the amount and concentration of hazardous fuels, especially in the WUI, but also in the back country. As a result, the number, size, and severity of wildland fires would all be reduced, causing a reduction in the cost of wildland fire suppression and the loss of life and property. Treatments that improve ecosystem health may increase or improve the amount and quality of commercial and casual uses, improve or maintain market and non-market values of existing uses, and reduce the cost of operations on public lands. However, it is not possible to quantify these benefits.

There would be potential beneficial effects on the social fabric of communities. Successful improvement in the productivity of rangeland would help sustain ranching-dependent communities. Successfully reducing hazardous fuels in the WUI could encourage people to remain in, or move to, a community. These potential effects should be examined more closely at the project-specific level.

Economic benefits of vegetation treatments on communities could be similar to social benefits. Improvements in range productivity, wildfire risk, and access or attractiveness for recreation activities would potentially improve employment opportunities and income levels in a community. The broad scale of this PER makes it impossible to quantify beneficial effects or to accurately predict whether, where, and to what degree they would occur.

There would be both direct and indirect economic effects from implementation of the vegetation treatment program. These effects would vary depending on several factors, including the treatment method selected for use. There would be dramatic differences in costs associated with different methods and with the different circumstances of each particular project. Treatment costs could vary from as little as $20 per acre for some applications of prescribed fire to as much as $700 per acre for difficult, remote manual treatments (see Chapter 2 and below). Regardless of the level of cost, expenditures by the BLM for labor, materials, and equipment would contribute to economic activity in the vicinity of a particular treatment project.

Population and Demography

None of the proposed treatment methods would be likely to cause substantive changes to existing patterns and trends in population or demographic conditions in the western states. While there would be some increased employment generated by the increase in BLM acreage treated under each method, the jobs would generally be temporary positions or contracted work, which would not be sufficient to encourage measurable immigration of workers and their families. With some exceptions, including pilots, certified herbicide applicators, and heavy equipment operators, jobs generated by the increased vegetation treatments program would tend to pay moderate wages. Depending on the size and duration of any particular treatment project, there could be small, localized population increases, but it is not possible to ascertain if, or where, such changes would take place at this time. It is likely that any such growth would be viewed as a benefit in most communities in the West.

Environmental Justice

It is not possible to determine whether minorities or low-income populations would be disproportionately affected at this broad scale of analysis because it is not known if treatment areas would coincide with concentrations of minority or low-income populations, or with Native American and Alaska Native use areas. Specific evaluations of environmental justice effects would be conducted in concert with environmental analyses for site-specific treatment project proposals. There could be small benefits for minority and low-income populations in localities where employment opportunities were created.

Employment and Income

All of the vegetation treatment methods would produce economic benefits to western states and affected local communities by providing employment and labor income opportunities. The BLM would require the services of herbicide applicators, pilots, equipment operators, laborers, and others, creating jobs and generating income. The benefits are not quantifiable at the scale of this analysis; they would be small in the context of the 17-state region, but could be significant for some communities near larger treatment projects, depending on the expertise and availability of personnel in the relevant BLM offices and in the communities.

Although local effects cannot be determined at the scale of this PER, more specific economic effects would be determined through NEPA analysis at the time specific projects were proposed and analyzed. Regardless of the local economic situation, the nature of treatments indicates employment and related income effects would be short-term in nature and geographically dispersed, particularly benefiting certain communities throughout the 17-state area. In general, it is expected that communities located in areas with large amounts of public lands, and therefore the most potential treatment acreage, would be most likely to receive the greatest employment and economic benefits. Nevada, Idaho, Oregon, and Wyoming are the four states with the largest anticipated treatment acreage, which suggests that communities in these states would also be among the most likely to benefit from employment and income opportunities. Employment and income effects would be greatest in smaller communities, where the increases in jobs and dollars would have a greater influence on the area economy than they would near larger towns and cities.

One of the priorities of the *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment 10-Year Comprehensive Strategy Implementation Plan* (USDI and USDA 2002) is to promote community assistance and increase contracting and jobs for forest health management. In FY 2004, the Department of the Interior assisted over 14,000 communities with risk assessment plans, fuels hazard treatments, wildfire preparedness, training, and other activities needed to reduce the risk of loss of life and property to local communities (USDI BLM 2006c). In addition, over $140 million in contracts were given out, and a meeting was held to discuss opportunities for expanded use of woody biomass as by-products of hazardous fuel reduction and forest restoration treatments.

Perceptions and Values

Individuals with a concern about wildfires or the effects of invasive species would likely favor the most efficient means of attacking vegetation problems, regardless of the method involved. Some westerners might be encouraged by plans to employ private contractors for some of the treatment work.

Invasive Species Control Cost Savings

Estimating the environmental and economic damages caused by invasive vegetation and the environmental benefits and cost savings from treating invasive vegetation, cannot be quantified at the 17-state regional scale. However, on a national scale, the costs of treating invasive vegetation can be enormous. For example, purple loosestrife, which occurs in 48 states, costs approximately $45 million per year to control (ATTRA 1997). A total of $100 million is spent annually on aquatic invasive species control in the U.S. (U.S. Congress Office of Technology Assessment 1993). In U.S. agriculture, crop losses due to weeds are estimated at $24 billion annually, and costs of herbicide treatments are about $3 billion annually (Pimentel 1997, 2005; Pimentel et al. 2005). Forage losses due to weeds total about $1 million annually, and ranchers spend about $5 billion annually to control invasive vegetation in pastures and rangelands. Total direct and indirect costs of leafy spurge in Montana, South Dakota, and Wyoming are estimated at nearly $2 million annually for wildlands and up to $46 million annually for grazing lands (Bangsund and Leistritz 1991; Bangsund et al. 1993). Annual losses from knapweed in Montana are estimated at over $40 million annually (Hirsch and Leitch 1996). The Oregon Department of Agriculture (The Research Group 2000) evaluated the impacts of 21 species of weeds and estimated that both existing and potential invasive weeds are costing Oregon about $100 million annually.

