CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter discloses the direct, indirect, and cumulative effects of the alternatives described in Chapter 2.

DIRECT AND INDIRECT EFFECTS

Direct effects are caused by the action and occur at the same time and place as the action. Indirect effects are caused by the action and occur later in time or farther removed in distance, but are still reasonably foreseeable.

Direct and indirect effects analysis for each alternative and each resource are based on description of the alternatives provided in Chapter 2, including the Features Common to All Alternatives; the EPMs (**Table 2-4**); Ongoing Weed Treatment, Prevention, and Education Program; and assumes all would be implemented as described. Included in the EPMs is a buffer on aerial spraying under Alternative A:

- "On each side of streams, a 300-ft buffer would be established where aerial application would initially not be allowed. Through site-specific drift monitoring at the time of application, this buffer may be reduced by 50-foot increments as long as monitoring results are favorable. In no case would aerial application buffers be less than 100 feet."

To assess impacts of Alternative A with this EPM, all resource analyses assume a 100-foot aerial buffer, as that is the assumption that would show most impacts. Where effects are displayed quantitatively, calculations were made with the 100-foot aerial buffer. A buffer of 300 feet compared to a buffer of 100 feet would reduce acres treated through aerial application by approximately 2,375 acres.

In the resource section this buffer is referred to as the "riparian aerial spray buffer." There are other buffer widths planned for other sensitive areas. These may be referred to specifically or may be included in the general term "buffer," which would include all the specific buffers.

Also, every resource assumed that all acres indicated in Chapter 2 would be treated in each of the alternatives. Due to the way the inventory and mapping was done, treatment acres may be less than those indicated. This is mostly caused by areas of no or light weed infestation included within a weed location "polygon" in the GIS data. The minimum size of a GIS weed polygon is .12 acres, where the actual size might be one plant or a small patch.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

NEPA requires identification of irreversible and irretrievable commitments of resources. These effects are identified in resources where they may occur, Soils, Vegetation and Wilderness and Inventoried Roadless Areas.

SHORT-TERM AND LONG-TERM EFFECTS

Unless otherwise specified, short-term effects are those that occur within three years after treatment, and long-term effects are those that occur in three to ten years after treatment.

CUMULATIVE EFFECTS

Cumulative impacts are impacts on the environment that result from incremental impact of action when added to other past, present, and reasonably foreseeable future action. For each resource, an analysis area was determined that could be used to adequately

measure cumulative effects of the proposed alternative. Unless otherwise stated, the cumulative effects area is the treatment area. Direct, indirect, and cumulative effects are limited to geographic and temporal scope of the project discussed in Chapter 1.

PAST, PRESENT, AND REASONABLY FORESEEABLE ACTIVITIES

Weed control efforts including aerial and ground application of herbicides will continue on privately-owned and public land within and adjacent to the Helena NF. Timber harvesting, fuel reduction, livestock grazing, and recreational use (hunting, hiking, motorized recreation, etc.) will continue to be dominant land uses. Wildfire will continue to be a source of disturbance. Reasonably foreseeable and ongoing (previously planned) activities on NFS lands considered in the effects analysis are shown in **Table 4-1** and **Table 4-2**.

TABLE 4-1
Reasonably Foreseeable Activities Considered in Cumulative Effects

Project Name	Type of Project	Location
American Bar	Fuels Reduction	T12N, R3W, S12 & 17
Atlanta/Mule Aspen Regeneration	Wildlife	Big Belts
Baxendale VFD Firehall	Special Use	T9N, R5W, S20
Blackfoot Land Acquisition	Lands	Blackfoot River
Cave Gulch Watershed	Flood Mitigation	Big Belts
Clancy/Unionville	Vegetation/Travel Management	South of Helena
Clancy/Unionville Allotment Management Plan	Range	South of Helena
Closures III-- Hazardous Mine Openings	Minerals	Elkhorns and Big Belts
Commercial Log Hauling	Road Use	South Elkhorns
Co-operative Urban Interface Fuels Program	Fuels Reduction	Helena Ranger District
Copper Creek Road Improvement	Access	Copper Creek Drainage, Lincoln District
Deep Creek Foot Bridge	Restoration	Maudlow-Toston Fire Area
Douglas-fir Beetle Control Project – Funnel Traps	Silviculture	Maudlow Toston and Cave Gulch Fire areas
Douglas-fir Beetle Control Project – Green Trap Trees	Silviculture	Maudlow Toston and Cave Gulch Fire areas
Douglas-fir Beetle Control Project – insecticide to protect cones	Silviculture	Maudlow Toston and Cave Gulch Fire areas
Douglas-fir Beetle Control Project – MCH anti-aggregate (to repel beetle)	Silviculture	Maudlow Toston and Cave Gulch Fire areas
Douglas-fir Beetle Control Project – planting	Silviculture	Maudlow Toston and Cave Gulch Fire areas
East Pacific/Sunrise/January Mines	Minerals Reclamation	T8N,R1W S 26
Flesher Rogers Trailhead	Recreation	Flesher Pass/ Rogers Pass
Harlen Exchange	Lands	T12N, R 1W, 2W
Helena National Forest Travel Plan	Travel Management	S.Belts, Divide and Blackfoot
Hunter Exchange	Lands	T8N, R2W, S7,8
Hunter/Outfitter Guide Permits	Recreation	Elkhorns and Belts
Indian Meadows Parking Lot	Recreation	Indian Meadows Outfitter Guide Area
Jerico Mtn. CDNST Reroute	Recreation	T9N, R6W, S24,25,& 36
Lincoln Compound Salvage	Vegetation	T14N, R8W, S19
Lincoln Springs Subdivision Fuels Mitigation	Hazardous Fuel Reduction	T15N, R9W, S34, 35

TABLE 4-1
Reasonably Foreseeable Activities Considered in Cumulative Effects

Project Name	Type of Project	Location
Lovely Exchange	Lands	T8N, R5W, S4
Magpie/Cave Watershed	Restoration	Big Belt Mountains.
Montana Army National Guard	Special Use	T8N,,R7W, S 1
Nevada Dalton	Vegetation/Travel Management	South of Highway 200, Lincoln Ranger District
North Belts Travel	Travel	North Big Belts
North Elkhorns Range Improvement	Range	Elkhorns
Northern Rockies Lynx Amendment	Plan Amendment	18 National Forests in Regions 1, 2, and 4
Outfitter Guide Permit Re-issuance	Recreation/Special Uses	Bob Marshall Complex
Pole Creek Prescribed Burn	Vegetation	Elkhorns
Prickly Pear Land Trust "Don't Fence Me In" race	Special Use	South of Helena- Dry Gulch
Scoffield Rental Cabin	Recreation	Deep Creek
Sheps Park Restoration	Vegetation	Elkhorns
Skelton Access	Special Use	T13N , R1E, S19
Skidway and Blacktail X-country Ski Trails	Recreation	South Belts
Snow Bank Core Drilling	Minerals	T11N,,R7W, S 20/21
Sourdough Trail	Recreation	Scapegoat Wilderness
South Hills Trails	Trails	Grizzly-Orofino
Telegraph Creek Snowmobile Route	Recreation	Telegraph Creek
Valley of the Moon Trail	Recreation	Scapegoat Wilderness
Watson Range Improvement	Range	Big Belts
York Townsite Act	Lands	T11N, R 1W

Notes:
MCH = 3-methylcyclohex-2-en-1-one
Source: April 2003 Quarterly Schedule of Proposed Actions, Helena NF

TABLE 4-2
Ongoing Activities Considered in Cumulative Effects

Project Name	Type Of Project	Location
Alice Creek Aspen Regeneration Project	Vegetation	Alice Creek Area
Wilson Ck Prescribed Burn	Vegetation/Wildlife Habitat	Wilson Ck
Flesher All Terrain Vehicle (ATV)	Recreation	Flesher Pass
Lewis & Clark Pass Project	Recreation/Cultural	Alice Creek Area
Fire Restoration Projects (Cave Gulch and Maudlow Toston)	Restoration	Big Belt Mountains
Cave Gulch Salvage	Timber/Restoration	North Big Belts
East Stemple Prescribed Fire	Hazardous Fuel Reduction	Virginia Creek
Nevada Dalton Allotment Management/H20	Grazing and watershed Improvement	T12 & 13N, R8-10W
Maudlow-Toston Post-Fire Salvage	Timber/Restoration	South Big Belts

SOIL RESOURCES

DIRECT AND INDIRECT EFFECTS

ALTERNATIVES A AND B

Effects of Herbicide Use

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

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

If herbicide-induced reductions of biodiversity do occur, a decrease in the extent of decomposition, nutrient cycling, and disease suppression occurring in the soil may be observed (Brussaard *et al*., 1997). While herbicide exposure can influence the diversity of soil microorganisms, the reported data indicate that this influence is transient as long as adequate time is allowed for the soil community to rebound between exposures. Brady and Weil (1999) report that negative effects of most pesticides on soil microorganisms are temporary and populations generally recover after a few days or weeks. Considering this short recovery time, the soil microbial community is expected to return to pre-herbicide levels within a year of herbicide application under the proposed schedule. Even in the presence of more highly persistent herbicides, microbial populations are expected to rebound in the short-term (1 to 3 years after treatment begins) once the herbicide application program enters the maintenance mode and applications occur less frequently.

Certain herbicides, such as glyphosate and dicamba, have been observed to cause weight reductions or mortality in earthworms. Surviving earthworms would be expected to recover, but the population may be decreased by 50 percent or more after each herbicide application. Soils with reduced earthworm populations would exhibit reduced water infiltration, nutrient cycling, and fewer stable soil aggregates compared to similar soils with greater earthworm populations (Brady and Weil 1999). In areas where earthworms are susceptible to the type of herbicide applied, the population may remain suppressed until application ceases.

A study of the effects of herbicide on soil arthropods found that no significant change in the arthropod population occurred due to herbicide exposure (Fuhlendorf 2001). The arthropod population was extremely variable from year to year regardless of herbicide application.

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

Slight increases in soil erosion may occur in areas where weeds are eradicated until native vegetation becomes established. Since these areas experience increased erosion as a result of weed infestation, any additional increase resulting from weed removal would be inconsequential and would cease once native vegetation is established.

Unintentional exposure of native vegetation to herbicides may occur where herbicide "drift" occurs during application. In the relatively small area where this occurs, impacts to soils are expected to be minimal and include the effects described above but to a lesser degree since less herbicide would be applied to such areas.

Herbicide exposure would cause a slight, temporary reduction in soil quality due to changes in the soil microbial population. Because these effects are not intense or long-term, no significant reduction in soil productivity would occur and productivity would be improved by weed control. A reduction in the earthworm population in soil

exposed to glyphosate, and possibly other herbicides, would cause a slight decrease in soil water infiltration and nutrient cycling until the earthworm population recovers. Overall, herbicide applications would increase soil quality by controlling weeds and minimizing the negative effects of weeds (Lacey *et al*., 1989; Olson (a), 1999; Olson and Kelsey, 1997). **Table 4-3** lists solubility potential for mobility and half-life of herbicides proposed for use.

Application Method

Aerial application of herbicide (in Alternative A only) would not have impacts on soils beyond the effects of the herbicide. The use of motorized vehicles for ground application of herbicides would result in a minor amount of soil compaction and erosion if vehicles were used in off-road areas for follow-up application on aerial units.

Biocontrol

Biological control agents are not expected to have any negative effect on soil quality since these herbivorous insects have a high degree of host specificity and would not be expected to target beneficial, native vegetation. Biological control agents would provide the benefit of weed control without the potential for changes to soil biota communities.

Grazing

High-intensity, short-duration grazing would occur on approximately 1,356 acres and would cause a degree of soil compaction that is proportional to the intensity and duration of grazing.

Handpulling

Incidental handpulling of weeds would result in minor soil disturbance where weeds are pulled. This would be outweighed by the benefit of removing the weeds as spread to other areas would be reduced and desirable vegetation would have the chance to reestablish, thereby protecting the soil against erosion.

ALTERNATIVE A

This Alternative would provide control of weed infestations in previously untreated, difficult to access areas. Effective treatment of weeds would reduce the negative impacts of weeds on soil quality (Lacey *et al*. 1989; Olson (a) 1999; Olson and Kelsey 1997). Herbicide use would have minor and short-term negative impacts on soil productivity. Aerial application would have no ground disturbing effect. Ground application, grazing, and handpulling would have minor soil disturbing or compacting effects. These effects would not be considered detrimental soil disturbance, as they would occur on relatively small areas that would subsequently support desirable plant species. Minor, short-term negative effects would be greatly outweighed by beneficial, long-term improvements in soil quality and productivity.

TABLE 4-3
General Characteristics of Herbicides to be Used

Herbicide	Solubility (ppm)	Potential For Mobility	Half Life (Days)
Chlorsulfuron	300 (pH 5), 7,000 (pH 7)	High (increases with pH)	30 to 120
Clopyralid methyl	1,000	High	15 to 287
Dicamba	4,500	High	7 to 42
Glyphosate	12,000 to 900,000	Low	3 days - several years
Hexazinone	33,000	High in soil, low in leaf litter	30 to 180
Imazapic	2,200	Moderate (increases with pH)	31 to 233
Imazapyr	11,272	Moderate to high	Several months
Metsulfuron methyl	1,750 (pH 5.4), 9,500 (pH 7)	High (increases with pH)	14 to 180
Picloram	430	High (increases with pH)	20 to 300
Sulfometuron methyl	10 (pH 5), 300 (pH 7)	Low (increases with pH)	30
2, 4-D	890 to 800,000	High	30 or less
Triclopyr	23 to 2,100,000	Moderate	30 to 46

ALTERNATIVE B

Approximately 7,319 more acres would receive ground herbicide application than in Alternative A. This increase in ground application would require more higher traffic, exposing more soil to minor compaction, as compared to Alternative A. This alternative would result in non-treatment of approximately 3,755 acres until the weed populations in these areas spread to treatable areas. While this acreage would not be subject to the effects of herbicide exposure, it would be exposed to increased erosion and reduced productivity, especially where non-treated acreage occurs in landtypes with a moderate or severe erosion hazard rating. In addition, allowing the weed population to exist in these areas would make future weed control more difficult as the weeds would be more deeply rooted and established.

Herbicide use would have minor and short-term impacts on soil productivity. Ground application, grazing, and handpulling would have minor soil disturbing effects. These effects would not be considered detrimental soil disturbance. Minor, short-term negative effects would be greatly outweighed by beneficial, long-term improvements in soil quality and productivity in areas where weeds are treated.

ALTERNATIVE C

Where weeds are treated, effects from herbicide use and biological control would be the same as those described in Alternative B. Approximately 6,797 acres of infestation would remain untreated and it is likely that infested acreage would continue to increase. While this alternative would reduce the acreage of soil subjected to the relatively minor or temporary negative effects of herbicide application, weeds would continue to displace native species and soil productivity would diminish.

The larger weed population resulting from Alternative C would provide less annual input of organic matter to the soil, especially near the surface. As the soil organic matter content declines, the amount of water available to plants stored in soil also declines (Brady and Weil 1999). Abundance of soil microbial biomass is generally related to the organic matter content of soils (Brady and Weil 1999). It is possible that weed infested soil with reduced organic matter content may support smaller populations of microorganisms than non-infested soil.

Soil erosion would increase, especially on landtypes with moderate or severe erosion hazard ratings. With less canopy and basal cover than native species, weeds would be less able to dissipate the kinetic energy of rainfall, overland flow, and wind that cause soil erosion (Torri and Borselli 2000, Fryrear 2000). Lacey *et al.* (1989) measured significantly greater sediment yield from spotted knapweed dominated sites (0.06 tons per acre) compared to adjacent native grass dominated sites (0.01 tons per acre) following 30 minutes of simulated rainfall.

Soil nutrient availability would decrease under Alternative C. Noxious weeds directly limit nutrient availability through their ability to out-compete native species for limited soil resources. Weeds have high nutrient uptake rates and can deplete soil nutrients to very low levels (Olson 1999a). Potassium, nitrogen, and phosphorous levels were 44 percent, 62 percent, and 88 percent lower on spotted knapweed infested soil than from adjacent grass covered soil (Olson 1999a citing Harvey and Nowierski 1989). In addition, some weed species germinate prior to native species and exploit nutrient (and water) resources before native species are actively growing (Olson 1999a). In instances where weed decomposition occurs slowly, nutrients remain immobilized in the plant tissue and unavailable for uptake by other species.

Weeds indirectly limit nutrient availability due to increased soil erosion that can occur in infested areas. Erosion selectively removes organic matter and the finer sized soil particles that store nutrients for plant use, leaving behind soil with a reduced capacity to supply nutrients (Brady and Weil, 1999).

CUMULATIVE EFFECTS

A level of uncertainty exists with regard to cumulative impacts on soil quality resulting from herbicide exposure. This is because the conditions described in scientific reports of herbicide behavior may not be completely representative of the site-specific conditions or interactions present on the Helena NF. However, effects due to herbicide exposure are expected to be minor with the exception of a short-term decline in the earthworm population in areas exposed to glyphosate.

Other foreseeable future impacts on soil quality include continued grazing and increased recreational use, including off road vehicles that may increase soil compaction and erosion, primarily when these activities occur off of established trails. Grazing and recreational use also provide mechanisms to spread existing weeds to other areas. Recurrence of forest fires may result in increased soil erosion, loss of productivity, and increase the acreage of soil susceptible to weed invasion and subsequent weed control treatments.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

No irreversible or irretrievable commitment of the soil resource is expected to result from Alternative A. Under Alternative B approximately 3,755 acres would be susceptible to the irretrievable loss of soil productivity as weeds spread uncontrolled in areas that would otherwise receive treatment under Alternative A. Herbicide application may have relatively minor effects on soil microbial populations and productivity but these effects would not be irreversible or irretrievable. Alternative C would result in the irreversible and irretrievable loss of soil productivity due to increased erosion of the biologically active upper soil horizon on approximately 6,797 untreated acres and possibly more as weeds spread to other areas.

CONSISTENCY WITH FOREST PLAN AND OTHERS LAWS AND POLICIES

As each Alternative provides some measure of weed control, they are consistent with the Forest Plan standards which state that all management activities would be planned to sustain site productivity and that reduction of sedimentation associated with management activities on highly sensitive granitic soils would have first priority for soil erosion control. They are also consistent with the Soil Conservation and Domestic Allotment Act (16 U.S.C. 590), as they limit decreases in soil productivity and suppress sedimentation. These Alternatives are also consistent with 43 C.F.R. § 1901 and MCA 76-13-101 which authorize land supervisors to manage vegetation in a way that reduces soil erosion. Additionally, preventing weed propagation is consistent with the Montana County Noxious Weed Management Act.

WATER RESOURCES

DIRECT AND INDIRECT EFFECTS

ALTERNATIVE A

Fate of Herbicide

Any liquid herbicide sprayed on target vegetation would fall on foliage and surrounding soil. The fate and transport of herbicides include the following possible transfer and degradation mechanisms (Siegel 2000):

- Adsorption and detoxification by plants;
- Photodegradation by sunlight;
- Volatilization;
- Adsorption to soil particles and organic matter;
- Chemical degradation;
- Microbial degradation;

- Solubilization and dilution in surface runoff; and
- Leaching through soil horizon and potentially to groundwater.

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

Microbial decomposition and volatilization are the predominant breakdown process of herbicides in soil. Leaching of herbicides through the soil horizon is the least likely route for water resource impacts. Refer to the Soil Resources Specialist Report in the project file (PF - Soil Resources) for more information on the fate of herbicides in soil. Direct application of herbicides to surface water is the route most likely to cause impacts on water resources. Mobilization in ephemeral channels also can affect water resources if run-off occurs soon after application. The combination of transfer and degradation factors listed above would likely result in herbicide concentrations that are not harmful to the environment (assuming proper and safe application procedures). Refer to the later discussion under "Herbicide in Surface Water" regarding results of modeling that were used to simulate the mixing of herbicides with surface water in the project area.

General Impacts on Surface Water

Direct impacts on water resources would be associated primarily with herbicide application on or near streams, lakes, ponds, springs, and/or wetlands. Such adverse effects, if any, could occur from aerial spray drift, or improper application rates or accidental spills of herbicides. EPMs (Chapter 2) would prevent the aerial application of herbicides near water bodies, and monitor to assure that drift does not reach non-application areas. Studies show that little or no herbicide drift occurs beyond 100 feet from the release area when applied under proper conditions (Felsot 2001). Spot treatment using ground methods can occur near perennial seeps, springs, and wetlands using aquatic label herbicides. Spot treatment also can occur within riparian aerial spray buffers. Picloram use would be prohibited within 50 feet of streams or subirrigated land. Less persistent herbicides would be used within 50 feet. Selection of appropriate herbicide would be based on product label restrictions and site characteristic evaluations (**Appendix E**).

Label instructions for herbicide use include the following restrictions: (1) no spray if precipitation is occurring or imminent; (2) no spray if air turbulence would affect normal spray pattern; (3) no spray if snow or ice covers target foliage; and (4) use only water as a chemical carrier. Most proposed application areas on the Helena NF have adequate soil development and vegetative cover that overland flow of precipitation would be minimal. Applied herbicide would tend to stay at or very near the intended application area. See later section "Sediment Impacts" for additional concerns in recently burned forested areas.

If any herbicide drift from aerial application reaches a stream or other water body, the small amount of herbicide in the drift would likely be diluted to very low, non-harmful concentrations. As stated previously for proposed environmental protection measures, aerial spray operations would be closely monitored, including use of spray drift cards. Monitoring efforts at the Mormon Ridge and Sawmill RNA spray projects, including sampling of herbicide drift patterns and water chemistry, suggest risk to water resources is minimal as long as mitigation/environmental protection measures are followed (USFS 1996b; USFS 2001c; Rice 2000). See next section "Herbicide in Surface Water" for information about calculations performed to estimate

concentrations of an herbicide (picloram) after mixing with surface water.

Some herbicide treatment would occur along roads in the Helena NF. EPMs previously described in Chapter 2 should prevent adverse impacts on surface water where herbicides are applied along roads near streams.

Herbicide in Surface Water

Results of calculating or modeling the mixing of herbicide with surface water are presented in detail in the project file (PF - Aquatic Resources). Values used to calculate flow in each of 105 watersheds that would have herbicide treatment for the Proposed Action are presented in **Table 4-4**. Also included in this table are resultant flow rates for two time periods (June and September) used to model dilution of herbicides in primary streams for each watershed. Typical high flow (flood magnitude for 2-year recurrence interval [Q_2]) and low flow conditions (mean monthly flow in September exceeded 20 percent of the years [$Q_{.20}$]) were used for the two modeled time periods. The calculated Q_2 flows for the 105 watersheds are in the range of 2 to 140 cfs, with the $Q_{.20}$ flows in the range of 0.1 to 20 cfs (**Table 4-4).**

Picloram was used in the model as the target herbicide because it is the only chemical that has a "high risk quotient" for fisheries (see **Table 4-6** in the *Fisheries and Aquatics* section). For Alternative A, the model shows that 19 of the 105 watersheds would exceed the "safety factor" for picloram toxicity to fish as calculated after mixing the herbicide in each watershed stream. Several of the watersheds do not support fish. The model assumes that all acres within the designated treatment polygon are treated with picloram in a single year. However, this would not be the case for actual treatment because some areas would be spot treated or not treated, including riparian aerial spray buffers, sensitive areas, scattered weed areas, and heavy canopy areas. Therefore, the model results are conservative with respect to total herbicide application areas used as one of the input parameters.