Studies that have attempted to project the costs and benefits of treating leafy spurge have shown that benefits could total over $50 million or more annually if leafy spurge is controlled in the Great Plains region (Bangsund et al. 1997, 1999a). Still, net returns per acre are often negative early in the treatment program, with gains in net return not seen until 10 years or more after treatment, and the greatest returns from ground spraying rather than aerial spraying programs (Bangsund et al. 1996, 1999b; Hartmans et al. 1997). The cost of treating 50 acres of public lands using a single application of herbicides and a single attempt at revegetation has been estimated at $7,500 at year 0 (Kadrmas et al. 2003). However, if the 50 acres were not treated and the weeds continued to spread, weeds would cover an estimated 182 acres by year 18, and the amount required to restore a healthy ecosystem would be approximately $27,000.

Wildland Fire Cost Savings

For all of the treatment methods, approximately half of the treatment acreage would be in the WUI. Neither the fire suppression cost savings nor the reduction in property losses can be quantified at the 17-state regional scale. The potential savings should be addressed further in environmental reviews for specific projects, although they may not be quantifiable even at that scale because of the number of variables contributing to when and where a fire may start and how much damage it may cause. Relevant variable factors include weather conditions, terrain, human acts of omission and commission, and structure type and density, among others. Further, it may take several years to build a sufficient experience base of data to quantitatively estimate the benefits of treatments associated with reduced damage and wildfire suppression costs. The Forest Service and BLM came to similar conclusions when trying to ascertain the effects of vegetation treatment activities on future fire suppression costs in the Interior Columbia Basin (USDA Forest Service and USDI BLM 2000b).

During 2005, the federal government spent about $984 million on fire suppression. On average, the Department of the Interior and Forest Service spent approximately $170 per acre to suppress fires during 1996 through 2005. In addition, these agencies spend approximately $24 million annually rehabilitating burned areas (USDI BLM 2006c). Despite the lack of quantifiable data, it is expected that vegetation treatments in both WUI and non-WUI areas would reduce hazardous fuels, including invasive weeds, which contribute disproportionately to fire risk. Downy brome provides one example of the potential cost savings from attacking invasive weeds. The costs of fighting downy brome-fueled fires have been estimated at around $20 million per year, and up to $15 million annually in southern Idaho alone, including rehabilitation costs (Duncan and Clark 2005). Consequently, it is expected that all of the alternatives would reduce the cost of fire suppression in the backcountry as well as in the WUI.

Economic Activity and Public Revenues Generated from BLM Lands

Treatments would result in long-term improvements in the condition of forest resources on public lands and would lead to increases in revenues generated from forest products over the long term. The potential effects are not quantifiable at the scale of this PER.

Effects of treatments on harvest of non-timber vegetation products would depend on the product and the design of specific vegetation treatment projects. Indiscriminate use of any treatment method could potentially damage resources or reduce their value, but control of undesirable, invasive plants could enhance habitat for desirable species. Public involvement in project planning and environmental review should be encouraged to minimize adverse effects and maximize benefits.

Forage production could decrease initially following treatment, but production would likely increase over the long-term as woody vegetation and weed species were controlled, increasing the suitability of rangeland areas for grazing. Treatments would result in an increased quantity and quality of forage, increased animal production, reduced fire hazard, and a reduced risk of sickness in livestock as a result of ingesting poisonous plants. As for other vegetation products, public involvement in project planning and site-specific environmental review should be encouraged to minimize adverse effects and maximize benefits.

Treatment Expenditures by the BLM

Vegetation treatments, as proposed, would require a large financial investment by the BLM, which would vary by treatment method. These costs represent a substantial input of financial resources into the states and communities surrounding public lands, particularly in areas where public lands are extensive. The following paragraphs address the range of expected expenditures by treatment method.

Prescribed Fire. Use of fire for vegetation treatment is typically one of the least costly means of addressing unwanted vegetation. During 2005, it cost the BLM approximately $593 and $317 per acre to treat hazardous fuels in the WUI using fire and mechanical methods, respectively. During 2006, it cost the BLM approximately $373 and $236 per acre to treat hazardous fuels in the WUI using fire and mechanical methods, respectively. These costs primarily reflect the cost of implementation, although some overhead costs are included. Costs for treating hazardous fuels in 2005 were greatest in New Mexico ($726/acre) and Wyoming ($684/acre) and least in Alaska ($86/acre) and Arizona ($180/acre; USDI BLM 2006c, d).

During 2005, it cost the BLM approximately $585 and $239 per acre to treat hazardous fuels in non-WUI areas using fire and mechanical methods, respectively. During 2006, it cost the BLM approximately $171 and $105 per acre to treat hazardous fuels in non-WUI areas using fire and mechanical methods, respectively. Costs for treating hazardous fuels were greatest in California ($1,331/acre) and Nevada ($899/acre) and least in Wyoming ($53/acre) and Alaska ($78/acre).