When compared to Montana's surface water quality standard of 500 micrograms per liter (µg/L) for picloram, results of the modeling show that three 6th HUC watersheds (Cave Gulch, Oregon Gulch, and Grizzly-Orofino Gulch) would exceed the standard with resultant calculated concentrations in the range of 590 to 1,300 µg/L (**Table 4-4**). These calculated exceedences would occur only during the fall low-flow period. As shown on **Table 4-4**, Cave Gulch and Oregon Gulch (located in Belts/Dry Range LA) both have 20 to 25 percent of their watershed areas proposed for weed treatment. Grizzly-Orofino Gulch, located in the Continental Divide LA, has 5 to 10 percent of its watershed area proposed for treatment.

Due to predicted toxicity exceedances, an EPM was developed to eliminate potential impacts. Treatment schedules for these drainages would be adjusted (treated in spring, acres reduced, increased timeframe, alternative herbicide) per EPMs discussed in *Chapter 2*. Another EPM addresses use of silicone-based surfactants that would be used outside of riparian areas or other high-runoff sites. Site characterization evaluation procedures would be used to determine where the application of herbicides mixed with surfactants is suitable. The proposed EPMs should result in no adverse impacts on surface water quality, including irrigation water that may be present downstream of the Helena NF.

Impacts on Impaired Water Bodies

Table 4-4 shows that out of the 105 6th HUC watersheds that would be affected by Proposed Action weed treatments, 35 stream segments are on Montana's 303(d) lists of impaired water bodies (nine streams in Belts/Dry Range LA, seven streams in Elkhorn LA, 12 streams in Continental Divide LA, and seven streams in Blackfoot LA). These include six streams in the nine representative watersheds presented in the Water Resources section of Chapter 3. Sources identified for the impairments in these streams are primarily agriculture and resource extraction, with primary causes including flow alteration, metals, and other habitat alterations.

Therefore, establishment of TMDLs for these water bodies in the Helena NF is not deemed necessary for the Proposed Action to proceed.

Two watersheds that are impaired (Cave Gulch and lower Trout Creek in Belts/Dry Range LA) would have 20 to 25 percent of the watershed area treated for weeds. Two other watersheds that are impaired (middle Crow Creek tributary in Elkhorn LA; Upper Little Blackfoot River in Upper Clark Fork LA) would have 5 to 10 percent of the watershed area treated. The remaining impaired water bodies that are located in watersheds to be treated would have less than 5 percent of the area treated for weeds. The EPMs described in Chapter 2 should prevent any adverse impacts on impaired water bodies.

Canyon Ferry Reservoir and Hauser Lake are also on Montana's 303(d) lists for nutrients, organic enrichment, and/or pesticides. Because of the relatively small treatment areas within the combined watersheds on the west side of the Belts/Dry Range LA, it is expected that proper use of herbicides, along with proposed EPMs, would not cause adverse impacts on water in these lakes and the Missouri River.

Sediment Impacts

If relatively large areas of weeds rapidly die from herbicides, short-term increases in erosion and sedimentation may result until replacement vegetation is established. Due to the limited acreage proposed for treatment as compared to total drainage area, however, increases in runoff or sediment are expected to be minor. Additional vehicle and foot traffic from performing treatment activities would be minimal and not result in increased erosion and sedimentation. No new roads or trails would be constructed to complete Alternative A. Refer to the project file (PF – Soil Resources) for additional information about soil conditions and potential erosion.

Deep Creek, Dry Creek, Magpie Creek, and Cave Gulch, all watersheds in the Belts/Dry Range LA, had major burn effects in 2000 (**Table 4-4**). Because of the reduced vegetative cover from burning in these watersheds, increased runoff and sedimentation are occurring until additional vegetation is established. Recovery of normal hydrologic conditions in affected watersheds is expected to occur within two to seven years of the fire. Treatment of weeds in these areas may further reduce vegetative cover for the short-term; however, as the weeds are replaced by native vegetation, the sedimentation problems would diminish.

A combination of grazing, biological, and handpulling methods would be employed to remove weeds on a total of 1,444 acres (Alternatives A and B). These methods would not cause any adverse impacts on water resources because they would only have short-term minimal disturbance to the ground (e.g., ground trampling from grazing animals). Follow-up treatment of some areas with inadequate weed eradication, or areas of new weed infestation, is not expected to cause adverse impacts on water resources because this treatment would be in relatively small areas and would occur over a period of several years after the initial applications.

TABLE 4-4
Calculated Surface Water Flow and Sensitivity Issues by Watershed

Stream[1]	6th HUC [2]	Area in Helena NF[3] (mi^2)	% Drainage Area >6,000 feet[4]	Average Annual Precipitation[5] (inches)	$Q_{.20}$ for Sept.[6] (cfs)	Q_2 [7] (cfs)	Sensitivity Issues[8]
Belts/Dry Range Landscape – 4th HUC No. 10030101 (Upper Missouri River)							
Faulkner Creek	020040	2.97	97.0	25.1	1.13	15.55	
Sherlock Creek	040010	8.46	51.5	21.1	2.34	34.65	
Upper Deep Creek	070010	39.32	55.8	29.1	14.70	134.04	Burn 2000
Upper Deep Creek tributary	070020	11.90	44.9	23.2	3.63	45.77	Burn 2000

TABLE 4-4
Calculated Surface Water Flow and Sensitivity Issues by Watershed

Stream[1]	6th HUC [2]	Area in Helena NF[3] (mi^2)	% Drainage Area >6,000 feet[4]	Average Annual Precipitation[5] (inches)	$Q_{.20}$ for Sept.[6] (cfs)	Q_2 [7] (cfs)	Sensitivity Issues[8]
Middle Deep Creek	070030	5.23	13.8	18.2	1.23	19.12	Burn 2000
Middle Deep Creek tributary	070040	10.59	84.4	34.4	5.55	45.85	Burn 2000
Dry Creek	090040	24.72	41.2	21.3	6.31	85.34	Impaired; Burn 2000
Greyson Creek	090060	8.46	80.3	23.9	2.77	37.38	
Ray Creek	100020	7.12	97.4	35.3	3.98	33.26	Sensitive Fish Spp.
Gurnett Creek	100030	5.10	99.9	37.3	3.16	25.00	
Confederate Gulch	100050	32.07	68.6	32.7	14.31	116.10	Impaired Sensitive Fish Spp.
White Gulch	110010	20.05	33.0	22.1	5.47	68.79	Impaired Sensitive Fish Spp.
Avalanche Creek	110020	35.72	40.1	22.8	9.69	117.08	Impaired Sensitive Fish Spp.
Hellgate Creek	110030	13.33	30.5	20.2	3.34	47.67	
Magpie Creek	110040	24.49	31.5	21.3	6.28	81.36	Impaired; Burn 2000 Sensitive Fish Spp.
Cave Gulch & others	110050	9.04	16.9	17.2	1.87	31.45	Impaired; Burn 2000; 20-25% treatment area; > picloram std.
Upper Trout Creek	160010	30.34	64.1	26.1	10.04	109.43	Impaired
Soup Creek	160020	20.19	23.2	18.7	4.40	65.89	
Lower Trout Creek	160030	23.50	8.9	18.4	4.94	67.55	Impaired; 20-25% treatment area
Oregon Gulch	160040	9.54	2.4	14.2	1.53	28.46	20-25% treatment area; > picloram std.
Favorite Gulch	160060	9.24	0.0	13.0	1.32	26.57	
Missouri River area	160070	3.78	0.0	11.1	0.47	12.20	
Upper Beaver Creek	170010	26.66	60.1	25.6	8.70	96.74	
Hunters Gulch	170020	8.91	50.0	21.2	2.46	36.18	
Middle Beaver Creek	170030	4.04	11.2	14.7	0.72	14.92	
Big Log Gulch	170040	9.76	20.3	17.4	2.05	34.42	
Lower Beaver Creek	170050	17.65	7.2	15.0	2.88	51.78	
Missouri River area	180050	20.91	8.6	16.8	3.93	60.89	
Belts/Dry Range Landscape – 4th HUC No. 10030103 (Smith River)							
Lower Big Birch Creek	020030	3.73	100	35.7	2.24	19.03	
Upper Camas Creek	050010	25.22	94.7	34.9	12.55	99.48	Impaired Sensitive Fish Spp.
Thomas Creek	050020	6.62	12.9	21.6	1.92	23.26	
Benton Gulch	050030	14.93	37.7	25.1	4.96	54.30	
Thompson Gulch	060040	2.56	92.1	29.1	1.21	13.54	Sensitive Fish Spp.
Beaver Creek	060050	14.47	69.2	25.3	4.87	58.17	
Upper Rock Creek	080010	36.21	77.8	28.0	12.98	131.79	
Antelope Creek	080020	14.75	65.4	26.0	5.14	58.62	
Ellis Canyon Creek	080040	16.50	12.0	20.5	4.14	51.15	

TABLE 4-4
Calculated Surface Water Flow and Sensitivity Issues by Watershed

Stream[1]	6th HUC [2]	Area in Helena NF[3] (mi²)	% Drainage Area >6,000 feet[4]	Average Annual Precipitation[5] (inches)	$Q_{.20}$ for Sept.[6] (cfs)	Q_2 [7] (cfs)	Sensitivity Issues[8]
Elkhorn Landscape – 4th HUC No. 10030101 (Upper Missouri River)							
Middle Crow Creek	080020	33.08	78.7	26.3	10.96	122.04	Impaired
Upper Crow Creek tributary	080030	16.16	83.7	25.8	5.54	66.14	Impaired Sensitive Fish Spp.
Middle Crow Creek tributary	080040	7.72	35.2	18.3	1.77	30.29	Impaired; 5-10% treatment area Sensitive Fish Spp.
Johnny Gulch	090030	7.97	100	24.2	2.66	36.85	
Lower Crow Creek	090050	2.54	23.9	16.3	0.55	10.91	Impaired
Indian Creek	090070	9.11	92.7	24.5	3.05	40.86	Impaired
Beaver Creek	100060	32.72	76.9	24.1	9.65	120.44	Impaired Sensitive Fish Spp.
Whitehorse Creek	100070	8.76	71.6	23.9	2.85	37.80	
Warm Springs Creek	120030	17.34	35.8	19.7	4.10	61.37	Sensitive Fish Spp.
Mid Prickly Pear Creek	120050	5.92	54.7	21.4	1.71	25.73	Impaired
McClellan Creek	120070	26.05	42.6	22.4	7.07	89.78	Public water supply for East Helena
Low Prickly Pear Creek	120080	6.03	6.8	14.4	1.02	20.23	
Spokane Creek	160050	5.85	48.8	18.8	1.42	25.02	
Continental Divide Landscape – 4th HUC No. 10030101 (Upper Missouri River)							
Clancy Creek	120040	12.89	84.5	23.4	3.95	54.41	Impaired Sensitive Fish Spp.
Lump Gulch	120060	28.47	45.9	23.4	8.17	98.10	Impaired Sensitive Fish Spp.
Upper Tenmile Creek – south	130010	40.33	69.3	28.3	14.53	141.98	
Upper Tenmile Creek – north	130020	16.61	32.0	16.3	3.05	58.13	
Greenhorn Creek - south	130030	13.69	22.7	16.8	2.66	46.88	
Middle Tenmile Creek	130050	13.18	19.7	15.7	2.36	44.51	Impaired; public water supply for Helena
Lower Tenmile Creek	130070	0.71	0.0	13.0	0.13	2.87	Impaired; public water supply for Helena
Grizzly-Orofino Gulch	150030	14.35	9.1	13.7	2.11	44.06	5-10% treatment area; > picloram std.
Upper Little Prickly Pear Creek – south	190010	16.30	51.6	23.2	4.84	61.53	
Upper Little Prickly Pear Creek – north	190020	17.00	52.0	25.7	5.78	63.89	
Marsh Creek	190050	8.05	60.6	25.5	2.88	34.19	
Continental Divide Landscape – 4th HUC No. 17010201 (Upper Clark Fork)							
Upper Little Blackfoot River – south	060010	28.03	97.4	32.5	12.56	109.60	Impaired TES Fish Spp.

TABLE 4-4
Calculated Surface Water Flow and Sensitivity Issues by Watershed

Stream[1]	6th HUC [2]	Area in Helena NF[3] (mi^2)	% Drainage Area >6,000 feet[4]	Average Annual Precipitation[5] (inches)	$Q_{.20}$ for Sept.[6] (cfs)	Q_2 [7] (cfs)	Sensitivity Issues[8]
Ontario Creek	060020	19.80	96.0	27.6	7.32	80.80	TES Fish Spp.
Telegraph Creek	060030	17.71	81.2	21.7	4.77	71.26	Impaired Sensitive Fish Spp.
Mike Renig Gulch	060040	6.49	84.7	20.8	1.80	29.98	Sensitive Fish Spp.
Upper Little Blackfoot River – north	060050	17.49	62.2	23.0	5.10	67.41	Impaired; 5-10% treatment area TES Fish Spp.
Hope Creek	070010	25.71	74.3	24.1	7.72	97.07	Sensitive Fish Spp.
Dog Creek	070020	7.18	66.9	19.7	1.83	31.44	Impaired Sensitive Fish Spp.
North Trout Creek	070030	5.67	70.2	20.7	1.58	25.82	Sensitive Fish Spp.
Snowshoe Creek	070040	5.72	71.6	21.0	1.62	26.11	Impaired Sensitive Fish Spp.
Elliston Creek	070050	8.87	42.2	17.5	1.89	35.11	Impaired TES Fish Spp.
Ophir Creek	070060	9.11	87.6	21.4	2.54	40.46	Sensitive Fish Spp.
Trout Creek	070070	7.56	78.9	19.5	1.90	33.80	Sensitive Fish Spp.
Spotted Dog Creek - West	080010	0.35	100	23.7	0.15	2.44	Impaired
Spotted Dog Creek - east	080020	9.06	80.2	22.0	2.63	39.69	Impaired Sensitive Fish Spp.
Blackfoot Landscape – 4th HUC No. 17010203 (Blackfoot River)							
Upper Landers Fork	010010	29.13	98.2	42.4	18.62	113.48	Sensitive Fish Spp.
Bighorn Creek	010020	37.38	85.3	35.4	18.29	137.59	Sensitive Fish Spp.
Upper Copper Creek	010030	26.35	75.7	41.5	16.49	99.50	TES Fish Spp.
Lower Copper Creek	010050	13.22	58.0	30.4	5.75	52.25	TES Fish Spp.
Alice Creek	020010	17.64	70.0	35.0	9.08	69.27	Sensitive Fish Spp.
Upper Blackfoot River	020020	15.48	45.9	26.8	5.60	57.74	Sensitive Fish Spp.
Willow Creek	020030	12.35	53.5	26.9	4.58	48.61	Impaired Sensitive Fish Spp.
Upper Blackfoot River tributary	020040	3.47	31.1	26.0	1.37	14.83	
Hogum Creek	020060	11.86	35.2	23.8	3.74	43.99	Sensitive Fish Spp.
Horsefly Creek	020070	6.29	19.5	23.9	2.10	23.35	TES Fish Spp.
Poorman Creek	030010	38.76	58.1	29.3	14.65	133.22	Impaired TES Fish Spp.
Humbug Creek	030020	8.34	35.8	24.3	2.79	32.48	Sensitive Fish Spp.
Keep Cool Creek	030030	20.98	47.3	31.0	9.03	75.58	Sensitive Fish Spp.
Beaver Creek	030040	13.80	39.4	33.5	6.81	51.05	TES Fish Spp.
Willow Creek	030060	9.30	46.3	25.9	3.35	37.11	Impaired Sensitive Fish Spp.
Sauerkraut Creek	030070	7.88	49.7	27.3	3.10	32.48	Sensitive Fish Spp.
Lincoln Gulch	030080	9.14	35.0	25.8	3.28	35.03	TES Fish Spp.
Arrastra Creek	030090	14.46	60.4	33.8	7.21	56.87	Impaired

TABLE 4-4
Calculated Surface Water Flow and Sensitivity Issues by Watershed

Stream[1]	6th HUC [2]	Area in Helena NF[3] (mi²)	% Drainage Area >6,000 feet[4]	Average Annual Precipitation[5] (inches)	$Q_{.20}$ for Sept.[6] (cfs)	Q_2 [7] (cfs)	Sensitivity Issues[8]
							TES Fish Spp.
Moose Creek area	030100	13.41	13.8	22.2	3.81	43.31	Sensitive Fish Spp.
Upper Nevada Creek	040010	28.49	78.8	26.6	9.71	107.21	Impaired TES Fish Spp.
Jefferson Creek	040040	4.26	85.9	28.0	1.83	20.84	Impaired Sensitive Fish Spp.
Buffalo Gulch	040050	7.76	44.6	25.8	2.83	31.51	Sensitive Fish Spp.
Chicken Creek area	040110	6.94	42.9	24.3	2.36	28.44	Sensitive Fish Spp.
Wasson Creek area	040150	7.62	36.0	25.2	2.69	30.03	
Meadow Creek	060010	18.99	84.2	44.1	13.25	76.17	
East Fk Blackfoot River	060030	30.21	85.9	41.6	18.77	114.48	Sensitive Fish Spp.
North Fk Blackfoot River	070040	6.59	46.1	31.5	3.19	27.48	Impaired TES Fish Spp.
Blackfoot Landscape – 4th HUC No. 10030101 (Upper Missouri River)							
Virginia Creek	190040	22.24	68.6	27.2	7.97	84.43	Sensitive Fish Spp.
Blackfoot Landscape – 4th HUC No. 10030102 (Upper Missouri River)							
Mid Fk Dearborn River	030000	7.59	50.4	28.8	3.21	31.52	
S. Fk Dearborn River	040010	8.23	34.9	23.9	2.69	31.96	

[1] See Figures 2 through 5 in Appendix A for stream locations and HUCs (hydrologic unit code).

Fk = Fork; Mid = Middle.

[2] HUC = hydrologic unit code; HUCs reported in this table are 6th-Code.

[3] Drainage areas (A) calculated from 6th HUCs received from Helena National Forest (Helena NF) clipped to the forest boundary.

[4] Elevations derived from USGS National Elevation Dataset 30m DEM; statistics computed using the Zonal Statistics command in ArcInfo Spatial Analyst 8.2. Percent area greater than 6000 feet elevation (HE) was created by reclassifying the DEM to areas <6000 feet and areas >6000 feet; the reclassified grid was vectorized and intersected with the clipped HUCs; areas were recalculated for the resulting theme.

[5] Average annual precipitation (P) from Oregon Climate Center PRISM polygon data; the PRISM data were intersected with the clipped HUCs and areas recalculated; an area-weighted average was calculated to determine average annual precipitation for each watershed.

[6] $Q_{.20}$ = monthly mean streamflow for September exceeded 20% of the years. Calculated using the following regression equation: $Q.20 = 0.00537(A^{0.917})(P^{1.35})$. Used to represent fall-time flows. Source: Parrett et. al, 1989.

[7] Q_2 = flood magnitude for 2-year recurrence interval. The southwest region was used for all watersheds. Calculated using the following regression equation: $Q2 = 2.48(A^{0.87})((HE+10)^{0.19})$. Used to represent spring-time flows. Source: Omang 1992.

[8] "Impaired" means the stream or river segment is on the 1996, 1998, 2000, and/or 2002 303(d) Lists of impaired water bodies in Montana. "Burn 2000" indicates those areas that had significant timber burned within the watershed during 2000. "% Treatment Area" is the portion of the watershed that is proposed for ground and/or aerial weed treatment (see Herbicide in Surface Water section). "> Picloram Std." indicates that mixing modeling shows the resultant picloram concentration in the watershed stream would exceed Montana's surface water standard of 500 micrograms per liter without prescribed EPMs during the fall period only (see Herbicide in Surface Water section).

Source: Montana DEQ 2002b (for impaired status)

Point-Source Impacts

Potential point-source impacts on water resources include leaks and spills of liquid herbicides, and improper storage, handling, or rinsing of herbicide containers. These types of inadvertent releases of chemicals would have the greatest potential to adversely impact

groundwater. Mixing and loading operations would occur in areas where accidental spills would not directly impact a stream or other water body before it could be contained. One of the EPMs previously described in Chapter 2 (**Table 2-4**) states that procedures would be followed for mixing, loading, and disposal of herbicides, as well as a preparation of a spill plan (**Appendix C**). Application of herbicides would be performed by or directly supervised by licensed applicators. These measures are expected to prevent point-source impacts from accidental herbicide releases to water resources.

Impacts on Groundwater

Adverse impacts on groundwater from herbicide application in the Helena NF are not expected, primarily because of the attenuation/degradation factors previously discussed in the "Fate of Herbicide" section of this section. Approximately 1,300 acres, or 6 percent of the proposed weed treatment areas for Alternative A, have soil types that typically have shallow groundwater conditions (see Soil Resources Report in project file; PF – Soil Resources). In these areas of wet meadows, floodplains, and near the streams, the EPMs proposed by the Helena NF in Chapter 2 (**Table 2-4**) would help prevent adverse impacts on groundwater from herbicide application in these areas. Refer to the following section ("Impacts on Water Supply Sources") for a discussion of potential impacts on water supply wells.

Impacts on Water Supply Sources

Two watersheds in the project area are public water supply sources – McClellan Creek in the Elkhorn LA for the town of East Helena, and Tenmile Creek in the Continental Divide LA for the town of Helena (**Table 4-4).** These two watersheds, however, have relatively small treatment areas (less than 3 percent) with respect to total watershed area. Neither of these two watersheds had calculated picloram concentrations in the streams that exceed Montana's water quality standards (see "Herbicide in Surface Water" section). In addition, the diversion locations are located well downstream of the herbicide application areas. Therefore, no adverse impacts on water quality are expected in the two public water supply drainages.

Numerous groundwater supply wells are located in the lower portions of some watersheds in the project area, mostly on private land located near Helena NF property boundaries. Most of these wells are for non-public supply for purposes of irrigation, stock watering, and/or drinking water. Some wells in the Helena NF are located at campgrounds or other facilities that are considered public water supply sources (e.g., Park Lake Campground). These wells are completed in both bedrock and alluvium to a variety of depths. Some public water supply wells are located near Helena NF property, such as at Frontier Town, Marysville House, Great Divide Ski Area, Feathered Pipe Ranch, Camp Child, and town of Elliston School District.

Because of the relatively small treatment areas with respect to total watershed areas, and the distance from herbicide application areas to the places of use, no adverse impacts on groundwater supplies in these watersheds are expected. Designated beneficial uses of all water resources in affected watersheds should be maintained during and after implementation.

ALTERNATIVE B

Alternative B would include all components of Alternative A, but would eliminate aerial application of herbicides. This alternative would result in non-treatment of approximately 3,755 acres. All direct and indirect impacts previously described under Alternative A would be similar for Alternative B with the following exceptions. Because weeds generally have less ground cover than native vegetation, the non-treated areas could have potential for increased runoff, erosion, and sedimentation in affected watersheds. The elimination of aerial application of herbicides would reduce the percentage of treatment area, and thus chemical loading in the chemical mixing calculations, especially for those watersheds that have

greater than 5 percent of the watershed area proposed for herbicide application under Alternative A. An exception is Grizzly-Orofino Gulch, which has only ground methods proposed for weed treatment. Based on results of the chemical mixing calculations previously described in the "Herbicide in Surface Water" section, the same three watersheds (Cave Gulch, Grizzly-Orofino Gulch, and Oregon Gulch) would exceed the picloram standard for surface water.

Due to the predicted exceedance, an EPM was developed to eliminate the potential impacts. Treatment schedules for these drainages would be adjusted (treated in spring, acres reduced, increased timeframe, alternative herbicide) per the EPMs discussed in *Chapter 2* (**Table 2-4**). The EPM should result in no adverse impacts on surface water quality.

ALTERNATIVE C

Under the No Action Alternative, no additional treatment of weeds beyond currently authorized treatment would occur on the Helena NF. Direct and indirect impacts associated with the No Action Alternative (C) would be similar to those described above for Alternative B due to the similarity in treatment methods and acres (18,913 for Alternative B versus 15,871 for Alternative C).

Invasive weeds can reduce infiltration and increase runoff and sediment production because weeds lower basal cover and allow crusting of exposed soil (Lacey *et al.* 1989). Tap-rooted weeds can reduce infiltration because they do not have the dense, fine root system of grasses. Water runoff was 56 percent higher and sediment yield was 192 percent higher on spotted knapweed plots compared to bunchgrass plots during a simulated rainfall period (Lacey *et al.* 1989). Where weeds invade areas along stream channels, riparian vegetative cover can be reduced or eliminated, causing greater stream bank instability. Overall reductions in vegetative canopy cover can also cause increases in stream temperature and decreases in organic matter.

CUMULATIVE EFFECTS

The cumulative effects study area for water resources includes the four landscape areas shown on **Figure 1-1**, as well as the major drainages located immediately downstream of the landscape areas. For the Belts/Dry Range LA, the major drainages include the upper Missouri River, Canyon Ferry Reservoir, Hauser Lake, Holter Lake, and Smith River. For the Elkhorn LA, major drainages include the upper Missouri River and Canyon Ferry Reservoir. Major drainages for the Continental Divide LA are the upper Missouri River and Little Blackfoot River. For the Blackfoot LA, the cumulative effects area includes the upper Blackfoot and upper Missouri Rivers.

Cumulative effects common to Alternatives A and B include additional, relatively minor herbicide loading to the environment. Herbicide application would continue in some areas by the Helena NF, county, and private entities in selected areas immediately surrounding some Helena NF properties. Information regarding the extent this is occurring on private land is limited. Several local agencies were contacted in an attempt to determine the level and location of picloram usage within watersheds in the cumulative effects analysis area. Data are not available on where, how much, or when picloram is used, except in very limited areas.

EPMs are in-place and proposed (**Table 2-4**) that assure direct and indirect impacts from herbicide use are minimized and that water leaving Helena NF lands is of acceptable quality. Herbicide application on other land must also meet acceptable levels of water quality protection. Weed treatments on private land would likely occur more in the valley bottoms where soil conditions are more conducive to infiltration rather than runoff. Many of these lower portions of the watersheds also have greater streamflow, which would allow for more dilution if herbicide was mixed with surface water. Cumulatively, there is a very slight risk that Helena NF and adjacent land

practices would result in adverse impacts on water resources.

Other activities that have affected and would continue to affect water resources on the Helena NF include fires, timber harvest, road building, livestock grazing, continued spread of noxious weeds, and recreational use, including off-road vehicles.

Implementation of Alternatives A and B may reduce negative cumulative effects of weed treatments on the Helena NF, primarily sedimentation. There may be short-term (less than one year) increases in sedimentation until native vegetation is reestablished; however, there would be long-term benefits. Implementation of Alternative C would perpetuate past and present conditions and could lead to a cumulative effect of long-term erosion and elevated sediment levels in streams in those areas of weeds that would not be treated.

CONSISTENCY WITH FOREST PLAN AND OTHER LAWS AND POLICIES

The Proposed Action and Alternatives would be consistent with the following management objectives in the Helena NF Plan: (a) maintain quality of water that currently meets water quality standards by applying accepted soil and water conservation practices; (b) maintain soil productivity and minimize sediment yield by applying soil and water conservation practices; (c) identify the effectiveness of best management practices; and (d) minimize use of chemicals to the extent feasible by coordinating with wildlife, watershed, and fisheries personnel, and using a certified pesticide applicator. The Proposed Action and Alternatives also would meet all water quality standards and maintain beneficial uses of surface water and groundwater resources, assuming implementation of environmental protection measures and other mitigations, as necessary.

WILDLIFE

DIRECT AND INDIRECT EFFECTS

Many of the potential impacts on wildlife would be the same for most, or all, groups of wildlife. Impacts associated with Alternatives A, B, and C include those effects from herbicide application on wildlife (ingestion, inhalation, or dermal) and on habitat; from increased noise and human disturbance; and from weed infestations and the resulting habitat modifications. Impacts common to all wildlife are discussed as well as specific impacts on individual species or groups of species.

EFFECTS COMMON TO ALL ALTERNATIVES

Weed Infestations

The effects of noxious weed infestations on wildlife are typically a result of the loss of suitable habitat and the displacement of native forage. The effects can ripple through the system causing habitat structure changes that can alter ecosystem interactions. Grass and forb production can be reduced, which can negatively affect big game, predators, small mammals, birds, reptiles, and amphibians. Noxious weeds can have detrimental impacts to wildlife, especially big game species that occupy foothill and mountain slopes as important winter range. For example, Spoon *et al.* (1983) estimated that forage loss due to spotted knapweed invasion of big game winter range could cause a decline of 220 elk on the Lolo National Forest within 15 years. Typically, noxious weed infestations are characterized by increased runoff and higher rates of erosion. This sedimentation can negatively affect water quality, aquatic organisms, and all species dependent on water quality (MT Department of Agriculture 1992).

Herbicides

Direct impacts on wildlife would manifest from the potential exposure to various herbicides

and associated chemicals through several routes. Wildlife could come in direct contact with herbicides either internally through ingestion of plants or in a highly diluted form in drinking water; topically through contact with vegetation or direct spraying; or inhalation through breathing direct spray or evaporated herbicide. It must be noted that Alternative C (No Action Alternative) would only use a subset of these including picloram, 2,4-D, glyphosate, and dicamba, and, in specal vegetation projects including fire restoration areas, chlorsulfuron, metsulfuron, and clopyralid.

Human health and ecological risk assessments for the application of herbicides to control noxious weeds and other unwanted vegetation have been prepared for the Forest Service (USFS 1992, USFS 1996c, USFS 1996d, USFS 1997c, USFS 1997d, USFS 1998b, USFS 1998c, USFS 1999b, USFS 1999c, USFS 1999d, USFS 1999e, USFS 2000b, USFS 2001f). The Human Health Risks section of this chapter presents information and discussion on these subjects as they relate to human health. However, that discussion applies generally to wildlife, particularly since toxicity testing is carried out on laboratory animals and not on human subjects.

These risk assessments evaluate the potential for impacts on terrestrial wildlife from exposure to herbicides. There are difficulties (uncertainties) in assessing possible risks because toxicity testing is often performed on laboratory animals, which may not be representative of free-ranging wild animals, or only a few wildlife species are tested. Also, the controlled exposures in the laboratory may not resemble the conditions under which wildlife might be exposed. Possible routes of exposure of terrestrial wildlife to herbicides include direct contact (spray), ingestion of contaminated food items and water, grooming, or indirect contact with contaminated vegetation or substrate. Another limitation is that testing on wildlife species generally includes fewer toxicological endpoints, and lifetime exposure studies are usually not available (Kendall et al. 2001; USFS 1999b)

Given these limitations, ecological risk assessments typically employ exposure estimates that yield conservative assessments of possible risk (i.e., overestimate the potential exposure) (Kendall *et al.* 2001; USFS 1992). The available risk assessments for all considered herbicides generally conclude that under recommended application rates and conditions, the potential risks to individual wildlife are far below toxic levels.

According to a 1992 risk assessment (USFS 1992), estimated exposures exceed high risk only under extreme assumptions for one species, the long tail vole, during the use of 2,4-D, dicamba, and triclopyr. The wildlife risk assessment was considered to overstate potential risks from pesticide exposure because many of the assumptions used were quite conservative. For instance, no degradation of herbicides was assumed to occur and all sprayed herbicide was assumed to be biologically available. Doses were calculated based upon multiple exposure routes including oral, dermal, and through inhalation. Typical dose estimates for all herbicides and carriers/additives were below USEPA low risk criterion (less than 1/5 LD_{50}) for all species. Extreme case exposure analysis resulted in moderate to high risk (e.g., moderate to high likelyhood of adverse effects on wildlife populations or communities) of toxic effects for several species from several herbicides or carriers/additives. The risk assessment concluded that the low probability of extreme exposures and rapid degradation of the herbicides in the environment preclude the possibility of significant adverse effects on wildlife populations or communities.

At the highest anticipated application rate (8 oz. per acre) and under conservative assumptions of exposure, sulfometuron methyl may cause short-term and probably transient changes in the blood in mammals that consume vegetation primarily. Nonetheless, the possibility of adverse reproductive effects in some potentially sensitive species cannot be dismissed. These

qualifications and uncertainties cannot be resolved with the available data (USFS 1998c). The Helena NF anticipates applying the chemical at an application rate of 2 oz. per acre or less. Small mammals consuming vegetation treated with triclopyr immediately after application could suffer impaired kidney function (USFS 1996d). These extreme-exposure cases are unlikely and there are no available data to determine their feasibility. Another extreme scenario suggested that birds might suffer reproductive effects and possibly overt signs of toxicity, if granules of hexazinone were consumed immediately following application. Again, the plausibility of that type of risk is questionable (USFS 1997d).

Field studies attempt to address exposures to organisms outside the highly controlled environment of a laboratory. The complexity of natural systems confounds interpretations of cause-and-effect relationships in wildlife and human health studies and is exemplified by the subject areas of carcinogenic effects of herbicides (Blair 1996; Ecobichon 2001) and endocrine disruption (Rogers and Kavlock 2001; National Academy of Sciences 1999; Carey and Bryant 1995). While some of these effects have been either associated or identified with members of the general chemical group of "pesticides", the chemicals typically implicated are fat-soluble insecticides or other chemicals unrelated to the herbicides being considered for this application (Blair 1996; National Academy of Sciences 1999). There is little evidence to suggest that the application of the proposed herbicides at the anticipated rates of application would induce such effects (USFS 1992; USFS 1996c; USFS 1996d; USFS 1997c; USFS 1997d; USFS 1998b; USFS 1998; USFS 1999b; USFS 1999c; USFS 1999d; USFS 1999e; USFS 2000b; USFS 2001f).

Of wildlife species, amphibians are potentially the most sensitive to herbicides because of their complex life cycles and more permeable skin. Almost all amphibians require moisture to complete their life cycle, and most are aquatic in their egg or larval stages. Hall and Henry (1992) summarized the status of studies to assess the effects of pesticides on reptiles and amphibians. They concluded that too little is known to determine if safety standards for other kinds of vertebrates are or are not adequate for reptiles and amphibians.

Carey and Bryant (1995) discussed a number of pathways through which amphibians could be impacted by environmental contaminants. They state "while a variety of results have been obtained (concerning amphibian tolerance levels of various environmental toxicants) because of the number of species, life stages, and techniques used, the literature suggests that adult and larval amphibians are not necessarily more sensitive to chemicals than other land or aquatic vertebrates." They caution, however, that toxicants need not be directly lethal to impact amphibians. Sub-lethal concentrations of some contaminants may increase susceptibility of larvae to disease; increase predation of larvae by impacting swimming ability, or by retarding growth rates. In particular, they point out that "endocrine-disrupting toxicants can have effects at tissue levels well below detectable levels," and that "toxicants designated as safe should not be considered to be free of endocrine-disrupting effects until proven otherwise."

The potential for herbicides to act as hormonally active agents and cause endocrine disruption in humans has been discussed under the Human Health Risks section of this chapter. Recently, Vincent *et al.* (2001) observed elevated serum testosterone and leuteinizing hormone (LH) levels in forest pesticide applicators (spraying 2,4-D) at the height of the application season. While these hormone levels were not of clinical concern and the sample size was small, the results suggest that 2,4-D may have potential to interact with the endocrine system. Triazine herbicides can affect the reproductive system by interfering with androgen synthesis (Thomas and Thomas 2001). A recent study (Hayes *et al.* 2002) reported that atrazine, also a triazine herbicide, can inhibit testosterone and induce estrogen secretion in frogs, and affect sexual development. Reported effective doses (≥ 1 ppb) were below the EPA drinking water standard (3 ppb) for atrazine.

However, it is not clear if similar effects are induced by hexazinone (see below), which is also a triazine herbicide.

These recent studies raise suspicion regarding the potential for some herbicides to be hormonally active. However, there is currently no evidence indicating that the herbicides considered for application would pose risks to wildlife at the recommended application rates and expected exposure levels. It should also be noted that the Forest Service would use an adaptive management approach for managing weeds. New information regarding herbicides and their effects would be used to reduce effects should they become evident.

Picloram

Picloram is the active ingredient in a number of herbicide formulations including Tordon®, Grazon®, and Pathway®. Tordon K®, Tordon 22K®, and Grazon PC® are picloram salt formulations and inert ingredients, primarily water and dispersing agents. Tordon RTU® and Grazon P+D® include picloram and 2,4-D salts as well as inert ingredients (Tu *et al.* 2001, Infoventures 1995i). Picloram can stay active in soil for relatively long periods of time, maintaining toxicity to plants for up to three years. The half-life can vary from one month to three years (Tu *et al.* 2001) though long-term buildup in soil generally does not occur. Carbon dioxide is the major end product of breakdown of picloram (Infoventures 1995i).

Picloram is almost non-toxic to birds, relatively non-toxic to bees, and low in toxicity to mammals. Mammals excrete most picloram residues unchanged and it does not bioaccumulate in animal tissue. Formulated products are generally less toxic than picloram (Infoventures 1995i).

Tu *et al.* (2001) and Infoventures (1995i) report an acute oral LD50 for rats for picloram of greater than 4,000 milligrams per kilogram (mg/kg). LD50s were reported to be greater than 2,500 and 5,000 mg/kg for mallard ducks and the bobwhite quail, respectively. The acute dermal LD50 in rabbits was reported to be greater than 2,000 mg/kg. In laboratory test with rabbits, picloram was not shown to be a skin irritant, but was a moderate eye irritant. Weight loss and liver damage in mammals has been reported following long-term exposure to high concentrations of picloram. Picloram is classified as a Class E carcinogen, a compound having evidence of non-carcinogenicity (Felsot 2001). Picloram showed no evidence of birth defects in rats or rabbits, and it was negative in two tests for mutagenicity (Infoventures 1995i).

Male mice receiving picloram at dietary doses of 1,000 to 2,000 mg/kg/day over 32 days showed no clinical signs of toxicity or changes in blood chemistry, but females did show decreased body weight and increased liver weights. Liver effects were also seen in rats at very high doses of 3,000 mg/kg/day over an exposure period of 90 days, and above 225 mg/kg/day for 90 days. Dogs, sheep, and beef cattle fed low levels of picloram for a month experienced no toxic effects. The ester and triisopropanolamine salt showed low toxicity in animal tests (OSU 1996d). Based on these studies, picloram does not appear to cause genetic damage or birth defects, has little or no effect on fertility and reproduction, and is not carcinogenic (Infoventures 1995i, Felsot 2001).

There have been some concerns expressed that picloram acts synergistically with 2,4-D or other ingredients to cause chronic effects on wildlife. There is some evidence that high concentrations of picloram and 2,4-D esters (fat soluble) (note: 2,4-D proposed for use by the Forest is an amine formulation, which is water soluble) have an additive, but not synergistic, effect, as they can accumulate in the body. Picloram and 2,4-D are both rapidly excreted in an unchanged form by mammals, reducing the risk of their interaction. In one study, a test group of sheep was fed a single dose of picloram (72 mg/kg) and 2,4-D (267 mg/kg) and others were fed a mixture of 7.2 mg/kg of picloram and 27 mg/kg 2,4-D for 30 days. There was no evidence of toxicity in any of these sheep (Dow 2001).

No adverse effects on endocrine activity have resulted from numerous studies conducted on mammals and birds to determine picloram

toxicity values. The evidence indicates that the endocrine system in birds and mammals is not affected by exposure to picloram at expected environmental concentrations (DOW 2001).

One byproduct in the manufacture of picloram is hexachlorobenzene (HCB). As there has been some concern that HCB is carcinogenic, the USEPA has required that there be a maximum concentration of 100 ppb in picloram. The manufacturer of Tordon has set its own limit at 50 ppb (50 micrograms per liter of formulation). In practice, the formulation is further diluted by a factor of 350 for spraying (Felsot 2001). As a result, residues of picloram after spraying do not contain more HCB than background levels (Felsot 2001).

2,4-D

The formulation proposed for use in this application is the amine salt. 2,4-D is not considered persistent in soil. It may remain active for up to six weeks, though it ultimately metabolizes into harmless products (Infoventures 1995k). The average half-life of 2,4-D is 10 days in soil and less than 10 days in water, dependent upon other factors (e.g., temperature, soil condition) (Tu *et al.* 2001). The toxicity of 2,4-D varies by form of the chemical and organism. In fish, ester formulations tend to be more toxic, while amine salts are practically non-toxic. In birds, 2,4-D ranges from being virtually non-toxic in its butyl ester form to moderately toxic as an amine salt. Mammals are moderately sensitive to exposure. It is relatively non-toxic to bees. Most LD50 values for 2,4-D range from 300-1000 mg/kg, though sensitivity varies greatly between animal groups and chemical form (Infoventures 1995k, Ecobichon 2001, Tu *et al.* 2001).

Studies in rats suggested 2,4-D was not cancer causing, though liver damage was seen at relatively low dosages. Pregnant rats showed no evidence of birth defects, though fetuses showed evidence of toxic effects. No effect on reproduction or fertility has been demonstrated in rats and 2,4-D did not cause genetic defects in most studies (Infoventures 1995b). While an association between 2,4-D exposure and canine malignant lymphoma has been reported (Hayes *et al.* 1991), a causal mechanism was not identified. In a recent review of 2,4-D epidemiology and toxicology, Garabrant and Philbert (2002) concluded that the evidence that 2,4-D might be carcinogenic was "scant."

2,4-D does not bioaccumulate in wildlife (Trevathan 2002). Risk to browsing wildlife however, appears to be low, as do risks to forging raptors. A study in Oregon after aerial spraying found concentrations on forest browse plants to be below those able to cause effects in mammals (Tu *et al.* 2001). Acid and salt formulations of 2,4-D have been shown in laboratory studies on rabbits to be eye irritants (Infoventures 1995k). In humans, 2,4-D has been found to rapidly distribute within the body with the greatest concentrations appearing in the kidneys and liver (Tu *et al.* 2001), which may also be the case for wildlife species.

Glyphosate

Glyphosate itself is an acid, but is commonly used in isopropylamine salt form. When applied to foliage it is quickly absorbed by the leaves and rapidly moves through the plant. It acts by preventing the plant from producing an essential amino acid. Glyphosate is metabolized by some plants, while others do not break it down. Glyphosate would remain in soil unchanged for a varying length of time depending on soil texture and organic matter content. Half-life of glyphosate is reported to be from 3 to 130 days (Infoventures 1995a). Soil microorganisms break down glyphosate and the surfactant used in Roundup to carbon dioxide.

Glyphosate is reported to be non-toxic, with a reported oral LD50 of 5,600 mg/kg in the rat, and over 10,000 mg/kg in mice rabbits, and goats (OSU 1996f). Toxicity of technical grade acid of glyphosate and Roundup® are nearly the same. The oral LD50 for the trimethylsulfonium salt is reported to be about 750 mg/kg in rats, which indicates moderate toxicity (OSU 1996f). Acute dermal LD50 for glyphosate and isopropylamine salt are reported to be >5,000 mg/kg, and the dermal LD50 for

the trimethlysulfonium salt are reported to be >2,000 mg/kg.

Studies of glyphosate lasting up to two years have been conducted with rats, mice, dogs, and rabbits, and with few exceptions no effects were observed (OSU 1996f, Infoventures 1995a, USFS 1996e). Some test have shown reproductive effects may occur at high doses (over 150 mg/kg/day), but there have been little to no reports of mutagenic, developmental, or carcinogenic effects. In humans, Glyphosate has been classified as a mild to moderate irritant to the skin and eyes, and although there are no data indicating that it causes sensitization in either animals or humans (USFS 1996e).

Hexazinone

Hexazinone is a triazine herbicide that acts by inhibiting photosynthesis. It is generally chemically stable, highly soluble in water, and relatively insoluble in various organic solvents. It has been reported that half of the applied dose is lost in soil after one to six months depending on climate and soil type (OSU 1996g). Hexazinone is broken down by soil microbes and sunlight. Hexazinone does not evaporate to any appreciable extent, and it can leach through the soil to the root zone.

Hexazinone has a low order of acute toxicity; however, it can cause serious and irreversible eye damage. In rats, the LD50 was reported at 1,690 mg/kg (OSU 1996g). Other LD50 reported for hexazinone are 860 mg/kg for guinea pigs and 3,400 mg/kg for beagle dogs. The LD50 for rabbits is reported to be greater than 5,278 mg/kg.

Studies of chronic toxicity of hexazinone in mammals show it to have a low order of chronic toxicity. Rats given moderate doses of hexazinone in their food for two weeks showed no evidence of cumulative toxicity (OSU, 1996g). Rats and dogs fed high doses of the compound for 90 days showed only slight decreased body weights. Very high doses did not appear to effect hamsters, and caused only increased liver weights in mice. It is generally not considered to be a reproductive, mutagenic, or carcinogenic compound based on chronic toxicological studies. Consumption of hexazinone granules by birds immediately after application could lead to reproductive effects or overt toxic effects. However, the plausibility of this risk is questionable, since there are no data indicating birds consume hexazinone granules (USFS 1997d).

Chlorsulfuron

Chlorsulfuron is absorbed by the leaves and roots and acts by preventing the plant from producing an essential amino acid. It is generally active in soil, and has a greater affinity to adsorb to soils having a higher organic content. It tends to leach in permeable soils, with leaching being reduced in soils having a pH of less than 6. Chlorsulfuron is degraded by soil microbes. The half-life has been reported from one month in slight acidic soils to three months in alkaline soils (Infoventures 1995c). It does not easily evaporate, and it is relatively soluble in water.

Chlorsulfuron has a low order of acute toxicity; with oral LD50 levels in the male and female rat, bobwhite quail, and mallard duck reported to be >5,000 mg/kg (Infoventures 1995c). The acute dermal LD50 has been reported to be >3,400 mg/kg. It is considered to be a mild irritant to the skin and a moderate eye irritant.

Chlorsulfuron is not considered to be a reproductive, mutagenic, or carcinogenic compound. Infoventures (1995c) reports that rats fed up to 5,000 ppm per day for up to two years did not show evidence of carcinogenicity. Teratology studies of rats and rabbits showed no evidence of developmental effects. A three-generation study in rats show slight decreased fertility at the highest does of 2,500 ppm, but no decrease in fertility was observed at doses up to 500 ppm. In their mutagenic tests, Chlorsulfuron did not cause genetic damage.

Dicamba

Dicamba is the active ingredient in Banvel® formulations. It is moderately persistent in soil, with a half-life of 1 to 6 weeks. Breakdown is slower with low soil moisture and low temperatures. The main metabolite of dicamba

breakdown in soil is 3,6-dichlorosalicylic acid (Infoventures 1995e).

Dicamba is slightly toxic to mammals, non-toxic to birds, non-toxic to bees, and does not bioaccumulate. Based on results of animal studies dicamba does not cause birth defects, cancer, or genetic damage (Infoventures 1995e). Exposure to dicamba has been associated with reproductive and possibly neurotoxic effects in laboratory animals (USFS 1996c). However, ecological risk assessment suggests no plausible or substantial effects to terrestrial or aquatic animals (USFS 1996c). Concentrated solutions of dicamba have been shown to cause eye irritation in rabbits, which is a common test species for ocular effects. The extent to which actual formulations may cause dermal or ocular irritation during normal use cannot be determined from the available data, however. In addition, moderate dermal sensitization was observed in guinea pigs after contact with a 10 percent solution of dicamba (USFS 1996c).

The manufacturing process for dicamba has the potential to result in trace amounts of 2,7-dichlorodibenzo-p-dioxin as a contaminant. It may be present in concentrations up to 50 parts per billion (ppb). The dioxin isomer, 2,3,7,8-tetra-chlorodibenzo-p-dioxin has not been found at the limit of detection (2 ppb) and is not expected as an impurity in dicamba (Pesticide Management Education Program 1983).