Although the costs range from $50 per acre to $1,300 per acre depending on the location of the burn (higher costs are associated with treatment of forest lands in California and Oregon and lands in the WUI), the cost in most circumstances would be about $290 per acre in the WUI, and $105 per acre outside the WUI, based on average treatment costs during 2002 to 2006 (USDI BLM 2006c). With 2.1 million acres proposed for fire treatment, and assuming treatments would be about equally split between the WUI and non-WUI, this method would require an expenditure of at least $400 million (more if Pacific Northwest forestlands receive fire treatment), similar to what the BLM and Forest Service currently spend on hazardous fuels reduction using all treatment methods (USDI BLM 2006b). Prescribed fire would be the second most labor intensive of the five proposed methods, with approximately 58% of the cost typically going toward payments to labor (USDI BLM 1991a). No data are available on how much of the labor costs would go to existing BLM staff and how much would go toward hiring outside contractors and/or workers.

Mechanical Treatment. The range of costs for mechanical treatments is also quite broad: from $100 to $600 per acre. Using a midpoint of $350, the 2.2 million acres proposed for mechanical treatment would require an expenditure of $770 million. The range of costs reflects the range of possible types of mechanical treatments, some including just mowing and others employing multiple large pieces of heavy equipment (see Chapter 2). The type of terrain and the type and size of vegetation requiring treatment would also affect the cost. Mechanical treatment would direct approximately 39% of the expenditure, or $300 million, to labor costs (USDI BLM 1991a). The types of workers required would include mainly skilled equipment operators, who would be relatively highly paid. It is expected that a significant, but unquantified, portion of mechanical treatment work would be contracted out. Consequently, there would be a substantial number of non-government jobs supported by this treatment method.

Manual Treatment. Estimated costs for manual treatments range from $70 to $700 per acre. Manual treatment is the most labor intensive of the five methods proposed, with approximately 92% of the cost going to labor (USDI BLM 1991a). Manual treatment is the least favored method in the proposed program, accounting for only 270,910 acres. At the $385-per-acre midpoint of the cost range, the program would require an expenditure of $104 million, approximately $96 million of which would go to labor. It is likely that many of the jobs would be filled by unskilled laborers at relatively low wage levels, although specific labor requirements are not known.

Biological Treatment. Costs for biological treatment vary depending on the type of organism employed. Use of domestic animals—cattle, sheep or goats—is quite inexpensive, in the range of $12 to $15 per acre. This method has limited efficacy, however, and animals require continuous management to be productive. Use of biological control agents such as insects, nematodes, mites or other pathogens is more costly, ranging from $80 to $150 per acre for ground applications and $150 to $300 per acre for aerial applications. Based on information provided by field offices, about two-thirds of the acres subject to biological control would be treated using domestic animals, and the remainder using biological control agents. Assuming an average treatment cost $13.50 per acre for domestic animal use, and $150 per acre for biological control agents, treatment of the proposed 453,750 acres would result in a total cost of approximately $26.8 million. No data are available for the labor component of biological treatment, but it could be assumed that the labor component would be a relatively small part of the total.

Chemical Treatment. Chemical treatment costs are divided between the cost of the herbicide selected and the cost of applying it. As itemized in the PEIS, the herbicide costs range from about $1 per acre for ground-applied tebuthiuron to over $125 per acre for ground-applied bromacil (see Table 3-23). In addition to the chemical costs, there would be costs for applying the herbicides. The Forest Service estimated the average cost at $100 per acre for ground application and $25 per acre for aerial application (USDA Forest Service 2005). The BLM's range of estimated application costs is even broader. For ground applications, these estimates range from $50 to $300 per acre for backpack or ATV applications and from $25 to $75 per acre for boom sprayer applications. Aerial applications are estimated at $6 to $40 per acre for fixed-wing aircraft and $25 to $200 per acre for helicopters. The differences are largely due to the variation in labor and time required to cover an acre by each application mode. It takes many more man-hours to treat an acre on foot or from a small ATV, for example, than to treat an acre with an aircraft. The portion of the total herbicide application cost attributable to labor has been estimated at 17% for aerial applications and 26% for ground applications. Assuming the overall average cost per acre would be approximately $96 per acre, application of chemical treatments on the proposed 931,850 acres would require an expenditure of approximately $89.5 million.

Summary. At best, these estimates of the costs of vegetation treatments are crude averages; actual costs would vary widely, dictated by terrain, scale of a treatment project, accessibility of the treatment area, size of the problem vegetation stand being treated, type of vegetation requiring treatment, and other factors. None of the specifics of these factors are available for evaluation at the programmatic level, but they would be analyzed in greater detail for specific projects as they were developed.

The source of labor for the five vegetation treatment methods would vary with the project. Aerial application projects would be contracted out in most cases. Ground applications would be done by a combination of contractors and BLM personnel, either full-time or part-time employees. The determination of in-house or contract application would be determined for each project individually, depending on the specific needs of the project and the capabilities of the state or local BLM offices.

If goods and services were purchased locally, or additional workers were hired locally in support of a vegetation treatment project, state and local economies would benefit both from direct local expenditures and from "multiplier" effects of the dollars circulating through additional local and state business enterprises. Further, state and local governments would benefit through increased tax revenues. The relative public benefits would depend on the taxing structure of the individual states.

An additional consideration pertaining to BLM expenditures is the distribution of payments to state and local governments (see Table 3-24). None of the vegetation treatment methods would affect these payments, since they are established by Congress; the proposed vegetation treatment program would have no effect on the formula.

Irrespective of the particular treatment method selected, the costs associated with restoring or maintaining an ecosystem through vegetation treatments is generally much less than the cost of suppressing wildfires and implementing fire rehabilitation programs (USDI 2001a). In FY 2005, $218 million was budgeted by the Department of the Interior for fire suppression; the Forest Service budget was nearly $650 million (USDI BLM 2006c). Annual costs of vegetation treatments, using the assumptions above, would be approximately $1.4 billion.

Effects on Private Property

Over the long term, a reduction in hazardous fuels on public lands would reduce the likelihood of wildfires migrating from public lands to nearby private property, including both private ranch lands and private residences in the WUI. Vegetation treatments would also reduce the risks of noxious weeds spreading onto neighboring parcels, including poisonous weeds, which could harm livestock. A reduction in such risks would ultimately tend to sustain or even improve property values. Any such effects are not quantifiable at this broad scale of analysis.

Human Health and Safety

Vegetation treatments involve risk, or the perception of risk, to workers and members of the public living or engaging in activities in or near treatment areas. An important goal of treatments is to manage vegetation to reduce hazardous fuels and restore fire adapted ecosystems to reduce the incidence of loss of life and injury to the public and firefighters resulting from catastrophic wildfires. Part of this goal includes developing smoke management plans to reduce the health effects of smoke on the public, and to identify herbicides that are safe to use around the public.

A human health risk assessment was conducted for the PEIS to evaluate potential human health risks that could result from herbicide exposure both during and after treatment of public lands. The HHRA was conducted to be scientifically defensible, to be consistent with currently available guidance where appropriate, and to meet the needs of the BLM vegetation treatment program. This PER focuses on potential human health risks that could result from other treatment methods, and fire use in particular.

Risk to two types of human "receptors" would be associated with vegetation treatments: occupational receptors and public receptors. Receptors are representative population groups that could have specific exposures to the treatments. Occupational receptors considered in the HHRA include workers that mix, load, and apply herbicides, operate transport vehicles and equipment, or conduct prescribed burns. In some cases an occupational receptor may perform multiple tasks, increasing his or her exposure. Public receptors included members of the public most likely to come into contact with applied herbicides, fire, or other treatment controls.

Scoping Comments and Other Issues Evaluated in Assessment

Respondents suggested that at-risk groups like infants, the elderly, sick people, and people with sensitivities to chemicals and smoke be specifically addressed. A number of comments proposed that risk assessments be performed for both prescribed and natural fires. During public scoping, a large number of respondents during public scoping were concerned about the risks to human health from herbicide treatments. Numerous respondents urged the BLM to describe all potential toxicological hazards of herbicide chemicals, including their ability to disrupt hormone systems and immune systems. Establishing a goal of using the minimum effective dosage and developing protocols for achieving this goal was encouraged. There was also concern for the effects of herbicides on basket plants and the people who collect them, in particular Native Americans. Some respondents felt that the uncertainties about the environmental effects of herbicides and inert ingredients should be disclosed. According to some respondents, Oust® (herbicide formulated with sulfometuron methyl) should be considered for evaluation even though it was evaluated previously in the 1991 13-State Vegetation EIS (USDI BLM 1991a). One respondent noted that if there are insufficient toxicological data to be found for a specific herbicide, then that herbicide should not be used.

Resource Program Goals

Important goals of the vegetation treatment program are to ensure the health and welfare of visitors to public lands, reduce the risk of catastrophic loss of people and property from wildfires, and provide a safe work environment for workers involved in vegetation treatment activities. Treatments that remove noxious and poisonous weeds and other harmful vegetation near public use sites and facilities would benefit public health and welfare and would involve all treatment methods. Because of concern regarding the potential effects of fire use and herbicides on public health, manual, mechanical, and biological control treatments would comprise a greater portion of the treatments in areas with high levels of public use, in the WUI, in cultural and traditional use areas, and in areas where there is a risk that fire or herbicides could affect people, structures, and traditional lifeway values. Fire use and herbicides would be the predominant methods in areas where dispersed recreation occurs and where treatment of large areas is required. During all treatments, worker safety would be paramount. All treatment methods could result in injury or death to workers if proper operating procedures were not followed.

During FY 2005, wildfires burned 6.8 million acres on public lands. Over three out of every four fires were caused by lightning, while the remainder were caused by humans (USDI BLM 2006d).

Wildfires cause the loss of life and property. According to the National Interagency Fire Center (2005), 12 people died from wildland fire-related accidents in 2005. From 1999 to 2005, the leading cause of firefighter deaths nationally, which include federal, state, and local firefighters and volunteers, as well as private individuals who were involved in direct support of wildland fire operations are: vehicle accidents (23.8%), heart attacks (22.7%), aircraft accidents (22.3%), and burnovers/entrapments (20.2%).

During FYs 2002 to 2005, 49 USDI personnel were injured conducting fire operations. During 2005, wildland fires resulted in the loss of 240 primary residences and 750 total structures on lands near BLM- or Forest Service-administered lands (USDI BLM 2006c).