Sulfometuron methyl

Sulfometuron methyl is a broad spectrum urea herbicide that works by blocking cell division in the active growing regions of the stem and root tips. It is generally active in soil, and is broken down by microbes, hydrolysis, and sunlight. It has been reported that half of the compound degraded within 30 days in silt loam soils (OSU 1996h) reports a field half-life for sulfometuron methyl in the range of 20 to 28 days. It is more strongly adsorbed to acidic soils and soils with a high organic content than to alkaline soils or soils with low organic content. Sulfometuron methyl is practically insoluble in water, and it mainly decomposes to carbon dioxide (Infoventures 1995j).

Sulfometuron methyl is a slightly toxic compound. The oral toxicity of this compound is very low, reported to have oral LD50 levels in rats of >5,000 mg/kg. (OSU 1996h) Acute toxicity LD50 values for the bobwhite quail and mallard duck were reported to be <5,000 mg/kg, respectively (Infoventures 1995j). The acute dermal LD50 has been reported to be >2,000 mg/kg in female rabbits, and >8,000 mg/kg in male rabbits. It is considered to be a mild irritant to the skin and a moderate eye irritant.

Some immunological toxic effects have been reported with chronic exposure to sulfometuron methyl in test animals. Dogs have experienced reduced red-blood cell counts and increased liver eights at exposures of 25 mg/kg/day for a year (OSU 1996h). USFS (1998c) also reported reduced red-blood cell counts and increased liver weights at does of 50 mg/kg/day. While there is some concern of reproductive and teratogenic effects from exposure to sulfometuron methyl in laboratory animals, the results of the studies are somewhat unclear (USFS 1998c. Infoventures (1995j) and OSU (1996h) report that sulfometuron methyl is unlikely to pose a mutagenic, carcinogenic or reproductive risk to animals and humans.

Metsulfuron methyl

Commercial formulations of metsulfuron methyl (Escort®, Ally®) contain 60 percent metsulfuron methyl and 40 percent inert ingredients. Metsulfuron is water-soluble and remains in the soil unchanged for varying lengths of time, depending on soil type and moisture availability. The half-life can range from 120 to 180 days. Soil microorganisms and chemical hydrolysis break it down (USFS 2000bInfoventures 1995h).

Metsulfuron methyl is practically non-toxic to birds, mammals, invertebrates, and bees (USFS 2000b). Acute oral LD50 was greater than 5000 mg/kg in rats and 2000 in mallard ducks; acute dermal LD50 was greater than 2000 mg/kg in rabbits (Infoventures 1995h). Based upon the results of animal studies, metsulfuron

methyl is not classified as a carcinogen, mutagen, teratogen, or reproductive inhibitor (Infoventures 1995h, USFS 2000b). The primary adverse effect from exposure to metsulfuron methyl appears to be weight loss (USFS 2000b).

Clopyralid methyl

Commercial formulations of clopyralid such as Reclaim®, Stinger®, and Transline® contain approximately 41 percent clopyralid, and 59 percent inert ingredients (water, isopropyl alcohol, and a surfactant) (USFS 1990c). It may be persistent in soils with low microorganism content. The half-life can range from 15 to 287 days depending upon soil type and climatic conditions (Infoventures 1995d).

Clopyralid is relatively non-toxic to birds, mammals and bees (USFS 1999c. It does not bioaccumulate in animal tissue. The acute oral toxicity in rats was LD50 greater than 4300 mg/kg (relatively non-toxic). In rabbits, clopyralid had a dermal LD50 of greater than 2000 mg/kg (relatively non-toxic). Clopyralid caused slight skin irritation and eye irritation in rabbits. Rats showed no adverse effects after four hours of exposure to concentrations of 1.3 mg/L in air (Infoventures 1995d).

Clopyralid showed no evidence of oncogenicity in a two year feeding study in mice or rats at the highest dose tested. It showed no evidence of developmental toxicity in mice and rabbits at the highest dosage tested. No effects on reproduction were observed in study of two generations of rats at the highest dose tested. No evidence of mutagenicity was observed in a number of laboratory studies on mice and rats. Based on the results of these animal studies, clopyralid is not classified as a carcinogen, teratogen, mutagen, or reproductive inhibitor (Infoventures 1995d).

Technical grade clopyralid methyl is contaminated with hexachlorobenzene and pentachlorobenzene at average concentrations of < 2.5 ppm and <0.3 ppm, respectively (USFS 1999c.). Hexachlorobenzene is potentially carcinogenic. However, because of the small proportion of hexachlorobenzene in clopyralid, the amount released into the environment from USFS programs contributes little to the background levels of hexachlorobenzene in the environment (USFS 1999c).

Triclopyr

Triclopyr is a pyridine and works by disturbing plant growth. It is absorbed by green bark, leaves, and roots and moves to the meristem (growth region) of the plant. It is active in soil, and is rapidly broken down by microbes, particularly in warm climates. The average half-life of the compound in soils is 46 days, with a range of 30 to 90 days (Infoventures, 1995b) in natural soil and aquatic environments, the ester and amine salt formations convert to the acid, which is neutralized to a non-toxic salt.

Triclopyr is a slightly toxic compound. The oral LD50 levels in rats have been reported in the range of 630 to 729 mg/kg (OSU 1996a). Acute toxicity LD50 values for mammals are reported to be 310 to 713 mg/kg, and ducks were reported to have an oral LD50 of 1,698 mg/kg (Infoventures, 1995b). The acute dermal LD50 has been reported to be >2,000 mg/kg in rabbits. Triclopyr is considered to be a slight irritant to the skin and eye.

Studies summarized in OSU (1996a), Infoventures (1995b) and USFS (1996d) indicated that triclopyr does not pose a carcinogenic, mutagenic, reproductive, developmental risk to animals or humans at doses anticipated for this project.

Imazapyr

Imazapyr is absorbed by the leaves and roots, and moves rapidly through the plant. It acts by accumulating in the meristem region and disrupting protein synthesis by interfering with cell growth and DNA synthesis. Unlike most other herbicides proposed for use by the forest, it can remain active in soil for six months to two years. (Infoventures 1995g) It has a strong affinity to bind to soils and is commonly found in the top few inches of the soil. As such, it has a low potential for leaching to groundwater, but may reach surface water during storm events over recently treated land. Imazapyr is broken

down by sunlight and microorganisms. Very little is lost by evaporation.

Imazapyr is practically non-toxic to mammals and birds (Infoventures 1995g; USFS 1999e). In birds, the LD50 was reported to <2,150 mg/kg and in mammals between 4,800 and 5,000 mg/kg (Infoventures, 1995g). Imazapyr has not been found to be mutagenic and there has been no evidence to support developmental effects. Imazapyr can cause irritant effects in the skin and eyes (USFS 1999e). The EPA has classified imazapyr as a Class E compound, one having evidence of non-carcinogenicity. Under typical and conservative worst-case exposure assumptions, the evidence suggests that no adverse effects would be expected from the application of imazapyr (USFS 1999e).

Imazapic

Imazapic is essentially non-toxic to terrestrial mammals, birds, amphibians, aquatic invertebrates, and insects (Tu *et al.* 2001, USFS 2001f)). It has a half-life of seven to 150 days, depending on soil type and climatic conditions. It is degraded primarily by soil microbial metabolism. It does not bioaccumulate in animals, as it is rapidly excreted in urine and feces (Tu *et al.* 2001).

The oral LD50 of imazapic is greater than 5,000 mg/kg for rats and 2,150 mg/kg for bobwhite quail, indicating relative non-toxicity by ingestion. The LD50 for honeybees is greater than 100 mg/bee, indicating that imazapic is non-toxic to bees. Imazapic is non-irritating to eyes and skin, even in direct applications. The inhalation toxicity is very low. Chronic consumption in rats for two years and in mice for 18 months elicited no adverse effects at the highest doses administered. Chronic consumption by dogs for one year caused minimal effects (Tu *et al.* 2001, USFS 2001f).

Imazapic may be mixed with other herbicides such as picloram or 2,4-D. Combining imazapic with other herbicides should not increase the toxicological risk over that of either herbicide when used alone (Tu *et al.* 2001).

Inert Ingredients

Herbicide manufacturers add inert ingredients (or "other ingredients") to enhance the action of the active ingredient. Inert ingredients may include carriers, surfactants, preservatives, dyes, and anti-foaming agents among other chemicals. Inert refers to any ingredient that is not intended to affect the target species and does not convey any information regarding the toxicity of the chemical (USEPA 2003). Many manufacturers consider the inerts in their herbicide formulations to be proprietary and do not list specific chemicals. "The lack of disclosure of specific inert ingredients indicates that none of the inerts present at a concentration of 0.1% or greater is classified as hazardous" (USFS 2001f). Listed inert ingredients for the herbicides formulations being considered include water, ethanol, isopropanol, isopropanolamine, kerosene, polyglycol 26-2, and polyoxyethylamine ((USFS 1992, USFS 1996c, USFS 1996d, USFS 1997c, USFS 1997d, USFS 1998b, USFS 1998c, USFS 1999b, USFS 1999c, USFS 1999d, USFS 1999e, USFS 2000b, USFS 2001f)). None of these chemicals are listed as Level 1 or Level 2 compounds (i.e., "Inert Ingredients of Toxicological Concern" or "Potentially Toxic Inert Ingredients", respectively) (USEPA 2003). Although there is some concern regarding the toxicity of polyoxyethylamine (POEA), a surfactant included in a formulation of glyphosate (Ecobichon 2001; USFS 1996e), there is no anticipated increase in toxicity of the glyphosate formulation as a result of POEA (USFS 1997c, USFS 1996e).

Phase II®

A risk analysis for Phase II®, the only additive/surfactant proposed for use on portions of the Forest (see Chapter 2), has not been performed. A MSDS exists for Phase II®, which provides a brief overview of the properties and effects of the chemical formulation; however, the information provided references human impacts and not those for wildlife. Although there is limited information available about the effects of this chemical formulation, by applying Phase II® at the

recommended application rate of 1-4 pints per 100 gallons, the toxicity of the formulation would be well below levels that could impact wildlife.

Summary

These risk assessment studies point to the potential for the proposed herbicides to cause a number of impacts including impaired kidney function, reproductive problems, eye irritation, and non-target plant impacts. Establishing effects thresholds is usually performed on rabbits and rats and then potential impacts on various other species are inferred. The problem with this type of analysis is that specific thresholds for a particular species are never truly quantified. Therefore, any data compiled that states exact toxicities of a given herbicide on a group of animals must be weighed in relation to the physiological similarities of the species in question and the species used in the testing. In addition, the concentrations used in testing are typically comprised of at least 50 percent chemical. When actually implementing an herbicide application plan, concentrations come nowhere near these levels. Formulations of the proposed herbicides would likely be anywhere from tens to thousands of times below those resulting in impacts on animals, and often, concentrations would be similar to those experienced as background levels.

Although there remains considerable uncertainty relative to potential herbicide effects, aquatic organisms, including eggs and larvae of amphibians, could be directly exposed to herbicide formulations in water as well and could be impacted. The degree of exposure however, would be extremely low based on recommended application rates already far below levels where impacts begin to surface. In addition, further dilution of the formulation by the water it enters would result in concentrations several hundred, or thousand times below scientifically established tolerance levels.

- To determine the degree of impact on wildlife from herbicides, several factors need to be considered.
- Twelve herbicides are being considered for use. Each may have a different impact on different species or groups of species;
- The proposed application rate of herbicide applied to an area;
- The persistence of the herbicide in the environment; and,
- The geographic extent of the proposed application.

Although there has been some concern regarding the synergistic effects associated with interactions between various chemicals (including herbicides), no evidence of synergistic effects with other chemicals has been demonstrated for any of these herbicides. No chronic effects analyses on terrestrial animals had been performed for glyphosate or triclopyr (Infoventures 1995a and b), nor have any recent studies involving chronic toxicity to wildlife been conducted. Various herbicide formulations have the potential to cause eye and skin irritation in the context of splash or spill scenario. The potential for eye and skin irritation to wildlife from normal application, while still possible, is expected to be less than that described above due to the reduced concentration of herbicide in a spray scenario when compared to a spill or splash scenario.

A risk analysis of various herbicides to terrestrial wildlife species prepared for the USFS (USFS 1992) considered toxicity, potential dosage through various routes (ingestion, inhalation, dermal), and length of exposure to a number of vertebrate wildlife species and concluded that potential risks for most wildlife species are low for most herbicides and surfactants using recommended application rates. Risk was moderate to high for only a few species and a few herbicides under extreme situations that would not occur under typical application scenarios.

Considering that most of the proposed herbicides are either non-toxic or of low toxicity to birds, mammals, and insects, none of those tested have been proven to cause cancer, birth defects, genetic defects, or problems with

fertility or reproduction. There is no evidence of synergistic effects or hormone disruption from any of these chemicals. Considering that the dosages after dilution with water are far below (often thousands of times below) concentrations of these chemicals that have demonstrated any level of acute or chronic toxicity in tests performed, it is very unlikely that any birds, mammals, or insects would be affected herbicide use following recommended application rate procedures (Infoventures 1995a-k). Triclopyr, while considered a moderately toxic compound does not pose a carcinogenic, mutagenic, reproductive, developmental risk to animals or humans at doses anticipated for this project (OSU 1996a; Infoventures 1995b; USFS 1996d).

The herbicides being considered for use have shown low to no toxicity for most animal groups, including insects, and EPMs (**Table 2-4**) are in place to minimize herbicide delivery into aquatic habitats. Therefore, it is unlikely that the proposed herbicide use would be toxic to amphibians.

Based on lack of data and uncertainty relative to herbicide effects on amphibians, there is the potential for an un-quantifiable negative impact on amphibians from herbicide application. However, because the extent and distribution of proposed treatment areas is relatively small, and if impacts from herbicides do occur on a local basis, amphibian populations as a whole are not expected to be negatively affected.

Table 4-5 summarizes potential ecological effects of the 12 herbicides and Phase Surfactant.

Effects on Vegetation Structure From Herbicides

Direct and indirect impacts on vegetation structure depend on the specific treatment used, including the particular herbicide, the rate of application, and the season of application. Direct impacts of herbicide application would be a change in composition of weeds, other forbs, grasses, and shrubs in treatment areas. As discussed in the *Vegetation* section of this Chapter, non-target plants could be damaged by unintentional application, drift, or residual soil activity of herbicides. These short-term impacts to plant composition and community diversity would likely be offset within as little as three years, as native forbs recover. There would be no long-term loss of species diversity of native vegetation due to the proposed treatments, and species composition under most treatments is expected to resemble native plant assemblages within one to three years (Rice *et al.* 1997a). For additional discussion relative to vegetation, see *Vegetation* in this chapter.

EFFECTS COMMON TO ALTERNATIVES A AND B

Increased Human Activity and Noise

Human disturbance would increase in treatment localities, generally of short duration. Use of helicopters under Alternative A would increase disturbance from noise due to over-flights along access corridors to and from treatment areas and in the treatment areas themselves. Portions of three days of disturbance in each treatment area would occur due to preparation, application, and monitoring activities.

Disturbance from vehicles, including trucks, off-highway-vehicles, and humans on horseback or foot would increase under both alternatives A and B during the periods of treatment if either Alternative were implemented. Ground application under Alternative B would result in an estimated three to five times the duration of disturbance than Alternative A.

Effects of noise on wild animals can be classified as those affecting auditory physiology and sensory perception, those affecting behavior, and those affecting populations (Bowles 1995). Noise levels are expected to marginally increase with helicopter activity around the subject treatment areas for a very short period of time. As a result of increased human activity and noise from operation vehicles and activities, some animals might be locally displaced near treatment areas during the period of treatment activity; however, due to the brief duration of

TABLE 4-5
Effects of Each of the 12 Herbicides and Phase Surfactant

Herbicide	Carcinogen (Cancer)	Teratogen (Birth Defects)	Mutagen (Genetic Damage)	Reproductive Inhibitor	Skin Irritant	Eye Irritant	Bio-Accumulate	Toxicity To Birds	Toxicity To Bees	Toxicity To Mammals	Target Plants
Picloram	No	No	No	No	Mild	Moderate	No	Almost non-toxic	Relatively non-toxic	Low	Broadleaf plants, brush, conifers and broadleaf trees
2,4-D	Not tumor causing; kidney damage at low doses	No	No	No	Mild to Moderate	Corrosive	No	Non to moderate based on form	Relatively non-toxic	Moderate	Broadleaf weeds, grasses and other monocots, woody plants, aquatic weeds, and non-flowering plants
Dicamba	No	No	No	Little to No	Mild	Corrosive	No	Non-toxic	Non-toxic	Slight	Broadleaf weeds, brush and vines
Metsulfuron methyl	No	No	No	No	Moderate	Moderate	No	Non-toxic	Non-toxic	Non-toxic	Brush and woody plants, annual and perennial broadleaf weeds, and annual grassy weeds
Glyphosate	Not enough information to determine	No	No	No	Mild	Mild to Moderate	No	Non-toxic	Non-toxic	Non-toxic	Grasses, herbaceous plants, brush, some broadleaf trees and shrubs, and some conifers.
Hexazinone	No	No	No	No	Mild	Corrosive	No	Non-toxic	Relatively non-toxic	Non-toxic	Broadleaf weeds, grasses, and woody plants
Sulfometuron methyl	No	No	No	Observed at maternally toxic doses	Mild	Moderate	No	Slight	No Info Available	Slight	Grasses and broadleaf weeds
Triclopyr	No	No	Not enough informatio n to determine	No	Mild to Moderate	Mild to Moderate	No	Very Low	Non-toxic	Slight	Woody plants and broadleaf weeds
Clopyralid methyl	No	No	No	No	Mild	Moderate	No	Low	Non-toxic	Low	Brush and weed species, broadleaf plants, thistle
Chlorsulfuron	No	No	No	No	Mild	Moderate	No	Non-toxic	Non-toxic	Non-toxic	Broadleaf weeds and some annual grass weeds
Imazapic	No	No	No	No	Non-irritating	Non-irritating	No	Non-toxic	Non-toxic	Non-toxic	Annual and perennial boadleaves and grasses
Phase (Surfactant)	Not listed by NTP, IARP, or ACGIH	Unknown	Unknown	Unknown	Yes, from MSDS	Yes, from MSDS	Unknown	Unknown	Unknown	Specific levels unknown	Used as an additive/surfactant in herbicide formulations
Imazapyr	Not enough information to determine	No	No	Not enough information to determine	Moderate	Moderate	No	Non-toxic	Low	Non-toxic	Grass and broadleaved weeds, brush, vines, many deciduous trees

the exposure, they would likely quickly resume their normal behavior after treatment were complete. Fluctuation noise levels may elevate heart rate, catecholamine levels, and corticosteroid levels in wild animals, but these elevated levels are generally of short duration, and animals often habituate to these disturbances over time. Short-term increases in these measures do not correlate well with actual stress experienced by animals (Bowles 1995). Disturbance associated displacement, if it occurred, would reduce the risk of herbicide exposure of displaced individuals. Along access corridors to multiple spatially similar treatment areas, the coming and going of weed treatment vehicles, personnel, equipment, and helicopters (under Alternative A) may displace wildlife for a longer period (on the order of weeks rather than days), however duration of disturbance would be much less than for areas aerial treated when compared to ground-based methods. Typically, the duration of traffic along these corridors would be limited to a few days and once complete, wildlife would return to these areas.

There is a potential for negative impacts on nesting raptors including goshawks, peregrine falcons, red-tailed hawks, golden eagles, and bald eagles fromhelicopters or other disturbance during nesting, though implementation of EPMs as described in Chapter 2 (e.g., helicopters would avoid by ¼ mile, known raptor nesting territories when flying to and from treatment sites and timing) would reduce this potential.

Grazing

Sheep and goat grazing would decrease the negative consequences of noxious weed infestations on wildlife although the livestock introduced to control weed populations would likely include some native plants in their diet. Sheep and goat grazing may displace some wildlife during the treatment period and could reduce forage in the treatment area for the treatment year (MT Dept. of Agriculture 1992).

Biocontrol

Biocontrol proposed on the Forest would decrease the negative impacts of weed infestation on wildlife by utilizing insects to impact the specific weed species they target. It is anticipated that there would be minimal or no direct or indirect effect on wildlife across the Forest from the introduction of insects as part of a biocontrol method of treatment (MT Department of Agriculture 1992).

Handpulling

Handpulling across the Forest would result in minimal impact on wildlife. Increased human activity in target treatment areas would occur, and result in short-term local avoidance of these areas by some wildlife species.

EFFECTS ON INDIVIDUALS OR GROUPS OF SPECIES

ALTERNATIVE A

Management Indicator Species

Based on habitat distribution and use, and its proximity to proposed treatment areas, the majority of MIS would be at low risk of coming in contact with herbicides.

Elk, Bighorn Sheep, and Mule Deer

The condition of winter range on the Forest is generally considered key for ungulate populations and winter ranges are often at high risk to invasion by weeds. Because various treatment areas occur on both summer and winter ranges across the Helena NF, implementing Alternative A would positively impact elk, bighorn sheep, and mule deer in the long-term due to the improvement of forage availability and the associated increase of carrying capacity (Rice *et al*. 1997a) post-treatment, primarily on winter range. As discussed in Chapter 3, approximately 80 percent of mapped weed acres lie within mapped winter range in the Belt, Blackfoot, and Elkhorn landscapes; and approximately 50 percent lie within mapped winter range in the Divide Landscape (PF-*Wildlife*).

It is possible that elk, bighorn sheep, and mule deer may consume vegetation that has been treated with herbicide, but due to their size and the extremely low toxicity of the herbicides when the proposed application rates are used, there is little potential for direct impacts. Also EPMs would be implemented that treat ungulate winter ranges during the summer months only. Direct and indirect negative effects on elk, bighorn sheep, and mule deer populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above.

Noise and other disturbances from aerial applications by helicopter may disturb these ungulate populations for a short time (one to three days), though these impacts would not persist. The greatest negative impacts on elk, bighorn sheep, and mule deer could occur to females if they are disturbed during or shortly after calving during May and June.

In order to minimize disturbances to these ungulate populations, winter range sites would be treated while the elk, sheep, and deer are occupying their summer ranges. Likewise summer range sites would be treated either in early spring or late fall to avoid disturbing the majority of these animals. Where these ranges overlap (e.g., for some deer populations), the potential for weed treatment activities to disturb the animals during the treatment period would exist.

Bighorn sheep would experience no effect as a result of treatment operations due to their preference of summer habitats that are remote, rocky, and generally above intense weed infestation areas. In those higher elevation areas that have weed infestations and are also preferred by the bighorn sheep, noise and visual harassment impacts from helicopters may occur, though these would be short-term (one day).

Grazing, biocontrols, and handpulling would have little to no effect on elk, bighorn sheep, or mule deer populations. In the short-term, grazing of goats and sheep may compete for suitable forage in very limited areas, though the expected increase in long-term forage production in those areas treated would offset any small scale impacts to non-target vegetation. To avoid the potential spread of disease, grazing by domestic sheep would not occur within known wild sheep range. Biocontrol insects proposed for use on the Forest are so highly specialized to target noxious weed species of interest they would not negatively impact ungulate populations.

Marten

Alternative A would treat approximately 1,700 acres of the 247,000 acres of modeled martin habitat across the Forest, representing less than one percent of marten habitat. The likelihood therefore, of marten inhabiting areas proposed for treatment is low. Marten generally avoid open grassland areas and areas with open tree canopies. Marten typically select continuous blocks of mature cover that are comprised of mesic late-successional spruce/fir and lodgepole pine stands, particularly those with complex cover near the ground (USFS 1999a). In addition, marten use riparian areas for foraging and travel. Based on the proposed riparian aerial spray buffers around open water and the fact that noxious weeds typically do not dominate in potential marten habitat (see *Affected Environment*), negative impacts to marten are likely to be minimal.