Standard Operating Procedures

Standard operating procedures designed to reduce potential unintended effects to human health are listed in Table 2-5. When conducting treatments, workers would always wear appropriate safety equipment and clothing and use equipment that is properly maintained. For fire use, the BLM would use some form of pretreatment, such as mechanical or manual treatments, in areas where fire could not be safely introduced because of hazardous fuel buildup. Workers would notify nearby residents who could be affected by smoke. Those involved in fire use treatments would maintain adequate safety buffers between the treatment area and residences/structures.

When cutting vegetation, all brush and tree stumps would be cut flat, where possible, to eliminate sharp points that could injure a worker or the public. Only qualified personnel would be allowed to cut trees near powerlines, and any burning of vegetation debris would take place outside of ROWs to ensure that smoke would not provide a conductive path from transmission lines or electrical equipment to the ground. Spark arrestors would be required on all equipment to reduce the risk of accidental fire.

Workers applying herbicides would minimize application areas where possible; establish appropriate (herbicide-specific) buffer zones; post treated areas with appropriate signs at common public access areas; and notify the public of the potential for exposure. In addition, the BLM would have a copy of Material Safety Data Sheets at work sites; notify local emergency personnel of proposed treatments; contain and clean up spills and request help as needed; and secure containers during transport. The results from the HHRA would help inform BLM field offices on the proper application of herbicides to ensure that effects to humans were minimized to the extent practical.

Adverse Effects of Treatments

The health and safety of workers could be at risk from exposure to herbicides; from working on uneven ground, broken terrain, and in dense vegetation; from use of hand and power tools; from inhalation of smoke; from exposure to falling debris; and from other accidental situations. The public could be at risk from flying debris if they were near an area where manual or mechanical equipment was used. For example, rocks or other debris could fly out from under a mower or brushhog during treatments along ROWs and near public high use areas and facilities.

Sensitive members of the public, including children and the elderly, and workers could experience minor discomfort from fire use, including eye, nose, and lung irritation. Workers could also suffer burns from fires. These risks would be minimized or avoided by following fire management plans, conducting burns during periods of favorable meteorological conditions to reduce smoke effects to the public, and by using proper equipment and following proper safety procedures. As discussed in the PEIS, herbicides pose risks to workers and the public. In general, mixer/loader/applicators would be most at risk from use of herbicides, and people living in close proximity to treatment areas would also be at low to moderate risk for adverse effects from some herbicides used by the BLM.

Risks from using biological control would be similar to those common to any human activities in a wildland environment (USDA Forest Service 2005).

Effects of Fire Treatments

Approximately 2.1 million acres would be treated using fire, with Nevada, Wyoming, and Oregon accounting for over half of the acres treated. Workers and the public would be at risk from wildland fire, prescribed fire, and fire use for resource benefits. Risks to workers and the public would include injury and fatality as a result of the fire itself, from inhalation exposure from combustion products, and from inhalation of volatized herbicide residues.

Risks from Fire

Prescribed burning presents various hazards to ground crews, who could possibly receive injuries ranging from minor to severe burns resulting in permanent tissue damage. Risks to workers would be minimized by use of protective clothing and by following standard safety procedures. The public could be exposed to similar risks if the fire escaped from the treatment area. The remoteness of most treatment areas and presence of fire crews and safety equipment would make the risk of injury to the public extremely low (USDI BLM 1991a).

Risks from Smoke

Substances that may be found in wood smoke include water, particulate matter, carbon monoxide, carbon dioxide, nitrogen oxides, aldehydes, ketones, and other substances (USDI BLM 1991a). Carbon dioxide and water make up over 90% of total mass emitted from wildland fires. Carbon dioxide may affect the global radiation budget (Sandberg and Dost 1990).

Particulate matter is the principal pollutant of concern from fires, particularly for particles less than 10 microns in diameter (Sandberg and Dost 1990, USEPA 1996). Approximately 14 to 50 tons of particulate matter is produced per ton of fuel burned. Particulate matter affects pulmonary function; and children, the elderly, and asthmatics are especially sensitive to exposure (Sandberg et al. 2002). Studies have shown that fine particles are linked (along or with other pollutants) to increased mortality and aggravation of preexisting respiratory and cardiovascular disease. Particulate matter can also affect immune systems (Ammann et al. 2001).

Although the long-term health effects from occupational smoke exposure are not well known, evidence suggests that brief, intense exposures to carbon monoxide and particulate matter can easily exceed short-term exposure limits in peak exposure situations such as direct attack and holding firelines downwind of an active wildfire or prescribed burn (Reinhardt and Ottmar 2000; Reinhardt et al. 2000). Average exposure over a worker's shift only occasionally exceeds recommended instantaneous exposure limits set by the American Conference of Governmental Industrial Hygienists, and rarely does it exceed Occupational Safety and Health Administration time weighted average limits (Reinhardt and Ottmar 2000; Sandberg et al. 2002). The long-term health effects to firefighters from smoke exposure are unknown, although there is anecdotal evidence that the incidence of cardiopulmonary disease and death may be greater than in the general population.

Smoke can cause highway safety problems when it impedes a driver's ability to see the roadway. Although this is a minor issue in the more remote areas of the West where most public lands are located, it is a problem in the southeastern U.S., where over a 10-year period 28 fatalities and 60 serious injuries were implicated with smoke from prescribed burning (Sandberg et al. 2002).