Direct and indirect negative effects on marten populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above. In areas that are proposed for grazing, biocontrols, or handpulling, impacts to pine marten would not occur.

Pileated Woodpecker

Alternative A would treat 830 acres (approximately one percent) of the 68,700 acres of modeled pileated woodpecker habitat on the Forest. Impacts to pileated woodpeckers from herbicide exposure would therefore, not likely occur. Negative impacts on pileated woodpeckers from increased human activity, noise, and weed treatment operations under Alternative A are also unlikely due to the

paucity of activity proposed within modeled habitat. Because the weed treatment operations would be of short duration (one to three days every three years), pileated woodpeckers would likely resume their natural behavior within one day of any disturbance.

Direct and indirect negative effects on pileated woodpecker populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above. In areas that are proposed for grazing, biocontrols, or handpulling, no effect on pileated woodpeckers would occur.

Hairy Woodpecker

Alternative A would treat approximately 3,660 acres (approximately two percent) of noxious weeds within the 205,500 acres of modeled hairy woodpecker habitat. Because hairy woodpeckers would not typically occur on proposed treatment sites, they are unlikely to be impacted by the implementation of Alternative A. Negative effects on hairy woodpeckers from increased human activity, noise, and weed treatment operations under Alternative A are also unlikely. In the event that weed treatment operations occur on suitable habitat (e.g., in recently burned areas), their ability to flee disturbances would minimize effects. In addition, treatment operations would be of short duration (one to three days every three years) and minimal; therefore, hairy woodpeckers would quickly resume their natural behavior.

Direct and indirect negative effects on hairy woodpecker populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above.

In areas that are proposed for grazing, biocontrols, or handpulling, no effect on hairy woodpeckers would occur.

Northern Goshawk, Bald Eagle, and Grizzly Bear

Each of these species is addressed in the *Threatened, Endangered, Proposed, and Sensitive Species* section below.

Threatened, Endangered, Proposed, And Sensitive Species

Grizzly Bear

Grizzly bears would not be negatively impacted by the implementation of Alternative A. It is possible that grizzly bears may consume vegetation that has been treated with herbicide, but due to their size and the extremely low toxicity of the herbicides when the proposed application rates are used, there would be no potential for direct impacts.

Direct and indirect negative effects on grizzly bear populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above.

Alternative A would likely maintain or improve the forage base for grizzlies. Grizzlies tend to eat carrion after emerging in the spring and the potential for increased carrying capacity and forage base for ungulate species would indirectly benefit the grizzly bear during the spring.

Alternative A would not result in the construction of new roads or change the current management of open or closed roads; therefore, increased segmentation of grizzly habitat and an increase in open road density across the forest would not occur.

In areas that are proposed for biological control or handpulling, no effect on the grizzly bear would occur.

Gray Wolf

Gray wolves would not be negatively impacted by the implementation of Alternative A. Because wolves depend heavily on ungulate species for prey, they would likely experience a positive indirect effect from the implementation of Alternative A. Because the noxious weed control program under Alternative A would increase the forage base and carrying capacity for ungulates, wolves would likely experience an increase in their prey base.

Direct and indirect negative effects on gray wolf populations attributable to herbicide exposure

are expected to be minimal. See *Effects of Herbicides on Wildlife* above.

In areas that are proposed for grazing treatments, it is possible that the wolves may take grazing animals as prey. In order to avoid this scenario, an EPM that requires coordination with USFWS would be implemented.

In areas that are proposed for biological control or handpulling, no effect on gray wolves would occur.

Bald Eagle

As discussed in the *Affected Environment*, bald eagle activity on most areas of the Forest is probably limited to overflights, rest stops at scattered perch sites, and foraging on carrion – particularly in spring and fall (USFS 1998a). Bald eagles may occasionally forage on carrion, particularly big game, within some of the proposed treatment areas. None of the proposed herbicides have any detrimental effects on mammals or birds, other than the potential for most herbicides to cause eye irritation in test animals and for 2,4-D to bioaccumulate in some animals. It is possible that bald eagles may consume contaminated prey, although the impact of this would be marginal due to the extremely low toxicities of the herbicides when applied at standard application rates, and the wide ranging foraging behavior of eagles and other raptors which would likely result in little risk of exposure through bioaccumulation. Implementation of EPMs under Alternative A would prevent herbicides from entering water and moving downstream from the treatment areas. Therefore, it is unlikely that bald eagles would ingest any herbicides or residues, and little likelihood of there being any negative impact on eagle health. The potential for or the extent of eye irritation impacts to individual eagles is difficult to assess due to uncertainties relative to potential exposure du4ring spray operations. EPMs relative to spray and disturbance buffers around occupied eagle nests would likely minimize the potential for direct spry exposure of eagles. Direct and indirect negative effects on bald eagle populations attributable to herbicide exposure are expected to be minimal. Negative effects on bald eagle habitat are also expected to be minimal.

Negative impacts on bald eagles from increased human activity, noise, and weed treatment operations under Alternative A are unlikely. In the event that weed treatment operations occur on habitat used by the bald eagle, their ability to flee disturbances would likely minimize effects. In addition, treatment operations would be of short duration; therefore, bald eagles would quickly resume their natural behavior.

Direct and indirect negative effects on bald eagle populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above.

In areas that are proposed for grazing, biocontrols, or handpulling, no effect on the bald eagle would occur.

Canada Lynx

Alternative A would treat approximately 3,680 acres of the 433,770 acres of modeled lynx habitat on the Forest, representing less than one percent of modeled habitat. Therefore, lynx are unlikely to occupy many of the areas proposed for treatment. Treatment operations could cause brief localized disturbance to snowshoe hare and other small mammal populations on which the lynx relies; however, lynx presence at these sites is unlikely and thus, the lynx would be minimally impacted. Implementation of Alternative A would likely maintain or increase the lynx prey base, where treatment occurred within lynx habitat, and result in a positive impact in the long-term. The potential for non-target vegetation, specifically shrubs, to be impacted in some areas, is discussed in the *Vegetation* section, could indirectly impact local snowshoe hare habitat use. Based on the relative proportion of lynx habitat compared to proposed treatment areas, the likelihood of impact to lynx across the Forest due to indirect impacts to local hare populations would be immeasurable.

Alternative A would not result in the construction of new roads or change the

current management of open or closed roads; therefore, impacts associated with segmentation of lynx habitat or an increase in open road density across the forest would not occur. Alternative A is not expected to change existing lynx habitat. An increase in human activity and disturbance associated with the proposed project may temporarily disturb lynx, though most proposed treatment areas are at elevations below preferred lynx habitat. A disturbance created by a spray truck on a road, or a mule/applicator on a trail is well within the existing, current level of disturbance.

Direct and indirect negative effects on lynx populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above. In areas that are proposed for grazing, biological control, or handpulling, no effect on the lynx would occur.

Black-backed Woodpecker

Based on habitat modeling conducted by the Helena NF, approximately 37,000 acres of black-backed woodpecker habitat are estimated to exist on the Forest, with modeled habitat only occurring in the Belt Landscape. Within the Belt Landscape, 1,430 acres of weed infestation are located in black-backed woodpecker habitat, which represents approximately four percent of the 37,000 acres of modeled habitat. The Divide, Elkhorn, and the Blackfoot landscapes contain no modeled black-backed woodpecker habitat, though based on the species' habitat needs, they likely occur throughout the Forest. This comparison of mapped habitat with known weed infestation areas for the Belt Landscape indicates that a relatively low percentage of black-backed woodpecker habitat has potential for weed treatment activities, with the majority of these areas being associated with recent burns.

Alternative A would treat approximately 1,430 acres (four percent) of the 37,000 acres of mapped black-backed woodpecker habitat (recent burns in the Belt Landscape) on the Forest. No other black-backed woodpecker habitat on the Forest has been mapped, though endemic populations likely exist in older forest stands in all landscape areas.

Ideal habitat on the Forest for the black-backed woodpecker is typically associated with fire-disturbed locations. The fact that these burned areas are also prone to invasion from noxious weed species results in the possibility for impacts on them. Although some treatment areas overlap with black-backed woodpecker habitat, the ability of these birds to flee disturbance from weed control operations would reduce the potential for effects to this species. In addition, weed control operations would generally be of short duration; therefore, black-backed woodpeckers would quickly resume their natural behavior.

Direct and indirect negative effects on black-backed woodpecker populations attributable to herbicide exposure are expected to be minimal. The potential for eye irritation from direct spray of herbicide is possible, though there remains uncertainty as to the severity and duration of the impact, should direct spray occur. See *Effects of Herbicides on Wildlife* above.

In areas that are proposed for grazing, biocontrols, or handpulling, no impact to black-backed woodpeckers would occur.

Boreal Toad

Boreal toads are found in a variety of habitats from valley bottoms to high elevations on the Helena NF. They breed in lakes, ponds, and slow streams with a preference for shallow areas with mud bottoms. Due to the uncertainties associated with effects of herbicides on amphibians, impacts to boreal toads have the potential to occur. Herbicide treatments are unlikely to directly affect adults, as dosages would be extremely low at standard application rates as well as of short duration. With the proper recommended application rate of herbicides and the implementation of the riparian aerial spray buffers around open water resources under Alternative A (see EPMs), the likelihood of direct negative impacts on adult boreal toads is unlikely.

Indirect impacts, if any, would be the result of exposure of eggs and larvae to waterborne chemical residues resulting from herbicide spraying. However, herbicide application would follow application guidelines, which are well below tolerance levels for most species (Infoventures 1995a-k). In addition, efforts would be made to keep all herbicides out of water (as described in Chapter 2). If herbicides were introduced into water resources, any potential residues would be diluted even further; therefore, while there remains some uncertainty relative to herbicide impacts to amphibians, adverse effects on boreal toads, eggs, or larvae are expected to be minimal.

Spot treatment up to the water's edge would likely further reduce potential for impacts on the boreal toad. Although the potential for impacts on individuals exist, the boreal toad population as a whole would not be affected.

In areas that are proposed for grazing, biocontrols, or handpulling, no effect on boreal toads would occur.

Fisher

Fishers are rare on the Helena NF. Fisher habitat primarily consists of continuous stands of mature and old-growth grand fir, cedar, and hemlock stands below 6,300 feet in elevation. They usually inhabit forested lands within 1,000 feet of riparian areas which they use extensively for foraging, resting, and as travel corridors.

The likelihood of fisher inhabiting areas proposed for treatment is low. Because of the implementation of a riparian aerial spray buffer around open water under Alternative A, and the fact that noxious weed species typically do not dominate landscapes preferred by the fisher, negative impacts on the fisher are expected to be minimal.

Direct and indirect negative effects on fisher populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above.

In areas that are proposed for grazing, biocontrols, or handpulling, no impact fishers would occur.

Flammulated Owl

Alternative A would not treat any weeds within modeled flammulated owl habitat (see *Affected Environment*). Because most of the potential flammulated owl habitat on the Forest consists of mature to old-growth pine/fir stands which have a dense understory of seedling, sapling, pole, and mature conifers and little grass/shrub understory (USFS 1997a), and due to the fact that mapped noxious weed infestations do not occur in these areas, it is unlikely that the flammulated owl would be impacted by the implementation of Alternative A. In the event that flammulated owl habitat did receive herbicide treatment, the potential for non-target shrub/sapling vegetation to be impacted would exist (see Vegetation), which could indirectly impact the owl's insect prey in those areas until the vegetation re-established (approximately 1-3 years). The flammulated owl's tendency to be active at night and twilight reduces their chance of being impacted by weed control activities. Negative effects on flammulated owls from increased human activity, noise, and weed treatment operations under Alternative A are unlikely. In the event that weed treatment operations occur on habitat used by the owl, their ability to flee disturbances would minimize effects. Moreover, treatment operations would be short duration; therefore, flammulated owls would quickly resume their natural behavior.

Direct and indirect negative effects on flammulated owl populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above.

In areas that are proposed for grazing, biocontrols, or handpulling, no effect on flammulated owls would occur.

Northern Leopard Frog

Northern leopard frogs are found in or near non-forest habitats, inhabiting dense sedge, wet-meadow, or cattail marshes. Under Alternative

A, these areas would be protected by the imposition of a riparian aerial spray buffer around open water resources.

Due to unertainties associated with effects of herbicides on amphibians, impacts to the leopard frog have potential to occur. Herbicide treatments are unlikely to directly affect adults, as dosages would be extremely low at standard application rates and of short duration. With the proper recommended application rate of herbicides and the implementation of the riparian aerial spray buffer around open water, the likelihood of direct negative impacts on adult leopard frogs is unlikely.

Indirect impacts, if any, would be the result of exposure of eggs and larvae to waterborne chemical residues resulting from herbicide spraying. However, herbicide application would follow application guidelines, which are well below tolerance levels for most species (Infoventures 1995a-k). Moreover, as described in Chapter 2, efforts would be made to keep all herbicides out of water. If herbicides were introduced into water resources, any potential residues would be diluted even further; therefore, no adverse effects on leopard frogs, eggs, or larvae are anticipated.

Spot treatment up to the water's edge would likely further reduce potential for impacts on the leopard frog by minimizing overspray and drift. Although the potential for impacts on individuals exist, the leopard frog population as a whole would not be affected.

In areas that are proposed for grazing, biocontrols, or handpulling, no effect on leopard frogs would occur.

Northern Bog Lemming

Across the Helena NF, only marginal fragments of suitable habitat for the bog lemming are present (USFS 1998a). Where they do exist, the implementation of a riparian aerial spray buffer around water (including wetlands and bogs) would likely prevent the lemmings from being directly impacted. There is a possibility that the lemmings could eat tainted leaf material shortly after treatment activities; however, the number of individuals likely to do so are limited and thus, impacts of implementing Alternative A would be minimal.

Direct and indirect negative effects on northern bog lemming populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above.

In areas that are proposed for grazing, biocontrols, or handpulling, no effect on northern bog lemmings would occur.

Peregrine Falcon

Peregrine falcon eyries are found primarily on cliffs near water. They typically select waterfowl and other birds as prey.

For peregrine falcon, the implementation of Alternative A may indirectly maintain or improve their forage base. In peregrine falcon habitat areas with weed infestations, increased human activity, noise, and visual harassment impacts from helicopters may occur, though these would generally be extremely short-term (one to three days). Their ability to flee disturbance activities associated with weed control operations would minimize potential for effects such as direct spraying; however, if peregrine falcons are repeatedly disturbed, they may abandon the nest. The potential for eye irritation if falcons come into direct contact with spray would exist, though the likelihood of direct spray to adults is expected to be low. The potential for direct spray to nestlings would be low as well, due to implementation of EPMs as described in Chapter 2.

Direct and indirect negative effects on peregrine falcon populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above. In areas proposed for grazing, biocontrols, or handpulling, no effect on peregrine falcons would occur.

Townsend's Big-eared Bat

On the Helena NF, big-eared bats are most closely associated with caves, cliffs, and rock outcrops of sedimentary origin (often limestone); however, they are extremely rare.

They also make use of abandoned mine adits, as well as hollowed trees and snags in old-growth forests. They are extremely sensitive to human presence at sites where they are roosting or caring for young.

Townsend's big-eared bats are insectivorous, feeding primarily on small moths typically higher in the forest canopy than most bats; although they occasionally glean beetles, flies, and insects from leaves. It is possible that the bats may prey upon spray-tainted insects; although, due to the extremely low toxicities of herbicides when applied at recommended rates, it is unlikely the Townsend's big-eared bat would be affected. Moreover, direct exposure from herbicides would be doubtful based on this animal's nocturnal lifestyle and the fact that they roost in protected areas generally associated with mine adits, caves, trees, and outcrops.

Direct and indirect negative effects on Townsend's big-eared bat populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above.

In areas proposed for grazing, biocontrols, or handpulling, no impact to Townsend's big-eared bat would occur.

Wolverine

Wolverines are solitary animals, ranging widely over a variety of habitats. Wolverine home ranges can be as large as 150 square miles in Montana. Isolation from human impacts and a diverse prey base seem to be the most important habitat components. Wolverines feed primarily on rodents and carrion, although they are opportunists, and would consume berries, insects, fish, birds, and eggs when available. Wolverines seldom eat vegetation.

Due to the elusive nature of wolverines, it is unlikely they would be impacted by weed control activities. In areas proposed for treatment under Alternative A, ability of wolverine to flee disturbance would minimize negative impacts. Because a large part of wolverine diet consists of rodents, and due to the fact that rodents would likely experience a mid-term increase in habitat and forage, it is likely wolverines would experience an increased prey base. Because wolverines do not typically consume vegetation, they would not be impacted by short-term reduction in vegetative forage.

Direct and indirect negative effects on wolverine populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above. In areas proposed for grazing, biocontrols, or handpulling, no impact to wolverines would occur.

Northern Goshawk

Alternative A would treat approximately 3,160 acres (approximately one percent) of weeds within the 278,000 acres of the Forest's modeled goshawk habitat. Northern goshawks are associated with old-growth mixed conifer and deciduous woodland, often in mountainous terrain. Its nesting habitat is typified by a dense overstory of large trees and an open understory of grass and shrubs, often near clearings. Because most lower to mid-elevations on the Forest are suitable habitat for goshawks, and because weed treatment operations under Alternative A involving helicopters are proposed on lands that are suitable goshawk habitat, disturbance, which could cause goshawks to abandon their nests (see Chapter 2) would be minimized by employing appropriate EPMs during treatment activities in or near occupied goshawk habitat. Because of the relatively low percentage of goshawk habitat that would be treated and the implementation of EPMs, the effects on goshawks from implementing Alternative A would be minimal.

Direct and indirect negative effects on northern goshawk populations attributable to herbicide exposure are expected to be minimal. See *Effects of Herbicides on Wildlife* above. The potential for eye irritation if goshawks come into direct contact with spray would exist, though the likelihood of direct spray to adults is expected to be low. The potential for direct spray to nestlings would be low as well, due to

implementation of EPMs as described in Chapter 2.

In areas that are proposed for grazing, biocontrols, or handpulling, no effect on northern goshawks would occur.

Birds

Avian species including raptors, game birds and waterfowl, landbirds, and neotropical migratory species would experience minimal effects from the implementation of Alternative A. Although the primary foods taken by these various avian species on the Forest are quite variable, no direct effect is anticipated as a result of proposed treatments operations. Indirect effects to birds associated with impacts to non-target vegetation (shrubs, small trees) may occur, which could locally impact bird habitat at least for the one to three year period before re-establishment

Implementation of Alternative A would maintain or improve most landbird and game bird foraging opportunities as an indirect positive effect. Because increased forage for landbirds and game birds would result under Alternative A, those raptor species that prey upon them would also experience an indirect positive effect. Very few waterfowl nest on the Helena NF. With the implementation of the riparian aerial spray buffer around all water, impacts on these species are not likely. In addition, all avian species are capable of fleeing disturbances, which would further reduce negative effects on them, including the potential for eye irritation resulting from direct spray; therefore, the effects of weed treatment activities are not likely to negatively impact most avian species.

No direct or indirect negative effects on avian populations attributable to herbicide exposure are expected. See *Effects of Herbicides on Wildlife* above.

Grazing, biocontrols, and handpulling would have little to no effect on most avian species. Grazing of goats and sheep may cause brief disturbance to landbird species such as grouse, and may cause local reduction in non-target vegetation due to non-selective grazing; however, improvements to habitat used by these species would occur in the long-term, as additional habitat with the necessary structure and diversity would be created. Biocontrol across the Forest would specifically target the noxious weed species of interest. Because most avian species do not typically forage on the target weed species as a primary browse, little competition would occur and no effect would result. Handpulling on the Forest would contribute a minimal impact through disturbance to birds as crews are mobilized to subject infestation sites. While crews are treating infestations, avian species would tend to abandon the area; once infestations are treated, most avian species would quickly return.

Reptiles and Amphibians

There is no evidence that properly applied herbicides are detrimental to adult amphibians (Carey and Bryant 1995). Amphibian species including long-toed salamander, Rocky Mountain tailed frog, boreal toad, Pacific chorus frog, Columbia spotted frog, and the leopard frog would not be adversely impacted by Alternative A. Several species are affiliated with riverine or riparian habitats including Rocky Mountain tailed frog, boreal toad, northern leopard frog, and the spotted frog. Herbicide treatments are unlikely to directly affect adults, as dosages would be extremely low at standard application rates and of short duration. With the proper recommended application rate of herbicides and the implementation of the riparian aerial spray buffer around open water resources, the likelihood of direct negative impacts on adult amphibian species is unlikely.

Indirect impacts, if any, would be the result of exposure of eggs and larvae to waterborne chemical residues resulting from herbicide spraying, as there remain uncertainties with regard to the potential impacts of herbicides on eggs or larvae. However, herbicide application would follow application guidelines, which are well below tolerance levels for most species (Infoventures 1995a-k; Tu *et al.* 2001). Moreover, efforts would be made to keep all

herbicides out of water (e.g., riparian spray buffer to minimize risk of spray drift, hand application via spot treatment within riparian spray buffers). If herbicides were introduced into water resources, any potential residues would be diluted. While no adverse effects on amphibian species are anticipated, there may still be impacts to local populations due to unknown impacts to eggs or larvae. Impacts that affect Forest-wide amphibian populations are not anticipated.

Reptile species including western skink, northern alligator lizard, common garter snake, western terrestrial garter snake, racer, rubber boa, western rattlesnake, and gopher snake would not likely be impacted by the implementation of Alternative A. Reptiles unlike amphibians are not directly tied to water resources and are known to inhabit a rather wide variety of habitat types. Many reptiles utilize rodent and insect species, as well as grasses and forbs for food. Reptile species that inhabit the Forest may be negatively impacted by the spread of noxious weeds, and therefore implementation of Alternative A would maintain or improve their forage base. The potential mid-term increase in the amount of suitable habitat for rodent species would result in an improved prey base for carnivorous reptiles including snakes. Omnivorous reptiles would likely experience a mid-term increase in their forage base due to the replacement of noxious weed dominated communities with native vegetation.

In areas that are proposed for grazing, biocontrols, or handpulling, no effect on reptiles or amphibians would occur.

ALTERNATIVE B

Implementing Alternative B would eliminate aerial spraying of proposed treatment areas. Generally, this would limit the effects of noise and visual harassment on wildlife from helicopter use and would, in instances of difficult access or in areas with safety concerns for ground based treatment, likely cause specific weed populations to expand, migrate, and continue to cause land degradation, increased runoff and erosion, and loss of habitat and forage availability across the Forest.

Elimination of aerial spraying would reduce the probability of direct herbicide application to some wildlife, and reduce the potential for aerosol ingestion or inhalation of herbicide by some wildlife. It would also reduce the possibility of herbicide application outside of proposed treatment areas due to potential drift from helicopters. Wildlife living in areas to be ground treated would still be exposed to herbicide on vegetation, through skin contact and/or ingestion, as well as increased disturbance from human and vehicle activity; however, due to the extremely low toxicity of the herbicides when applied at the recommended application rate, no effect would result. For specific effects on wildlife, please see *Effects of Herbicides on Wildlife* section above.

Implementation of Alternative B would decrease the already low risk of impacts on some species of wildlife from contact with herbicides and from disturbance from helicopters. Indirect negative impacts include potential loss of prey base for bald eagle, grizzly bear, gray wolf, lynx, wolverine, northern goshawk, and peregrine falcon as weed infestations spread in untreated areas. Those species that depend on native vegetation as suitable forage would also be affected by the implementation of this alternative.

Overall, under Alternative B, there would be effective weed treatment on approximately 19,000 acres of currently infested areas. Because treatments methods are all ground-based, the duration of human disturbance associated with mobilization, treatment, and monitoring would be greater on those areas proposed for aerial treatment (approximately 6,600 acres) under Alternative A.

ALTERNATIVE C

Under Alternative C no additional control of noxious weed populations beyond the current annual control program of treating approximately 16,000 acres would occur.

Impacts to wildlife would include those negative impacts associated with continuing loss of grass and forb cover, forage quantity and quality, and vegetative diversity in the approximately 6,600 infested areas that would not be treated by Alternative C. Less human disturbance from noise, vehicles, and ground personnel associated with weed treatment would occur than for either Alternative A or B.

If Alternative C were implemented, changes in vegetation composition in infested areas not proposed for treatment would be long-term, and would negatively impact most wildlife species. Approximately 3,150 acres of untreated winter range of elk, mule deer, and bighorn sheep would continue to decline in condition, decreasing the carrying capacity, and ultimately causing a decline in populations of these species (Bedunah and Carpenter 1989). The indirect effects of ungulate population declines would in turn cause a decrease in populations of predatory carnivores that depend on ungulates for prey.

Some small mammal populations, particularly those inhabiting grasslands and meadows (e.g., voles), would be reduced as weedy species reduce grass and forbs cover and composition, and forage base. In some instances, small mammal species composition changes as native vegetation is replaced by weeds. Numerous studies demonstrate reduced numbers and/or diversity in birds, reptiles, small mammals, and insects in stands of non-native plant species (Huenneke 1996). Boreal toads utilize upland habitats for part of the year; therefore, they could be negatively impacted by the spread of noxious weeds and the loss of grass and forbs cover and diversity as well. Avian populations would be negatively impacted, including many neotropical migrant species dependent on grasslands, meadows, and shrub for nesting and foraging. Habitat for grouse, particularly brood habitat, would be reduced, potentially affecting grouse populations.

This alternative would allow weed infestations to intensify and spread on approximately 6,600 acres of weed-infested sites that would be treated under Alternative A, but not Alternative C. Loss of vegetative cover and species diversity in these areas would indirectly affect the species discussed above, as well as directly affect those species whose prey base may be reduced by an increase in weed infestations. Those species include gray wolf, bald eagle, black bear, grizzly bear, mountain lion, lynx, wolverine, peregrine falcon, and northern goshawk.

Predators of all affected wildlife would also be impacted negatively. These predators include gray wolf, bobcat, red fox, bears, lynx, weasels, owls, hawks, eagles, and falcons. Predators would be negatively impacted by the spread of noxious weeds based on their utilization of ungulates and small mammals for prey, and ungulate carrion in spring. With the lack of an intensified treatment program, infestations would continue to increase and spread thereby reducing carrying capacity and lowering forage production and ungulate populations that would indirectly affect predators.

CUMULATIVE EFFECTS

Cumulative impacts common to Alternatives A and B would include the negative impacts of herbicide exposure (minimal for most or all species) combined with exposure to other environmental impacts and contaminants such as non-quantified but potentially negative impacts from herbicide use on private or state land. Additionally, other activities with the potential to disturb wildlife (road and trail construction, timber management, wildfire suppression) could result in a cumulative or additive impact to those direct and indirect impacts described above.

Other past activities that have impacted wildlife on the Forest include widespread fires in the early part of the twentieth century, followed by nearly 100 years of fire suppression, which has changed the structure and distribution of vegetation on the Helena NF; trapping and poisoning, which directly reduced specific species numbers; timber harvest and road building especially in the second half of the twentieth century; livestock grazing throughout much of the Forest; and the invasion of noxious

weeds onto the Forest. Livestock grazing on wildlife summer and winter ranges has increased the probability of weed invasions in many areas through several avenues, including direct spread of seeds, decreasing vigor of some plants through localized overgrazing, and creating areas of bare or disturbed soil through hoof action. Past and ongoing activities that have occurred on private or other land off-Forest include development, forest fire ignition, fire suppression, and dispersed and developed recreation.

Recreational use of the Forest has also influenced the invasion and spread of weeds, as well as recreation related disturbance to wildlife. Projects recently implemented by the Forest which both negatively and positively impacted wildlife populations and/or habitats relative to this project include road closure projects, road obliteration projects, trail and road relocation, Off Highway Vehicle management, Burn Area Rehabilitation Projects, allotment management planning, forest thinning and underburning, vegetation management, and weed control.

Foreseeable future impacts on wildlife could result from increased recreation on public lands, including an increase in off-highway-vehicles such as snowmobiles and 4-wheelers, an increasing potential for catastrophic fire, suppression activities associated with fire, and continued spread of noxious weeds.

Increased disturbance from traffic associated with weed treatment operations in Alternatives A and B would add to traffic throughout the Forest and on adjacent land.

Implementation of Alternatives A or B would reduce cumulative negative effects of weed invasions on wildlife inhabiting the Forest and adjacent property in the long-term (> three years). These reductions would include those currently ongoing and reasonably foreseeable impacts to wildlife habitat structure and composition (primarily in grasslands) and big game forage. Alternative A would have the greatest positive impact on long-term forage production and ecological health, followed by Alternative B.

Implementing Alternative C would not address negative impacts to wildlife from weed infestations on the Forest and adjacent properties relative to the approximately 6,600 acres of un-treated area. Weed infestations on the Forest not currently being treated would be allowed to spread under Alternative C. Long-term effects of expanded noxious weed communities would result in large tracts of degraded land with little to no native vegetation structure. Ungulate species would experience a reduced forage base and associated carrying capacity and may inevitably suffer population declines. The problems related to noxious weed infestations would intensify in the future and the increased erosion and runoff from a lack of ground cover would negatively impact water quality resulting in negative impacts on aquatic species and amphibians. Shrub, grass, and forbs structure would be lost from infestation sites leading to a reduction in suitable habitat for birds, small animals, and ungulate species on those acres not being treated as well as in areas resulting from spread of those weed infestations. Eventually, an irreversible negative effect would be reached beyond which species and habitat may be lost permanently.

CONSISTENCY WITH FOREST PLAN AND OTHER LAWS, REGULATIONS AND POLICIES

ALTERNATIVE A

Under Alternative A, all actions relating to wildlife effects are consistent with the Helena Forest Plan, National Forest Management Act, Migratory Bird Treaty Act, Endangered Species Act, and other laws, regulations, and policies. Implementation of Alternative A would assist in the recovery and improvement of habitat diversity and increase the quantity and quality of forage for ungulates, predators, small mammals, reptiles and amphibians, birds, as well as those species that depend on these animals for prey.

ALTERNATIVE B

Under Alternative B, all actions relating to wildlife effects are consistent with the Forest Plan and other laws, regulations, and policies. Implementation of Alternative B would aid in the recovery and improvement of habitat diversity and increase the quantity and quality of forage for ungulates, predators, small mammals, reptiles and amphibians, birds, as well as those species that depend on these animals for prey. Although not all infestations would be treated under this alternative, major habitat and forage base improvements would occur across most of the Forest which would be in line with the Helena Forest Plan, National Forest Management Act, Montana Weed Management Plan, Migratory Bird Treaty Act, Endangered Species Act, and other laws, regulations, and policies.

ALTERNATIVE C

Under Alternative C, noxious weed communities would be allowed to dominate and expand throughout many areas across the Forest. Specific goals in the Forest Plan to "maintain and improve habitat over time" for big game, grizzly bears, bald eagles, gray wolves, and peregrine falcons would not occur (FP pg. II/2) because efforts to "provide adequate browse, species diversity, and quantity to support current moose populations" would not occur (FP pg. II/19). In addition, maintenance or improvement of big game summer and winter ranges, visual quality objectives, wildlife and fisheries habitat, and general preservation of current suitable habitat and structure would not be initiated leading to a loss of resources that currently exist on the Forest. Therefore, Alternative C is less responsive to wildlife goals and objectives stated in the Helena Forest Plan.

FISHERIES AND AQUATIC RESOURCES

One of the primary means by which toxicological effects of specific contaminants on aquatic life are determined includes use of standardized laboratory bioassays. Sutter (1995) identified several shortcomings of bioassays; in particular, their applicability to expected field conditions. However, bioassays remain a useful tool in quantifying toxicological effects of specific contaminants on aquatic life in a consistent, relatively reproducible manner (Munn and Gilliom 2001). The way the bioassay information is used, is to develop a "threshold level" at which it is unlikely a species would suffer any effects—this is called the No Observable Effects Level (NOEL).

The most frequently used tool to assist in determining acceptable level of risk is a risk assessment. Risk assessments evaluate the various avenues by which a species can be affected. Examples include effects on the animal in any life stage from possible toxic effects of a specific herbicide and effects on other non-target organisms that might be important to some portion of the life history or habitat.

The maximum acceptable toxicant concentration (MATC) (Mayes *et al*. (1987) is an approach to determine theoretical threshold toxic levels. The U. S Fish and Wildlife Service followed up on this concept in developing a manual on Acute Toxicity where there is an attempt made to pick a grouping of species that provides protection for most other species most of the time (Mayer and Ellersieck 1986) Their findings suggested that 1/15th of the LC_{50} (lethal concentration) for rainbow trout provided protection for most other species 95 percent of the time and 1/25th of the rainbow trout LC_{50} provided protection for most other species 100 percent of the time. A different approach for risk was recommended by Norris *et al.* (1983). They recommended use of 1/10th of the LC_{50} as providing for an adequate safety margin. The USEPA uses a safety factor of 1/20 the LC_{50}, which they believe should not result in an unacceptable risk to endangered aquatic species (USFS 2001d). The National Academy of Sciences-National Academy of Engineering (1973) cited in Norris *et al*. (1983) specifically recommended 1/20th of the LC-50 for persistent chemicals. Based on the need to provide high margins of safety for fish species listed under the Endangered Species Act and

fish species currently classified as sensitive, 1/20th of the lowest 96 hour LC_{50} that could be found in the literature for cutthroat trout has been selected for delivery modeling by the Helena NF.

Other important elements that come into play during a risk assessment include: how much chemical can reach the water; if it reaches the water, what would the concentration of the chemical be and how long would that concentration be maintained? There have been various approaches used to gauge this type of risk. Some models focus on the worst-case scenario for how much chemical can get into a waterbody.

In 2001, the Nez Perce National Forest prepared a Biological Assessment (USFS 2001d) for herbicide treatment of noxious weeds. As part of the aquatic analysis for herbicide application, a risk quotient was calculated for each herbicide proposed for use. This risk quotient was calculated from a NOEL divided by an expected environmental concentration (EEC). The risk quotient provides a reference from which a worst-case scenario can be viewed. If the risk quotient is greater than 10, the level of concern is categorized a "low". If the risk quotient is between one and 10, the level of concern is "moderate." If the risk quotient is less than 1, then the level of concern is "high."

The level of concern (risk) analysis is based on direct application of the active ingredient of a chemical product to a pond containing one acre-foot of water. This illustrates an extreme case, which should not occur during implementation. The risk of a direct application is mitigated by selecting appropriate application techniques (hand application vs. aerial spray), applying buffers adjacent to water, taking into account such factors as chemical volatility, wind speed and direction, temperature, precipitation, ground slope or use of chemicals that are approved for direct application to water (USFS 2001d). In some cases it may be appropriate to limit how much chemical is applied in any given drainage if it is a high risk chemical for aquatic species. **Table 4-6** shows the risk analysis using the risk quotient method as identified in the Nez Perce National Forest Biological Assessment (USFS 2001d). Risk can be assessed based on the level of chemical considered to be reaching a stream as well as incorporating the chemical's toxicological effects. Using the approach described for the Nez Perce National Forest to assess the high-risk chemicals, the Helena NF identified picloram as falling into this category.

SITE SPECIFIC APPROACH

Of the 149 watersheds on the Helena NF, 105 would be receiving some form of herbicide treatment under the Proposed Action. These 105 watersheds were evaluated with a method developed to model Picloram delivery via surface water runoff/overland flow to the aquatic system after application. This effort was undertaken to ensure that concentrations of picloram in streams would not reach levels that would result in acute toxicity and ensure that risk for any chronic effects are minimal. Details of the methodology are found in the Project File (PF – Fisheries). Multiple treatment types (aerial, ground and mechanical) are proposed for these watersheds. Both runoff and infiltration conditions exist within these watersheds. To make this model representative to conditions on the Helena NF, the following assumptions were made (Walch and Stuart 2002):

- Picloram would not be used within 50 feet of a waterway.
- Delivery rate within 300 feet of aquatic systems equals 2 percent of chemical applied over a period of 6 hours. These represent runoff-dominated sites.
- Delivery rate for all other treatment areas outside the riparian aerial spray buffer equals 1 percent of chemical applied over a period of 24 hours. These represent infiltration-ominated sites.

TABLE 4-6
Level of Concern for Chemical Use Using the Risk Quotient Method

Chemical	1/20 Of LC_{50} (ppm) (for fish)	EEC (ppm)	Risk Quotient	Level of Concern
Chlorsulfuron (Telar)	12.5	0.0690	181.27	Low
Clopyralid	5.2	0.1398	37.21	Low
2,4-D	12.5	0.3677	33.99	Low
Dicamba (Banvel)	50	0.2758	181.27	Low
Dicamba (Vanquish)	6.75	0.2758	24.47	Low
Triclopyr (Garlon)	26.1	1.8389	14.19	Low
Hexazinone (Velpar)	16	1.4711	10.88	Low
Metsulfuron methyl	7.5	0.0114	657.84	Low
Imazapic	5	0.0919	539.40	Low
Imazapyr	5	0.0919	539.40	Low
Picloram	0.075	0.0919	0.82	High
Triclopyr (Redeem)	26.1	1.2872	20.28	Low
Sulfometuron (Oust)	0.625	0.0172	36.34	Low
Glyphosate	4.3	1.4711	2.92	Moderate

Note: LC_{50} = Lethal Concentration where 50% mortality occurs ; EEC = expected environmental concentration. The EEC is calculated using application rate in pounds of active ingredient per acre applied to an acre foot of water that gives an anticipated expected environmental concentration; ppm = parts per million.

Flow during two treatment periods was evaluated.

1. A storm event with a two year recurrence interval (Q2) was used to simulate spring time flow and was calculated using a US Geologic Survey regression equation (Omang 1992). (Note: These calculations are based on a regression equation developed for ungaged sites in the Southwest Region of Montana, using variables for drainage area (NFS land only) and percentage of drainage area above 6,000 feet elevation).

2. Fall flows were calculated by using mean monthly discharge in September that was exceeded 20% of the time (Q.20) (Parrett et al. 1989). (Note: The above calculations are based on a regression equation developed for the Upper Missouri River Basin, Montana, using variables for drainage area (NFS land only) and mean annual precipitation).

The model assumes that all acres within weed polygons would be treated at a rate of .25 pounds of picloram per acre. (Note: This may over-estimate the amount of herbicide to be used, especially in ground-based treatment. Where weeds are scattered, spot-spraying may result in treatment of a very small percentage of the acres in the polygon. Weed density is highly variable within an infestation and therefore difficult to measure or to portray on a map or in a database).

Modeling was done specific to picloram for treatment areas identified in each watershed and analyzed for the Alternatives A, B, and C. Detailed results of the analysis are presented in the Project File (PF-Fisheries).

DIRECT AND INDIRECT EFFECTS

There is some risk for direct and indirect effects to various aquatic resources as a result of herbicide treatments or lack of herbicide treatment. Those effects or risk of those effects are discussed in depth throughout the rest of this section.

ALL ALTERNATIVES

Herbicides

Of the chemicals proposed for use in all alternatives, picloram is the only one to have a risk quotient that was categorized as "high." The risk quotient for glyphosate is "moderate"

while all others are "low" (see **Table 4-6** above). Risk of using picloram has been evaluated closely via literature review, and conservative direct modeling identified a very low probability of adverse toxic effects on fish as detailed in the sections below. Therefore, direct impacts on aquatic organisms would be even less by using chemicals with low to moderate risk quotients.

The potential effects of picloram from acute and chronic exposure have been widely discussed, and some dated data and research exist on the topic (see discussion of picloram in the literature review section). Available data on toxicity have been collected under laboratory conditions which rarely consider other environmental variables such as temperature, wind, photo-degradation, soil permeability, precipitation frequency and intensity, local geochemical influences, stream volume (dilution factor) or water quality (Munn and Gilliom 2001).

Based on the available studies and the EPMs (**Table 2-4**) planned in this proposal, it is extremely unlikely that the lowest known acute toxicities levels for any aquatic species would ever be reached in streams. Risks to aquatic species from chronic exposure are also unlikely, but somewhat less certain. Woodward (1976) documented chronic exposure effects in lake trout fry (closely related species to bull trout) after 60 days.

Chronic effects on growth were noted for cutthroat trout during a 60 day test where exposure to fish occurred periodically over a 24 day period at very low levels of 0.076 mg/l (Woodward 1979). It is unlikely that there would be any chronic exposure effects on aquatic species from this project; given exposures of a few hours on a few days over the course of a year at levels likely to be well below 0.075 mg/l as opposed to a 24 to 60 day continuous exposure at those levels.

With mitigation measures in place, modeling efforts undertaken to limit the likely concentration of picloram in surface waters to below .075 mg/l, and the probability that the time of exposure to herbicide would be very short, it is concluded that the risk for any chronic effects on fish species would be minimal.

Generally, macroinvertebrate species adapted to highly variable stream environments are better able to tolerate change than those in more stable lake and pond environments (Mackie 1998). How macroinvertebrate species respond to pollutants can vary. The level of impact on an aquatic system is dependent on the chemical and physical properties of the pollutant and the ability of a given species to tolerate an impact (Nimmo 1985). Impacts on species abundance and diversity resulting from catastrophic substrate loss or degradation are well documented. Macroinvertebrate community response studies (Resh *et al.* 1988) have shown that recolonization within a few years generally results, though responses can vary within an individual species (Minshall 1982).

Since the timing of chemical releases and water conditions relative to the distribution and life cycles of organisms determines the potential exposure and, correspondingly, the biological effects of exposure, the effect of herbicides is more difficult to track. The effect on benthic (stream bottom) species is determined primarily by the amount in the water and substrate. The composition and toxicity change rapidly and continuously as individual compounds are transported through the aquatic system and dispersed and degraded at differing rates by physical, chemical, and biological processes (Nimmo 1985). The rates of these weathering processes and population recolonization vary depending on temperature, currents, wind, concentrations of suspended and dissolved components of the receiving water, sediment sorption, and biological activity. Based on the very low projected levels of herbicide to be found in surface waters and the toxicity studies reviewed, the conclusion is that it is extremely unlikely that there would be any effect on aquatic invertebrates.

Surfactant

Information is limited on the types of surfactants used and the toxicity of surfactants. Surfactants are proposed for use with the same EPMs as picloram. The surfactant currently used by the Helena NF is Phase II®, which is a non-ionic surfactant that is vegetable-based (rapeseed oil) and contains organosilicone. Phase II® is known to be toxic to fish and other aquatic life and contamination of surface water and ditches would be avoided. The likelihood that surfactant would reach surface water at great enough concentration to affect fish is analyzed below along with herbicides as adjuvant (tank mix additive aid or modify the action of the mixture). Some surfactants are labeled for use in and around water including: Activate Plus®, LI-700®, Preference®, R-11®, Widespread®, and X-77®.

Runoff

Most herbicides and adjuvant are applied in liquid formulations and are sprayed on the foliage of the target vegetation. Rarely, soils may be a major receptor and contamination can occur by herbicides and adjuvant leaching through the soils to groundwater and ultimately reaching the aquatic environment. This method of introduction usually poses the least amount of risk to the aquatic environment because chemicals typically disappear from the ground surface by either plant uptake of the chemical, volatilization, natural decomposition of the active ingredients or adsorption by soil particles. As Norris *et al.* (1991) indicates, leaching of chemicals through the soil profile is of major public concern, but is least likely to occur in undisturbed forest environments. The half-lives of the proposed chemicals once they have been applied to the soil indicated picloram has a half-life in soil that ranges from 20 to 277 days, significantly more than any of the other proposed chemicals.

Point source impacts such as leaks, spills, improper storage, handling or rinsing of containers are often the result of most pesticide related surface and groundwater contamination. An environmental protection measure has been included in Chapter 2 of the EIS to avoid this, and, therefore, risk from an accidental spill of herbicide into a water body is considered very low.

Another mode of pesticide entry to the aquatic system includes overland flow from precipitation events. Risks vary depending on soil composition and the timing and intensity of the precipitation events after application. Risks tend to be lower on well-vegetated forests and rangeland where soil infiltration is typically greater than precipitation. Norris *et al.* (1991) indicated that overland flow occurs infrequently on most undisturbed forest lands because the infiltration capacity of the forest floor and soils is usually far greater than the rate of precipitation. However, denuded and compacted soil typically provides increased potential for surface runoff. After a wildfire, soil hydrologic function has been shown to decrease, and infiltration rates have been reduced. The magnitude of accelerated erosion is expected to be greatly diminished by the second year after a fire, because soil erosion would cease once the erosion rills break through the soil hydrophobic layer (DeBano *et al.* 1998), and as vegetation recovery provides increased soil cover. Recovery of soil hydrologic function is also expected to occur within two to seven years following the fire.

Results of picloram modeling for all alternatives on the 105 watersheds are found in the Project File (PF-Fisheries). **Table 4-7** identifies those watersheds where the modeling identified exceedances of the safety factor for picloram in surface water. Of those watersheds where exceedances occur, the Helena NF fisheries biologist indicated that only the following watersheds do not contain fish: Cave Gulch, Favorite Gulch, Grizzly-Orofino Gulch, Oregon Gulch, and Middle Crow Tributary.

Due to the predicted exceedences, an environmental protection measure was developed to eliminate the potential impacts. Treatment schedules for these drainages would be adjusted (treated in spring, acres reduced, increased timeframe, alternative herbicide) per the *Environmental Protection Measures* discussed

TABLE 4-7
6th Code HUCs Exceeding the Picloram Modeling Safety Factor

Stream Name	Alt. A*	Alt. B*	Alt. C*
Cave Gulch & others	X	X	X
Chicken Creek Area	X	X	
Favorite Gulch	X	X	X
Grizzly-Orofino	X	X	X
Lower Beaver	X	X	X
Lower Crow	X	X	X
Lower Trout	X	X	X
Magpie	X		
McClellan	X	X	X
Middle Beaver	X	X	X
Middle Crow Tributary	X	X	X
Missouri River Area	X	X	X
Moose Creek I	X	X	
Ophir Creek.	X	X	X
Oregon Gulch	X	X	X
Spokane	X	X	X
Spotted Dog East	X	X	
Upper Little Blackfoot River	X	X	
White Gulch	X	X	X
TOTAL	19	18	14

Note: All modeled safety factor exceedances occurred with fall application.

See Appendix D of the Aquatics Report in the project file for complete model results.

in *Chapter 2*. These measures would mitigate these exceedences and produce "no impact" or "a very low probability of adverse toxic effect on fish."

ALTERNATIVES A AND B

Grazing

Goats or sheep used for weed control would be herded or fenced to prevent bank trampling and keep them out of the stream channel. This would reduce the potential for short-term sedimentation, nutrient loading or disruption of in-stream habitat. There would be no direct or indirect effects on fish from this activity.

Handpulling

Handpulling weed treatments at the level proposed would have no direct or indirect effect on fish.

Adaptive Management Strategy

An EPM has been included in Chapter 2 (**Table 2-4**) of the EIS establishing yearly application limits for picloram usage. As long as these limits are not exceeded, future herbicide treatments under the Adaptive Management Strategy would have the same effects as those described for herbicide treatments above and below. Initially, aerial application of herbicides would be prevented within 300 feet of water bodies and, therefore, drift of chemicals would not be expected to cause adverse impacts on water resources. This assumes that application would not occur during times when there is significant wind and/or precipitation during or immediately after application. Aerial application would be evaluated with drift cards and reduced to a minimum of 100 feet if monitoring demonstrates no drift is occurring. This would allow for faster and sometimes more efficient treatment of weeds in the riparian aerial spray buffer.