The gaseous components of smoke, including carbon monoxide, carbon dioxide, and nitrogen oxides, generally decompose or diffuse into the atmosphere relatively quickly. Emissions of carbon monoxide range from about 80 pounds per ton of wood burned for flames to 800 pounds per ton for smoldering fires. Carbon monoxide could represent a direct hazard to human health at the fireline. Carbon monoxide from prescribed fires likely poses no risk to community air quality (Sandberg and Dost 1990).

Polynuclear aromatic hydrocarbons (PAHs) are of significant toxicological concern when evaluating the effects from wood smoke because they contain at least five carcinogenic materials (USDI BLM 1991a). Aldehydes and ketones are ciliary toxicants that inhibit the removal of foreign material from the respiratory tract. Aldehydes are also known irritants that may be adsorbed onto the surface of particulate matter.

An HHRA was done in 1991 for the *Final Environmental Impact Statement Vegetation Treatment on BLM Lands in Thirteen Western States* (1991 13-State EIS) to assess the risks to workers and the public from PAHs found in wood smoke. Based on this assessment, estimated cancer risks from exposure to PAHs are not expected to exceed 1 in 1 million for any worker or member of the public, even in extreme cases.

Risks from Herbicides in Brown-and-burn Operations

Vegetation may be treated with herbicides several weeks before beginning a prescribed burn, with the goal of drying the vegetation to accomplish a more efficient burn. Herbicides that could be used for this purpose include 2,4-D, glyphosate, hexazinone, picloram, and triclopyr. An analysis of the risk from volatilization of herbicide residues was also done as part of the 1991 13-State EIS. Based on this assessment, neither workers nor the public would be expected to be at risk from herbicide residues volatilized in a brown-and-burn operation (USDI BLM 1991a). Other studies have shown that hot fires thermally degrade most herbicides, but that smoldering fires have the potential to volatilize large amounts of some herbicides (Bush et al. 1998). Exposure analyses indicate, however, that no significant health risks occur from herbicides incorporated into forest soils. Naturally occurring chemical by-products of combustion were of greater risk to human health.

Effects of Mechanical Treatments

Approximately 2.2 million acres would be treated using mechanical methods under the proposed treatment program, which is a 3-fold increase from current levels. Most mechanical treatments would occur on public lands in Nevada, Idaho, Oregon, and Utah. About 15% of mechanical treatments that remove vegetation would involve mowing, while the remaining treatments would involve cutting, crushing, shredding, and logging.

Workers using tractors and other heavy equipment would face the same types of risks as workers using similar equipment; however, risks of severe injuries from mechanical treatments would be low if workers adhered to standard safety procedures (BPA 2000). During a 4-year period, only one BPA worker was hurt operating mechanical equipment during vegetation control treatments; similar low accident rates would be likely for BLM workers and contractors.

Contact with cutting blades, mulchers, shredders, drills, or similar equipment during operation could hurt machinery workers. Operators could be injured or killed by losing control of their equipment, which would be most likely to occur during treatments on steep slopes, near wetlands or other unstable surfaces, or in dense foliage. Rocks and other flying debris kicked up by equipment could harm the operator or other workers near the treatment site. These risks could be minimized by avoiding treatments on steep slopes or traveling perpendicular to the slope, maintaining equipment in optimal working order, and using shields on equipment to deflect flying debris. High noise levels during equipment operations could cause operators to experience partial hearing impairment. Use of hearing protection devices would help to reduce noise risks (USDI BLM 1991a). Exhaust gases could be harmful to equipment operators working in tight spaces. Workers using machinery in powerline ROWs would need to be extra careful to avoid contact with the powerline, or with vegetation touching the powerline, to avoid electrocution.

The public would be at a slight risk for injury from flying debris. Risks to the public would be greatest for vegetation treatment activities near public facilities and along ROW. Maintaining a safety buffer around treatment areas would limit the risk of harm to the public from mechanical treatment operations.

Fuels and lubricants used in mechanical equipment could spill into a stream or other water body from an accident or leak, or during refueling, potentially fouling drinking water sources. The BLM would refuel trucks, tractors, and other equipment away from water bodies, preferably at a designated fueling site, and would carry sorbents or other spill cleanup materials or equipment to work sites to clean up any minor spills that occurred during equipment operation.

Effects of Manual Treatments

Under the proposed treatment program, manual treatments would be used on about 5% of public lands. Nearly all manual treatments would involve pulling or cutting vegetation with non-motorized hand equipment or chainsaws. Workers would be exposed to a variety of risks when using hand tools and pulling weeds. Hand pulling exposes workers to the hazards of physical contact with irritant weeds, such as leafy spurge, common tansy, and poison ivy, which can cause blisters, dermatitis, and inflammation. Workers could also suffer allergic reactions to pollen from ragweed and other grasses and forbs.

Workers would be at risk from biting and sucking insects, such as ticks and mosquitoes. Certain tick species carry diseases such as Rocky Mountain spotted fever and Lyme disease. Workers could also come into contact with poisonous snakes in most regions except Alaska. Workers frightening or surprising bears and other wildlife would be at risk for attacks. Some manual treatments would occur in remote areas, especially in wilderness or other special areas where use of motorized equipment is discouraged. The time required to obtain medical treatment in remote areas might complicate some injuries (USDI BLM 1991a).