ALTERNATIVE A

Aerial treatment over a total of 11,074 acres would be expected to cover about 80 percent of the treatment area, with the remaining 20 percent of missed areas to be ground treated the following year. Follow-up aerial and/or

ground treatment would be implemented during subsequent years, as necessary, to effectively control the weeds. Not all of the 22,668 acres proposed for treatment in Alternative A would be treated during the first year; at least three years would be used for initial treatment of all areas.

Drift

Under Alternative A, direct effects on aquatic organisms from noxious weed management are primarily associated with the herbicide application on (resulting from direct aerial spray or drift) and/or around streams and associated riparian areas, lakes or wetlands. The extent to which direct effects occur is a function of the toxic characteristics of herbicides, concentration to which the organism is exposed, duration of exposure and the susceptibility of the animal to the chemical toxins (Virginia Cooperative Extension 1996).

Aerial spraying near aquatic zones has the potential to expose aquatic organisms to contaminants either through direct application or drift. Mobilization in ephemeral steam channels can also be an issue because ephemeral stream channels are often difficult to recognize from the air and may be sprayed inadvertently (USFS 2001a). Under Alternative A, aerial treatments have specific mitigations (buffer zones) preventing herbicide application within riparian areas as detailed in the potential mitigation and monitoring measures discussion of this section.

If any herbicide drift from aerial application reaches a stream or other water body, the small amount of herbicide in the drift would be diluted to non-detectable concentrations. Studies show that little or no herbicide drift occurs beyond 100 feet from the aerial release area when applied during proper conditions (Felsot 2001). Monitoring efforts at the Mormon Ridge and Sawmill RNA spray projects, including sampling of herbicide drift patterns and water chemistry, suggest that risk to water resources is minimal as long as mitigation/environmental protection measures are followed (USFS 1996b; USFS 2001c; Rice 2000).

Under Alternative A, with EPMs in place, herbicide treatment of weeds would have a very low probability of adverse toxic effects on fish.

ALTERNATIVE B

All direct and indirect effects from restoration, biological agents, and ground application of herbicides to control noxious weeds would remain the same as described for all alternatives. Not aerial applying herbicides on approximately 3,755 acres in the Helena NF would directly and indirectly affect the aquatic environment as detailed under the No Action Alternative (Alternative C) in those areas left untreated.

Elimination of aerial spraying would eliminate the probability of accidental direct herbicide application to aquatic habitats, and reduce the potential for aerosol drift into riparian areas and aquatic habitats but not completely eliminate it since drift can also be a component of ground application. Weed infestations on areas proposed for treatment under Alternative A that would not be treated under this alternative would remain, would likely increase in density in many areas, and would likely spread to adjacent areas. The negative impacts of expanding weed infestation on aquatic habitats are discussed below in Alternative C, but are somewhat less because there are more acres of weeds treated in this Alternative.

ALTERNATIVE C

Under the No Action Alternative, existing weed management programs (including herbicide treatment) would remain in place and no additional treatment of weeds associated with the Proposed Action (or alternatives) would occur.

Without the proposed treatment, noxious weeds would continue to spread where weed treatment does not occur (about a third of the currently infested area). Adverse impacts that may result in these areas include: (1) increased runoff, erosion, and sedimentation due to less

overall vegetation density and diversity; (2) reduction in stream bank stability where weeds invade along stream channels and eliminate riparian vegetation cover; (3) increased surface water temperature because of reduced canopy cover; and/or (4) less organic matter that enters surface water.

Invasive weeds can reduce infiltration and increase runoff and sediment production because weeds lower basal cover and allow crusting of exposed soil (Lacey *et al.* 1989). Tap-rooted weeds can reduce infiltration because they do not have the dense, fine root system of grasses. Water runoff was 56 percent higher and sediment yield was 192 percent higher on spotted knapweed plots compared to bunchgrass plots during a simulated rainfall period (Lacey *et al.* 1989). These conditions would have long-term adverse effects on water resources in the vicinity of proposed treatment areas.

Increases in sediment could directly affect aquatic organisms in several ways. Bull trout, westslope cutthroat trout, Yellowstone cutthroat trout, as well as many of the other aquatic species, require habitat with little sediment. An increase in fine sediment in spawning gravel can reduce the potential spawning habitat. Sediment increases can also negatively affect prey species (macroinvertebrates). Reduction in the populations of these prey-base species can be amplified through other species higher up the food chain.

A potential benefit of Alternative C, as well as Alternative B, would be a reduction in the volume of herbicide chemicals added to the environment as compared to the Proposed Action. Implementing Alternative C would limit the type of chemicals used to picloram, 2,4-D, glyphosate, and dicamba. Only a small amount of glyphosate would be used, in very specific applications (e.g. parking areas) and dicamba has not been used in recent years (pelleted formulation used in past on only portions of the Helena NF). The following herbicides are used as part of specific projects, including the 2000 fire areas: chlorsulfuron (Telar), metsulfuron (Escort), and clopyralid.

CUMULATIVE IMPACTS

ALTERNATIVES A, B AND C

Noxious weed control via herbicide application is likely on land adjacent to Helena NF lands. Information regarding to what extent this is occurring is limited. Several local agencies were contacted in an attempt to determine the level and location of picloram usage within watersheds in the cumulative effects analysis area. Data are not available on where, how much or when picloram is used, except in very limited areas. In all cases, information available was only partial information, which precluded a meaningful quantitative analysis of potential cumulative concentrations of picloram within any of the watersheds in the cumulative effects analysis area.

EPMs (**Table 2-4**) are in place to assure that direct and indirect impacts from herbicide use are minimized and that waters leaving Helena NF lands are of a quality to protect threatened, endangered and sensitive aquatic species. Herbicide practices on other lands must also meet acceptable levels of water quality protection. Treatment on private lands would likely occur in the valley bottoms where soil conditions are more conducive to infiltration than runoff. If runoff were to occur, much of the private treatments occur low in the HUCs, where streamflow would likely be greater, allowing for faster dilution than those locations being treated in the headwaters. However, cumulatively, there is a very slight risk that Helena NF and adjacent land practices may exceed those thresholds proposed by the Helena NF. It should be noted that these guidelines are very conservative and have incorporated safety factors in the event an exceedance does occur.

Increased erosion and sedimentation in burned areas may increase due to implementation of Alternatives A and B along with its resulting effect on fish habitat. However, these impacts appear to be temporary and based on significant

runoff events. Conditions may be such that weeds are removed and desirable species restored with limited sedimentation or other water quality issues.

Under Alternative C, as weed infestations become severe, it becomes more difficult to restore natural or near natural conditions. Conditions arise where, instead of using relatively low applications of low toxicity herbicides, more intensive applications at higher concentrations of more toxic herbicides may be necessary to control later stages of weed infestations. When this occurs, the risk to the aquatic environment also increases.

Increased erosion and sedimentation in burned areas may increase due to implementation of Alternative C along with its resulting effect on fish habitat.

VEGETATION

DIRECT AND INDIRECT EFFECTS

Effects of Herbicides

Desired effects of herbicide application include suppressing, containing or eradicating noxious weeds, resulting in an increase in native plant abundance and vigor, creating more weed-resistant plant communities by decreasing growth, seed production, and competitiveness of susceptible noxious weeds (Bussan and Dyer 1999). Selective control of noxious weeds, while allowing non-target species to survive and proliferate, can be accomplished by applying appropriate herbicides (e.g., selective to different types of plants, with varying lengths of residual activity) at appropriate rates, when non-target species are dormant and not susceptible to herbicide effects, and through avoiding contact with non-target species.

Although herbicides have the potential to affect both noxious weeds and desirable species, there are differences in susceptibility among species. Some plants (both noxious weeds and non-target species) metabolize herbicides, which reduces toxic effects. Some species also do not readily absorb herbicides through foliage and roots. For herbicides to be effective, they must be taken into the plant and impair physiological processes.

Herbicides are usually classified based on their chemical structure or mode of action and are taken up by plant roots or through foliage and transported within the plant through the vascular system. Herbicides kill or stress plants by inhibiting enzymes involved in photosynthesis, respiration, and other physiological processes.

Plants that have similar growth forms (e.g., leaf structure and root systems) and genetic composition often are similarly affected by herbicides; consequently, herbicides have the potential to adversely affect noxious weeds and non-target native species that have similar growth forms, genetic makeup, and life history characteristics. **Table 4-8** lists non-target species affected by four widely used herbicides and their relative susceptibility to herbicide treatment.

In general, most herbicides proposed for use on the Forest (with the exception of glyphosate) have a higher potential to affect broad-leaf plants (dicots) than grasses and sedges (monocots). Therefore, non-target broad-leaf species would have a higher potential to be adversely affected by herbicide application than non-target grasses and sedges. Broadcast application of herbicides to native plant communities could in the short-term, reduce dominance and diversity of native broad-leaf herbaceous species and shrubs, thus allowing grasses and sedges to increase as a result of decreased competition (Tomkins and Grant 1977).

Non-target plants could be damaged by unintentional application or drift of herbicide away from the application site, exposing non-target plants to toxic levels of herbicide. Felsot (2001) found that in most cases, off-site effects of herbicide volatilization and drift are usually limited to 100 feet. Using herbicides according to label instructions (as proposed for all alternatives) would avoid damage to non-target

TABLE 4-8
Non-Target Plant Susceptibility to Picloram, Dicamba, 2,4-D, and Clopyralid

Plant	Picloram	Dicamba	2,4-D	Clopyralid
Douglas-fir	MS	S	I-R	R
Lodgepole pine	MS	--	--	--
Spruce (spp.)	I	I-R	I-R	--
Juniper (spp.)	MS-S	S-I	R	--
Willow (spp.)	S	S-I	S	--
Cottonwood (spp.)	S	S	S-I	--
Alder (spp.)	S	S	S-I	--
Ponderosa pine	MS-S	--	R-MS	R
Quaking aspen	S	S	S-I	
Big sagebrush	R	S	S-I	
Fringed sage	S	S	S	
Mountain mahogany	S	S	I	
Rubber rabbitbrush	S	S-I	S	
Serviceberry	--	--	S-I	R
Shrubby cinquefoil	MS-S	S	S-I	
Kinnikinnik	R	--	R	R
Bitterbrush	S	S	S	--
Snowberry	MS	S	S-I	R
Lupine (spp.)	S	S	S-I	
Geranium (spp.)	S	S	S-I	
Clover (spp.)	S	--	S	
Bluegrass (spp.)	R	R	R	
Western wheatgrass	R	R	R	
Bluebunch wheatgrass	R	R	R	
Idaho fescue	R	R	R	
Rough fescue	R	R	R	
Yarrow	I	--	I	I
Blue aster	S	--	S	S
Hairy golden aster	S	--	S	S
Arrowleaf balsamroot	R	--	R	R
Fleabane (spp.)	R	--	R	R
Ballhead sandwort	S	--	S	S
Weedy milkvetch	S	--	S	S
Nine-leaf lomatium	S	--	S	S
Douglas knotweed	S	--	S	S
Deptford pink	S	--	S	S
Nodding onion	R	--	R	R
Pussytoes	R	--	R	R
Blue-eyed Mary	R	--	R	R
Wild strawberry	R	--	R	R
Penstemon	R	--	R	R

Notes: R-resistant, MS-moderately susceptible, S-susceptible, I-severely injured. Care must be taken in interpreting results because herbicide applications rates, timing of application, and phenology of plants vary with treatments

Sources: BLM 1985, Rice and Toney 1996.

plants by avoiding spray drift or unintended application of herbicides to native plants. Use of herbicides with low volatilization potential near sensitive areas (e.g., sensitive plant habitats, wetlands, and gardens) would reduce the risk of spray drift.

Non-target plants also have potential to be affected by residual activity of herbicides remaining in soil. Some herbicides are short-lived and become detoxified in a few days or weeks, whereas others (e.g., picloram) can remain active in soil for years. Herbicides with short periods of toxicity generally have little effect on spring- and early summer-flowering

species, when applied in fall. Many native Montana broadleaf plants flower and set seeds in spring and summer and are dormant in fall.

When plants are dormant, they are not as susceptible to herbicides.

Typically, many noxious weeds have vigorous periods of growth in spring and fall when temperatures cool and precipitation increases. Noxious weeds are most susceptible to effects of herbicides when they are actively growing. Fall application of herbicides can selectively kill weeds that re-initiate growth in fall, while not affecting native species that are dormant after spring and summer growth.

Herbicide Effects on Community Diversity

Effects of herbicides on community diversity have been studied in western Montana grasslands and grassland/forest ecotones (Rice *et al.* 1997a; Rice *et al. 1*997b; Rice and Toney 1998; Rice *et al. 1*992; and Rice 2000) and on the Helena NF (Brown *et al.* 2002). Rice *et al.* (1992) found that herbicide treatments (picloram, 1 pint per acre; clopyralid, 2/3 pints per acre; and 2,4-D, 1pound per acre, mixed with clopyralid, 0.19 pounds per acre) cause short-term depressions in community diversity. Suppression of the competitively dominant noxious weeds released resources to support the growth of native plant species. Plant species that are relatively tolerant to herbicides (e.g., grasses and sedges) expanded following the first year of spraying. Plants affected by the herbicide responded to increased resources in subsequent growing seasons as the herbicide levels declined in the soil (Rice *et al.* 1992). Sullivan *et al.* (1998) found that herbicide application of triclopyr and glyphosate reduced shrub species richness in the first year, though recovered to untreated levels by the second year. Herbaceous species diversity was not affected by herbicide treatment.Weed treatments (Tordon, 0.5 pounds per acre and a mixture of Tordon and Plateau 0.94 pounds per acre) to control Dalmatian toadflax in ponderosa pine and Douglas-fir habitat types that had burned on the Helena NF (Brown *et al.* 2002) reduced the density and diversity of non-target forbs and shrubs, but did not affect grasses. Common shrubs in the ponderosa pine and Douglas-fir habitat types in the area treated included snowberry and buffaloberry. Species of forbs affected by herbicide treatment are not identified by Brown *et al.* (2002).

In general, as forest community moisture regimes increase, density and biomass of grasses and upland sedges decrease, while density and biomass of broadleaf forbs and shrubs increase. Wetter forest community types (e.g. aspen, moist Douglas-fir, and spruce/fir) tend to have a higher proportion of broadleaf forbs, shrubs, and mosses; consequently, application of herbicides (triclopyr and glyphosate, 1,3-2.5 quartz per acre) to plant communities with higher moisture regimes would have the potential to kill or impair more component broad-leaf species and mosses (Newmaster *et al.* 1999). Currently, there are no proposed weed treatment areas in aspen communities or moist/wet forest types likely to harbor a diversity of forbs and mosses, potentially sensitive to herbicides. In the drier forest communities, herbicides would shift dominance to grasses and sedges, whereas, in moister forest communities, resistant shrubs and resistant forbs would probably increase.

Although not thoroughly researched, some studies indicate that herbicide treatments can affect species diversity of non-vascular plants (bryophytes and lichens) and ferns in some communities. Bryophytes are small spore-producing, nonvascular, plants that include mosses, liverworts, and hornworts. They are often the first plants to colonize habitats, especially harsh habitats, and are important in nutrient cycling, moisture retention, soil stabilization, and seedling establishment. Studies have shown that some mosses are sensitive to herbicides and other species are relatively tolerant.

Newmaster *et al.* (1999) found that treatments of boreal forest vegetation with triclopyr and glyphosate (1.3-2.5 quartz per acre) caused a decrease in bryophyte abundance and species richness. Bryophytes most sensitive to herbicide treatments were species growing on

shaded, relatively moist sites, under a forest canopy. Bryophytes least sensitive were invasive, drought-tolerant species growing on dry soil (e.g., *Ceratodon purpureus*, *Pohlia nutans*, *Bryum caespiticium*, *Polytrichum juniperinum*, and *Marchantia polymorpha*). Populations of bryophytes most affected by herbicide treatment did not fully recover species abundance and diversity for at least five years following treatment (Newmaster and Bell 2002).

The lack of herbicide effects on soil-growing mosses was also reported by the BLM (1985). One study found that glyphosate applied to moss-dominated biological soil crusts had no short-term impact on bryophyte cover. In fact, bryophyte cover decreased significantly in control plots due to litter buildup from exotic annual grasses that had invaded the site, while bryophyte cover stayed the same or increased slightly on treated plots.

Lichens responded to herbicide treatments (triclopyr and glyphosate, 1.3-2.5 quartz per acre) similarly to bryophytes in studies conducted on boreal forest vegetation (Newmaster and Bell 2002). Species abundance and diversity decreased for lichens under a forest canopy but had little effect on species growing on relatively dry soils. Some species increased in abundance after herbicide treatments. Species that increased after herbicide treatments are colonizers of mineral soil and other disturbed habitats (e.g., *Peltigera canina* and several *Cladonia* species).

Herbicides (i.e., glyphosate and triclopyr) applied to pteridophytes (i.e., ferns and fern-allies) resulted in reductions in species diversity and abundance (i.e., canopy cover). Effects of herbicide treatments were detected for at least five years following application (Newmaster and Bell 2002). Susceptibility to toxic effects of herbicides on bracken fern was rated negligible for 2,4-D, moderate for picloram, and high for dicamba and glyphosate, although no application rates were stated (BLM 1985).

The US Forest Service (USFS 1997c) rated the susceptibility of several sensitive species, *Botrychium* spp. (moonworts) and *Thelypteris phegopteris* (northern beech fern) to herbicide effects associated with noxious weed control. Susceptibility of *Botrychium* species and *Thelypteris phegopteris* was rated low for 2,4-D and clopyralid, moderate for picloram, and high for dicamba and glyphosate, but did not state herbicide application rates.

Field observations of herbicide effects on a prairie population of a rare moonwort (*Botrychium* sp.) in Fergus County, Montana indicate that this fern was adversely affected as a non-target species by roadside weed control with herbicides. Herbicide application in June of 2002 caused developing plants to turn yellow, cease growth, and apparently die within one week of herbicide application. Observation of this population in June of 2003 indicated that the effects from last year's exposure to herbicide had minimal long-term effects. Botrychium plants on the treated site were growing normally, including production of sporangia.

EFFECTS COMMON TO ALL ALTERNATIVES

The properties of herbicides proposed for use are described in the project file (PF-Vegetation). Only picloram, 2,4-D, dicamba, clopyralid, metsulfuron methyl, chlorsulfuron and glyphosate would be applied with Alternative C; however, the general effects of herbicides addressed in the following sections also apply to these herbicides. It is assumed that application rates for all herbicides (**Table 2-6**) would be the same for all alternatives.

Grasslands

Noxious weeds present on the Forest have a high potential to invade grasslands, especially grasslands that have had the soil disturbed from overgrazing, roads, and other factors. The lack of a forest overstory and the bunchgrass structure of native grasslands on the Forest render them susceptible to weed invasion and infestation.

Spotted knapweed (10,455 acres) and Dalmatian toadflax (7,358 acres) are the most

widespread and frequent (highest acreage infested) weeds. They proliferate and are often intermixed in disturbed grasslands. Most areas treated through aerial application and ground-based broadcast treatments would target these species and less common Canada thistle (3,545 acres) and leafy spurge (851 acres).

Herbicides shown to be effective and proposed for use to control spotted knapweed are picloram (1 pint per acre), 2,4-D (1quart per acre), and clopyralid (2 quarts per acre). Proposed treatments of Dalmatian toadflax would include application of picloram (0.5 -1 quart per acre), imazapic (8-10 ounces per acre), chlorsulfuron (1.5 ounces per acre), and 2,4-D (1 quart per acre). This range of herbicides and application rates also would be used to control other noxious weeds on the Forest.

Noxious weeds that require the highest levels of herbicide application for effective control appear to be leafy spurge and Dalmatian toadflax. Effects of herbicide treatment of these species represent the worst-case example of potential effects of weed treatment on non-target plants. The herbicide that appears to pose the most risk to non-target plants is picloram, when applied at rates of 1 quart per acre or higher.

Montana studies (Rice and Toney 1996) have shown with applications of picloram (1 pint per acre), clopyralid (0.66 pint per acre) or a mixture of the two (Curtail, 2 quarts per acre) short-term effects on some native species. Over the three-year study, seven native forbs decreased and two increased after treatment. Initial decreases in native forbs cover recovered to pre-spraying levels after three years.

Effective treatment of Dalmatian toadflax can require higher rates of herbicide application (2 quarts per acre of Tordon 22K®). Studies by Brown *et al.* (2002) on the Helena NF found that picloram (1 pint per acre) and a mixture of picloram and imazapic, applied together in fall to control Dalmatian toadflax, substantially reduced non-target forbs and shrubs. Proposed application rates of picloram and imazapic for treatment of Dalmatian toadflax also would likely reduce biomass and species diversity of non-target forbs and shrubs. The duration of the reduction is not known, but studies are ongoing to assess this effect as well as the efficacy of control for target species.

Other studies on the Forest (Winfield 2003) indicate that picloram (0.5 pints per acre) and chlorsulfuron (0.094 pounds per acre) both are effective in controlling Dalmatian toadflax when applied in fall. The relatively low concentration of picloram used in this study would pose a negligible risk to non-target species. Based on label information for Telar, provided by DuPont, application rates of 1 to 3 ounces per acre would adversely affect non-target species such as aster, bedstraw, common cinquefoil, yarrow, red clover, wild onion, and some members of the carrot family (*Apiaceae*). The proposed application rate of chlorsulfuron (Telar, 1.5 ounces per acre) is lower than the rate recommended (2 to 3 ounces per acre) by Dupont, the manufacturer of Telar (chlorsulfuron), for the control of Dalmatian toadflax.

Treatment of spotted knapweed and Dalmatian toadflax would have little or no effect on dominant grasses and grass-like plants if applied as proposed. Grasses and grass-like plants account for nearly 40 percent of the plant species and most of the vegetation cover in these vegetation types (Mueggler and Stewart 1980). Most common species in grasslands (arrow-leaf balsamroot, fleabane, and pussytoes), dominated by Idaho fescue, rough fescue, western needlegrass and, bluebunch wheatgrass, would probably not experience long-term effects of herbicide treatments at proposed application rates.

Common species such as fringed sage, snakeweed, and dotted gayfeather, soft cinquefoil, American vetch, sticky geranium, and juniper (common, and creeping juniper) would likely be adversely affected by herbicide exposure (especially picloram at rates of 1 quart per acre or higher) if they were in active growth stages when exposed to herbicides.

Mosses and lichens, adapted to dry site conditions, are present as ground cover in many grassland communities. Herbicide application would have little effect on mosses adapted to growth on dry sites, such as proposed for treatment on the Forest (Newmaster *et al.* 1999; BLM 1985). Although boreal mosses and lichens, adapted to moist forest habitat types are often sensitive to herbicide applications, mosses and lichens on dry sites are usually unaffected or increase in density and biomass after herbicide application. Few, if any, wet forest types supporting dense stands of boreal mosses would be treated with herbicides on the Forest.

Application of herbicides in late summer or fall when most native grasses and forbs are dormant or have low levels of physiological activity would substantially reduce adverse effects on non-target species. If herbicides were applied in spring, it is likely that cool-season non-target plants would be initiating growth and would be susceptible to herbicide effects. Often plants are most susceptible to herbicide effects when they are rapidly developing. Herbicide effects on grasses from spring herbicide application would likely be short-term and would not reduce species diversity or biomass production.

Monitoring areas treated with herbicides for effects on both noxious weeds and non-target species, would provide information on application rates that minimize effects on non-target plants, while providing a suitable level of control noxious weeds.