Workers implementing manual treatments should be in good physical condition. Nonetheless, physical exertion during hot weather could lead to heat stroke. Exertion could also exacerbate existing chronic health problems, such as arthritis or tendonitis, or result in a stroke or heart attack. Falls or other accidents could also occur. When using hand tools, workers could hit or cut themselves with tools, be hit by falling trees, shrubs, or debris, or fall onto sharp equipment or the ends of cut vegetation. Injuries could range from minor scrapes to major bleeding or bone fractures. Severe injuries occurring in remote areas could become fatal. Maintaining equipment in optimal working condition and using automatic shut-off devices would help to reduce the likelihood of injury. Workers would be exposed to noise and exhaust from motorized equipment. Use of hearing protection and operation of equipment in well-ventilated areas would minimize effects to operator health.

It is unlikely that the public would be at risk from manual treatments. It is possible that flying debris could accidentally hit a person, but safety zones around work areas should minimize this possibility.

Effects of Biological Treatments

Approximately 8% of public lands would be treated using biological control methods, with half of these treatments occurring in Idaho, Montana, and Wyoming. Nearly two-thirds of all biological treatments would involve domestic animals (such as livestock). Most of the remaining biological treatments would utilize insects; pathogens would be used on less than 100 acres annually.

Livestock managers could be stepped on, trampled, kicked, or bitten by livestock, or hurt while operating vehicles when transporting livestock to or from the treatment area. Workers could also suffer minor discomfort from exposure to livestock fecal material and animal odors. Members of the public could experience similar effects if they were to come into contact with livestock. Large numbers of livestock, combined with a long period of vegetation containment, could result in large amounts of fecal material within the treatment area. If fecal material were to enter surface waters through direct deposition or from runoff, members of the public downstream from the treatment site could drink contaminated water. Using stock tanks as an alternate water source, constructing range fencing, and moving and dispersing livestock away from riparian and other aquatic areas would reduce this risk (USDI BLM 1991a).

Workers could be hurt during operation of equipment to transport and release insects and pathogens at treatment sites. Only biological control agents that have been studied and determined not to pose a risk to non-target or desirable species would be used to treat vegetation. Thus, it is unlikely that Native peoples or other members of the public would come into contact with these organisms when harvesting vegetation.

Effects of Chemical Treatments

The risks to workers and the public from the use of 24 herbicides currently available or proposed for use by the BLM were evaluated in the HHRA prepared for the PEIS (see Human Health and Safety in Chapter 4, and Appendix B). The following sections summarize the results of that assessment.

Human Health Risks by Application Method and Amount

Aerial applications of herbicides pose a greater risk to the public due to off-site drift than ground applications, as herbicides applied at greater distances from the ground are able to drift farther from the target application area. Therefore, public receptors within a larger radius of the treatment site would be at risk if the herbicide was applied aerially than if it was applied by a ground application method.

Spot applications would be less likely to pose a risk to downwind receptors than boom/broadcast applications. However, spot applications would be more likely to pose a risk to the worker charged with applying the herbicide; because these workers are more likely to come into contact with the herbicide, their exposure doses could be higher. In particular, there would be a low to moderate risk to workers applying diquat by backpack or horseback from exposure to the herbicide, whereas those applying diquat at the typical application rate by ATV or truck would not be at risk.

Most of the herbicides do not pose a risk to human receptors when applied at the typical application rate. At the maximum application rate, however, more herbicides, under more exposure scenarios, have the potential to adversely affect human health. Based on the HHRAs, fluridone, chlorsulfuron, clopyralid, glyphosate, picloram and triclopyr would not pose a risk when applied at the typical rate, but would pose a risk under one or more exposure scenarios involving applications at the maximum application rate. There would not be risks associated with scenarios involving applications of dicamba, diflufenzopyr, imazapic, imazapyr, metsulfuron methyl, or sulfometuron methyl at the maximum (or typical) application rate.

Human Health Risks by Receptor

There would be risk to workers treating vegetation with 2,4-D, 2,4-DP, asulam, atrazine, bromacil, diquat, diuron, fosamine, mefluidide, simazine, or tebuthiuron at either the typical or the maximum application rate. Atrazine and diuron pose risks to most receptors under scenarios involving the typical application rate. There would be low to moderate risks to receptors aerially applying 2,4-D, atrazine, diquat, bromacil, simazine, or tebuthiuron, even at typical rates, and most workers would be at risk when applying these herbicides at maximum application rates. 2,4-D, 2,4-DP, atrazine, and fosamine pose risks to ground applicators, particularly under scenarios involving the maximum application rate. Mixer/loaders would be at low risk during aerial applications of fluridone, and high risk during aerial applications of atrazine, bromacil, diuron, simazine, or tebuthiuron. Applicators would be at risk during ground broadcast applications of atrazine or diuron at the typical rate, and during ground broadcast applications of 2,4-DP, bromacil, chlorsulfuron, fosamine, or tebuthiuron at the maximum rate. All occupational receptors would be at risk from applying atrazine, hexazinone, tebuthiuron, and triclopyr at the maximum application rate. The rest of the potential occupational exposures would not pose a risk to receptors. Workers involved in the aerial application of herbicides appear to be at greater risk than other occupational receptors; however, the application method that poses the greatest risk to workers appears to vary depending on the herbicide, so application methods for each herbicide should be carefully evaluated with respect to potential human health effects.

In general, public receptors are less at risk than occupational receptors. However, within this category, children can be more at risk than adults. Public receptors do not appear to be at risk from applications of chlorsulfuron, dicamba, diflufenzopyr, imazapic, imazapyr, metsulfuron methyl, or sulfometuron methyl. Diquat application at the typical application rate poses low risks to child residents. When applied at the maximum rate, diquat would pose low to moderate risks to all public receptors, except swimmers. Diuron would pose risks to most public receptors under worst-case exposures. In addition, 2,4-D, 2,4-DP, asulam, atrazine (also at maximum exposure), bromacil, clopyralid, diuron, fluridone, fosamine, glyphosate, hexazinone, mefluidide, picloram, simazine, tebuthiuron, and triclopyr could pose risks to public receptors under one or more accidental exposure scenarios (e.g., exposure resulting from the spill of an herbicide into a small pond). For most herbicides (except diquat), risks to public receptors could be minimized or avoided by using the typical application rate and following SOPs that would greatly reduce the likelihood of accidents.

Beneficial Effects of Treatments

As discussed in Chapter 1, Purpose of the Environmental Report, the President and Congress have directed the BLM, through implementation of the *National Fire Plan* (USDI and USDA Forest Service 2001), and the *Healthy Forests Restoration Act of 2003*, to take more aggressive actions to reduce catastrophic wildfire risk on public lands. These actions would be taken to protect life and property, and to manage vegetation in a manner that provides for long-term economic sustainability of local communities, improved habitat and vegetation conditions for fish and wildlife, and other public land uses. As outlined in this PER, these actions include a proposed 3-fold increase in the use of fire and other treatment methods from current levels to reduce hazardous fuels and the risk of catastrophic wildfire, and the identification and evaluation of several new herbicides that could be used to treat vegetation with less risk to humans than most other herbicides currently available to the BLM. About half of this effort would be conducted in the WUI, where risks to human health from smoke and fire are greater than in more remote lands.

Unplanned or unwanted fires, such as catastrophic wildfires, can pose serious threats to public health and safety, as well as to air quality. Because these fires are uncontrolled, they can pose significant threats to the safety of firefighters and the general public and destroy property. The intense or extended periods of smoke associated with uncontrolled fires can also cause serious health problems and decrease visibility (USEPA 1998a). Wildfires cause the loss of life and property. According to the National Interagency Fire Center (2005), 12 people died from wildland fire-related accidents in 2005. Wildfires have also destroyed thousands of structures and caused the evacuations of thousands of residents in recent years.

Prescribed fires and fire use for resource benefit, on the other hand, are used to restore natural fire cycles, reduce the buildup of hazardous fuels, and restore native vegetation and natural ecosystem processes. Scheduling burning during favorable weather conditions and controlling the amount of fuel and acreage burned can minimize emissions and adverse effects of smoke on public health and the environment. In addition, fire management agencies, including the BLM, work closely with the USEPA, the National Interagency Fire Center, and tribal, state, and local fire agencies to manage smoke from prescribed fire activities. As part of this effort to manage smoke and its health effects, wildland owners and managers are encouraged to consider alternative treatments to fire, including mechanical, manual, and chemical treatments, and reduce fuel levels before burning. Mechanical thinning and biomass utilization are part of the suite of treatments the BLM would use in areas where fire presents an unacceptable risk. If fire were to lead to violation of the PM air quality standards, the USEPA would work with states or tribes to review and upgrade smoke management programs to ensure that human health was not compromised by use of fire (USEPA 1998a, USDA Forest Service and USDI BLM 2000b).

The *Restoring Fire-adapted Ecosystems on Federal Lands: A Cohesive Strategy for Protecting People and Sustaining Natural Resources* (Hann et al. 2002) modeled the effects of existing and proposed higher levels of treatments on fire risk to ecosystems and communities. In addition, the strategy looked at the benefits of less aggressive measures, such as creating defensible space around homes, in reducing loss of property and life. Based on the cohesive strategy, aggressive actions to reduce hazardous fuels and improve ecosystem function within the WUI, similar to those proposed in this PER, would reduce the risk to people and property by about one-third.

Herbicides would be used to treat vegetation to reduce hazardous fuels, restore native vegetation, and restore natural ecosystem processes. In addition to increasing the number of acres treated with herbicides, the BLM proposes to use four new herbicides (diflufenzopyr [as a formulation with dicamba], diquat, fluridone, and imazapic) that have been shown to be effective in the treatment of aquatic and terrestrial vegetation, as well as any new chemicals that become available in the future.

Based on an HHRA, three of the four new herbicides (all except diquat) appear to be relatively harmless to humans; therefore, there would be increased options for appropriately managing vegetation while minimizing the risk to human receptors. If these three new herbicides were used in place of currently-available herbicides that are more harmful to humans, there would be fewer risks than under current herbicide treatment programs. Since diquat potentially presents greater risk to humans under many application scenarios, it should not be used, or be used only in very limited scenarios at the typical application rate, where there is no risk to human receptors (e.g., ground applications from trucks in berry gathering sites or in areas that are not near residences).

Other treatment methods (mechanical, manual, and biological control), would have negligible to minor effects on worker and public health, while still contributing to overall control of vegetation and improvement in ecosystem function.