Adaptive management, based on results of monitoring, would involve seeking a balance between efficacies of noxious weed treatments, while avoiding impacts on non-target species. Fall applications of herbicides would avoid impacts on native species, which tend to be dormant in late summer and fall.

Shrub Communities

Like grasslands, shrub communities have high potential for noxious weed invasion and establishment. The same noxious weeds that invade grasslands are also present in shrub communities. Herbicide application would also be the same as proposed for treatment of noxious weeds in grasslands.

Non-target species that likely would be adversely affected over the short-term by herbicide treatments include low sagebrush, big sagebrush, shrubby cinquefoil, bitterbrush, and skunkbush sumac. Other dominant species such as bluebunch wheatgrass, rough fescue, and timber oatgrass would be resistant to herbicide effects, especially if herbicides were applied in fall when grasses are dormant. Mosses and lichens that typically grow in drier shrub communities would not be adversely affected. Spring application could reduce vigor and seed production of some of grasses but the effect would be short-term and would not alter species diversity or biomass production.

Coniferous Trees

Noxious weeds present in coniferous forest habitat types (Douglas-fir and ponderosa pine) are the same species that have the potential to invade grasslands and shrublands. The density and vigor of noxious weed populations are inversely related to shading and competition from overstory trees, seedlings, and saplings. Most noxious weed infestations are in open forest stands that have low tree densities and cover because of moisture limitations (e.g., dry ponderosa pine and Douglas-fir habitat types), fire, logging, or road construction.

Treatment of noxious weeds in forest stands would involve the use of the same herbicide and application rates as addressed in the previous sections on grasslands and shrublands; however, conifer forest with more than 30 percent overstory canopy cover would not be treated with herbicides through aerial application. Avoiding direct application to trees would reduce the risk of adversely affecting overstory trees. Ground-based, broadcast spraying and spot spraying would be the primary methods of applying herbicides to weed infestations on sites with more than 30 percent overstory canopy.

Seedlings and saplings of ponderosa pine and Douglas-fir would likely be exposed to herbicides through ground-based broadcast application because many logged areas, burned areas, and road margins with noxious weeds also have tree seedlings and saplings. Fire suppression over the last century has allowed Douglas-fir and ponderosa pine to proliferate in ponderosa and Douglas-fir habitat types and on meadows and other non-forested sites adjacent to forest communities. Reductions in pine and Douglas-fir seedlings and saplings on herbicide-treated sites would be a positive effect because it would slow the proliferation of trees that has occurred in absence of frequent, low-intensity fires.

Application of picloram to understory vegetation would pose a risk to ponderosa pine and Douglas-fir through leaching into the soil and root uptake by these trees. This risk could be avoided by not using picloram within the root zone of trees, as directed on the label. The use of other herbicides not as toxic to trees as picloram would minimize potential adverse effects (e.g., imazapic, chlorsulfuron, or 2,4-D for control of Dalmatian toadflax or use of clopyralid or 2,4-D to control spotted knapweed). Formulations of 2,4-D (1 quart per acre) generally do not affect ponderosa pine when applied in late summer and fall, following the cessation of height growth (Gratkowski 1977). Picloram, 2,4-D, imazapyr, chlorsulfuron, and clopyralid would have little or no effect on grasses or other herbaceous monocots. Most habitat indicator species belong to families that are susceptible to herbicides that would be applied at rates specified in **Table 2-6**. Species likely to be affected by herbicide treatment include heart-leaved arnica, yarrow, lupine, aster, violet, bitterbrush, wild rose, chokecherry, spirea, ninebark, virgin's bower, and meadowrue, common snowberry, and twinflower.

Other Habitats

No weed treatments are proposed in aspen stands, non-riparian wetlands, wet meadows, whitebark pine communities, or alpine areas, however, they may be treated under Adaptive Management (ground treatment with selective herbicide to minimize adverse effects) consequently, these habitats would not be affected by weed management alternatives. Riparian habitat would be treated to control several species, including Canada thistle, spotted knapweed, oxeye daisy and common tansy. Effects on non-target species could be minimized by spot-spraying and using herbicides licensed for use near water (e.g., 2,4-D amine).

Sensitive Species

Sensitive species that would have the greatest potential to be present in or near noxious weed infestations on the Forest are Austin's knotweed (Belts/Dry Range LA), long-styled thistle (Belts/Dry Range LA), and Missoula phlox (Continental Divide LA) (Barton and Crispin 2001 and 2002). Austin's knotweed typically grows on dry, rocky sites with sparse vegetation, usually bluebunch wheatgrass. Noxious weeds are not commonly found in populations of Austin's knotweed, but on one site, Dalmatian toadflax is dominant and threatens the population of Austin's knotweed and the site could support knapweed infestations.

Long-styled thistle is present in grasslands of the Belts/Dry Range LA, often in or near creek bottoms, and along roads (Barton and Crispin 2002). It also grows on sites disturbed by roads, livestock trampling and grazing, burned areas, logged areas, and sites with ground squirrel activity. Several noxious weeds commonly found in association with long-styled thistle are spotted knapweed, Dalmatian toadflax, and Canada thistle. Because Canada thistle and other non-native thistles resemble the sensitive long-styled thistle, there is a risk that, long-styled thistle would be mistakenly treated with herbicides. Barton and Crispin (2001) report that long-styled thistles on some weed-infested sites have been sprayed with herbicide during weed treatments on the Forest.

Missoula phlox is most common in the Continental Divide L A in the vicinity of MacDonald Pass in grasslands and on rocky

ridges. Dalmatian toadflax and spotted knapweed are present among and near populations of this species (Barton 2002). Proposed herbicide applications to control weeds among populations of Missoula phlox would have the potential to adversely affect this species, especially when the plant is actively growing in spring and early summer. Weed treatments in fall, when the plant is dormant would likely reduce the potential for adverse herbicide effects. Spot spraying of weeds in and near populations of Missoula phlox would reduce the mortality risk to phlox.

Species present on the Forest, but not likely to be affected by weed control are pale sedge, peculiar moonwort, English sundew, linear-leaved sundew, water bulrush, and Hall's rush. All of these species except Hall's rush and peculiar moonwort grow in fens that are not infested with noxious weeds. There would be no weed control in habitats harboring these species. Hall's rush, being a grass-like plant probably is not susceptible to most herbicides that are selective to broad-leaf species (e.g., picloram, 2,4-D, dicamba, and clopyralid). Peculiar moonwort populations are not near any known locations of noxious weeds or proposed treatment areas; consequently, risk to this species from weed management activities is negligible.

If sensitive plants are adversely affected by weed control measures, individuals may be damaged or killed, but it is unlikely that the viability of local and regional populations would be affected to the extent that there would be an increased probability that the species would be listed as threatened or endangered under the ESA.

Prior to weed treatment, areas would be surveyed for the presence of sensitive species. If sensitive species are found, weed treatments to minimize impacts on sensitive plants would be implemented such as; applying herbicides that have very short residual activity when sensitive plants are dormant, applying herbicides using spot-spraying or wand application, sponge- or wipe-type application of herbicide and similar methods of application applied directly to the tissues of target weeds, and hand pulling or digging. Educating herbicide applicators to identify and avoid sensitive plants would help minimize inadvertent exposure to herbicides. Monitoring of herbicide applications in the vicinity of sensitive plants by a qualified botanist would also reduce the risk of exposing these species to herbicide application.

The 100-foot spray buffer around sensitive plant populations would also reduce herbicide-exposure risks. In this buffer, only methods of noxious weed control that protect individual plants would be used (e.g. spot-spraying, wand-application of herbicides, and handpulling).

Summary

Herbicide treatments would likely kill some individual plants and temporarily inhibit growth in others over the short-term (Rice and Toney 1996). Herbicide application would reduce density and biomass of some non-target species (mostly broad-leaf forbs and shrubs) and increase the density and biomass of resistant plants such as grasses and sedges. It is unlikely that species diversity (number of species in a community) would be affected (no non-target species would be eradicated), but the relative proportions of component species would likely be altered. The degree to which changes would occur in communities treated with herbicides would depend on numerous factors such as effectiveness in killing noxious weeds, timing of application, concentration of herbicide, weather conditions, and physiological status of plants.

Mosses and lichens growing in dry ponderosa pine and Douglas-fir habitat types would likely not be affected by herbicide applications. As site conditions increase in moisture and forest overstory canopy cover increases, the composition of mosses and lichens shifts to dominance of boreal species more sensitive to herbicides. Boreal mosses and lichens would be more sensitive to herbicide effects (Newmaster *et al.* 1999), but typically, noxious weeds are infrequent in moist forest habitat types that have a rich component of herbicide-sensitive mosses and lichens. There would be little risk to mosses and lichens from the proposed herbicide treatments.

Adverse effects on non-target plants would be reduced through spot-spraying of herbicides and applying herbicide in fall when many native species are dormant.

Effects of Mechanical Treatments

Mechanical treatment such as handpulling and digging would be used in limited areas where use of herbicides would conflict with other resource values (e.g.. picnic areas, sensitive plant populations, and wetlands). Hand pulling on low-density knapweed infestations reduced soil disturbance and has been an effective management method on small areas (Marler 2001). Hand pulling and grubbing can be selective in terms of plants removed. A study conducted on the Lolo National Forest measured effects of mowing and hand pulling on spotted knapweed control and changes in the plant community. Hand pulling increased bare ground from 2.7 percent to 13.7 percent the year of treatment (Brown *et al.* 1999).

In some situations, hand pulling would be implemented with light applications of herbicides. Species such as common burdock and spotted knapweed could be controlled with repeated treatments and monitoring. Hand pulling would have negligible effects on non-target species but would create small areas of bare soil that could be recolonized by noxious weeds. Hand pulling can inadvertently affect non-target species or sensitive species growing in close proximity to invasive weeds from trampling by pulling crews.

Mechanical treatments would reduce weed seed production for the season they are treated. Most noxious weed species are prolific seed producers and have the ability to regenerate and produce seed following removal of top growth. Handpulling as the sole method of eradicating noxious weeds is often ineffective because of the long-term viability of weeds in the soil. Residual seed in soil can also germinate and allow populations to maintain themselves and expand. Mechanical treatments would be combined with reseeding or other restoration efforts. Mechanical treatments in conjunction with other control techniques would help control noxious weeds as part of an integrated program.

Effects of Biocontrol

Biological control is the deliberate introduction of or manipulation of a pest's natural enemies with the goal of suppressing the pest population (Wilson and McCaffrey 1999). Because most noxious weeds were introduced from outside the United States, there are few insects, native pathogens, or grazing animals in the United States that can keep noxious weeds in check. In their native countries, noxious weeds are eaten or parasitized by insects, mites, nematodes, and host-specific pathogens that are not present in the United States.

Biological control agents are being tested experimentally to control noxious weeds on the Helena NF (Winfield 2003). Release of the insect *Mecinus janthinus* reduced Dalmatian toadflax in the area that it was released by 90 percent.

Biological control would involve the continued use of insects that exhibit a host-specific preference for noxious weeds and controlled grazing that targets specific weeds. Insects released for biological control would likely reduce vigor and reproductive potential for species such as leafy spurge, knapweed species, musk thistle, Canada thistle, Dalmatian and yellow toadflax. Species such as oxeye daisy, houndstongue, sulfur cinquefoil, and common tansy would not likely be amenable to control with biological control agents. To date effective biological control agents have not been found for these species.

Biological control projects are developed according to the following protocols (Wilson and McCaffrey 1999):

- Determine the extent of the weed problem and suitability for biological control.
- Survey the naturalized and native ranges of the weed for natural enemies and select candidates for biological control.

- Determine the feeding range of the potential biological control agent and their general suitability.
- Following a period of limited importation and quarantine, released approved agents into the field.
- Document the impact of the agent or their failure.

Biological control agents are extensively tested to ensure that they have a very narrow host range, and would not pose a serious threat to non-target plants. The testing process for a biological control agent is typically three to four years in duration and involves 50 to 75 test plant species with final approval by USDA, Animal Plant Health Inspection Service. Although extensive screening and testing reduces the potential for injury to native plants, biological control is not risk-free. Agents may attack plants closely related to the host weed. Private, state, and county entities release biological control agents on land adjacent to the Forest. Therefore, there is potential for movement and establishment of these agents on NFS land in the absence of intentional introductions by the Helena NF.

Biological controls proposed for use have been tested for their species specificity and would not likely have an appreciable effect on native vegetation or threatened or sensitive plants. Biological controls would contribute to long-term weed reductions, which would benefit native plant communities and threatened and sensitive plants.

Biological weed control is an evolving science. Researchers are still working to understand how plant-insect and plant-disease interactions and interrelationships influence weeds, biological control agents, and the environment (Rees *et al.* 1996). Impacts of biological control agents on target plants depend on 1) density of weeds compared to the density of the agent, 2) effect of the local biotic and abiotic conditions on the agent and on the weed; 3) plants' reproductive ability (seeds only or seeds and vegetative reproduction); 4) an agents ability to stress the plant each year and the plants ability to maintain and replace root reserves; 5) plants' ability to recover from the effects of the biocontrol agent; and 6) interactions of multiple biocontrol agents attacking a single weed species (Rees *et al.* 1996).

A weed infestation may increase in density and area faster than the newly released biocontrol agent populations; therefore, other control methods must be used in conjunction with the release of biocontrol agents. The perimeter of the infestation may be sprayed to keep the weed from spreading. As biocontrol agents increase in density and begin to occupy more area, herbicide use may be reduced to occasional spot treatments.

Timing of herbicide applications may be an extremely important factor in the interaction of biological control agents and the host plants. Herbicides would be applied when their effects on the host plants would not interfere with the life cycle of the biological control agents. Indirect effects of herbicide applications might become apparent if the sprayed weed dies or the foliage becomes unpalatable before the biocontrol agent has completed its development. Research continues on the interactions between biological control agents and other weed management techniques (Rees *et al.* 1996).

Biological control agents could potentially be released throughout the project area. Biological control agents can be used to enhance other treatments, or as priority treatments in areas that are not accessible. Use of bio-controls is intended to be flexible and allow the ability to respond to changing priorities or in light of new information regarding bio-controls or other treatment methods (i.e., adaptive management).

With biological controls, there is the potential for some biological control agents to attack non-target plants that are closely related to native species. Several introduced leafy spurge insects are able to develop on native spurges species and beetles imported to attack musk

and plumeless thistle also feed on native species (Wilson and McCaffrey 1999; Beck 1999).

Plants most likely to be attacked by biological control agents are native thistles (including the sensitive long-styled thistle). Barton and Crispin (2001) reported that populations on the Forest of long-styled thistle contained larvae. They speculated that these larvae might have been biological control agents released to control noxious thistles.

Effects of Grazing

Grazing animals, especially goats and sheep, can effectively suppress reproduction and vigor of knapweeds, Dalmatian toadflax and leafy spurge but not hounds tongue, common tansy, sulfur cinquefoil, and thistles. Grazing cannot eradicate noxious weeds but can help control weeds with repeated annual grazing at times of the year when noxious weeds are most palatable. With grazing some non-target species would also be eaten or trampled. Selective grazing by sheep and goats can shift the plant community toward more desirable grass species; however grazing can selectively reduce the vigor and competitiveness of grass, shifting the community in favor of weeds.

Sheep and goats prefer broadleaf herbs and have been used to control leafy spurge, Russian knapweed, and toadflax. Sheep can be useful in the control of spotted knapweed, and oxeye daisy (Tu *et al.* 2001). Sheep grazing negatively impacts spotted knapweed, but minimally affected the native grass community (Olson 1999b). Grazing would occur in grassland areas only, and would not affect other plant communities.

ALTERNATIVE A

Aerial herbicide application is less precise than ground application; consequently, there is a higher probability that in Alternative A, herbicides would adversely affect non-target plants outside the treatment area due to spray drift. Applying herbicide in fall when many native plants are dormant would reduce the risk to non-target plants. Using herbicide formulations at concentrations that have minimum toxicity to native species as proposed in Alternative A (Rice *et al.* 1997b; Rice and Toney 1998) would also minimize adverse effects on non-target species.

Aerial applications to grasslands, shrublands, and open savannah-like forest would be most effective in treating noxious weed infestations because there would be few trees to intercept the herbicide. Aerial application directly to tree canopies (mature trees, seedlings, and saplings) would pose a risk of killing or weakening trees, especially during spring when they are actively growing. Application of herbicides to Douglas-fir and ponderosa pine may not directly kill the trees but could weaken them, increasing the risk of secondary infestations of insects and other forest pathogens.

When dominant noxious weeds are reduced in density and vigor, community diversity would increase as a result of increased dominance of desirable plants (often grasses). Species suppressed by noxious weeds would increase in size and vigor, and re-establishment of native plants from seeds dormant in soil and seed dispersal from adjacent undisturbed sites would likely take place.

The response of plant communities dominated by noxious weeds would depend on factors such as the proportion of native and other desirable species prior to weed treatment. Treatment of a monoculture of noxious weeds or weed-infested site with few native species may not result in the proliferation of suppressed desirable species because the composition of desirable species could be too low to exert dominance. It is likely that viable seeds of both desirable native species and noxious weeds would remain in the soil following weed treatment. On sites dominated by noxious weeds, it is likely that the highest proportion of seeds in the soil would be those of noxious weed species. Therefore, it is likely that seed germination and growth would occur in proportions similar to the composition of the plant community before weed treatment. Sites dominated by noxious weeds prior to treatment, would likely become dominated by

noxious weeds following treatment without seeding to establish desirable species.

Following treatment of a monoculture or near-monoculture of noxious weeds, desirable species would have to be seeded to establish a vigorous stand and prevent re-invasion by noxious weeds.

Alternative A would help re-establish native plant communities by removing dominant and aggressive noxious weeds. Native communities are more at risk from suppression and elimination by noxious weeds than to changes in community composition resulting from proposed herbicide treatments.

Some native plants would be killed by herbicide treatments, however, they would naturally reoccupy treated areas if re-invasion by noxious weeds was inhibited and adequate reproductive potential of desirable plants were maintained or established. The Forest plans to revegetate areas with low species diversity and foliar cover to avoid creating or maintaining conditions compatible with the proliferation of weeds.

Other Habitats

There are currently no weed infestations identified in aspen stands, wetlands, alpine areas, or other sensitive habitats, therefore, no weeds would be treated unless some are identified for treatment through the Adaptive Management Strategy. Hand pulling would not adversely affect aspen but could affect herbaceous understory species. Glyphosate, picloram, imazapyr, hexazinone, triclopyr, 2,4-D, and dicamba are commonly used to control aspen where they are not desired and would have detrimental effects on aspen.

Some weed infestations in riparian areas would be treated. To prevent adverse effects on non-target species several methods would be used, including using herbicides with short periods of residual activity, spot-spraying, or wand, sponge- or wipe-type application and similar methods, and hand pulling or digging.

Sensitive Species

Alternative A would have a greater potential to affect sensitive species because more acres would be treated; however, with pre-treatment plant surveys and implementation of EPMs (**Table 2-4**), adverse effects on sensitive species would be negligible. Alternative A would not decrease the viability of any sensitive species or lead to listing under the Endangered Species Act.

ALTERNATIVE B

Alternative B would include the use of herbicides, mechanical treatments, biological control agents, and grazing to manage noxious weeds. Differences between Alternative A and Alternative B are that no aerial application of herbicides would occur with Alternative B and all areas of weed infestations would not be treated under Alternative B.

General effects on vegetation would be the same as discussed for *Effects Common to All Alternatives*, but approximately 3,755 acres currently infested, would continue to be untreated. Weeds on these untreated areas would likely infest new areas that are steep, remote, or otherwise difficult to treat with ground-based control measures. Generally, untreated grasslands, shrublands, and the drier Douglas-fir and ponderosas pine communities would have the greatest potential to act as noxious weed reservoirs and spread weeds to surrounding areas. Noxious weeds are less competitive and invasive in the moister forest communities with higher tree canopy cover.

Other Habitats and Sensitive Species

The effects would be the same as those described for Alternative A.

ALTERNATIVE C

The No Action Alternative would continue to treat noxious weed infestations as in the past. Herbicides would be applied and other integrated weed management techniques (other than grazing) would be implemented. The No Action Alternative differs from other

alternatives in types of herbicides used (more herbicides would be available for use with Alternative A and B), areas of weed infestation treated, and mode of application (aerial or ground-applied). With this alternative, herbicide use would be restricted to picloram, 2,4-D, dicamba, and clopyralid. Approximately 15,871 acres would be treated with integrated weed management. An additional 6,797 infested acres would not be treated.

Weeds on these untreated acres would increase in density and spread to adjacent areas currently not infested. Like Alternative B, untreated grasslands, shrublands and the drier tree-dominated communities would pose the greatest risk of acting as reservoirs and spreading noxious weeds to adjacent areas.

Some herbicides that have been effective in experimental treatments on the Forest (e.g., Telar® and Plateau®) would not be available for use with this alternative. These herbicides have been shown in experimental treatments to be effective in controlling Dalmatian toadflax, a difficult weed to eradicate. Picloram, also shown to be effective at controlling Dalmatian toadflax would be available for use with this alternative; however, picloram use poses a greater risk to ponderosa pine and Douglas-fir than do Telar® and Plateau®.

Alternative C would not include adaptive management techniques involving use of new herbicides, if future studies show that new herbicides are more effective and/or pose less risk to non-target plants.

Other Habitats

The effects would be the same as those described for Alternative A.

Sensitive Species

Without treatment of all infested areas, noxious weeds would continue to spread. Long-styled thistle, Austin's knotweed, and Missoula phlox, would be species most likely impacted without control of existing noxious weed populations. Currently, noxious weeds are invading populations of long-styled thistle, Austins' knotweed, and Missoula phlox. Areas with sensitive plants being invaded by noxious weeds may not be areas that would be sprayed under Alternative C. Inadvertent herbicide application to sensitive plants would continue to be a slight risk, outweighed by the risk posed by unchecked proliferations of noxious weeds.

CUMULATIVE EFFECTS

Cumulative effects on vegetation include potential for non-target exposure to herbicides from currently on-going weed treatment projects on the Forest and on private and other public land in the area, and ongoing spread of weeds. Other activities currently authorized and occurring on the Forest with the potential to impact vegetation include livestock grazing, timber harvest, trail and road maintenance activities, and recreation. Livestock grazing can result in local ground disturbance and increase the potential for weed invasion and spread. Timber management, including road, skid trail, and landing construction has the potential to introduce and facilitate spread of weeds. Recreation activities can be a vector of introduction and spread of weeds as well.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Implementation of Alternatives A or B with appropriate mitigation and site rehabilitation would result in no irreversible or irretrievable loss of native plant communities. Currently, native plant communities are more at risk from invasion and displacement by noxious weed populations. Implementing Alternative C could result in irretrievable impacts to native plant communities on some areas if noxious weeds spread from untreated areas and dominate large areas that cannot be treated under existing policies and methods of weed control. With Alternative C, weeds would continue to proliferate and control measures would not be sufficient to prevent continued expansion of weeds and associated losses in native plant community diversity and productivity.

CONSISTENCY WITH FOREST PLAN AND OTHER LAWS AND POLICIES

All alternatives would be consistent with direction in the Forest Plan.

WILDERNESS AND INVENTORIED ROADLESS AREAS

Of the wilderness attributes, unique characteristics, manageability, and boundaries would not be affected by implementation of any of the alternatives in wilderness areas, IRA, or unroaded areas.

DIRECT AND INDIRECT EFFECTS

ALTERNATIVE A

No aerial herbicide treatments would occur in wilderness. Areas identified for ground herbicide treatment within the Scapegoat Wilderness include about one acre of picloram and telar (one site), five acres of picloram, clopyralid and 2,4-D (five sites), 16 acres of picloram (eight sites), 39 acres of picloram and 2,4-D (five sites), one acre of picloram and escort (one site), five acres of picloram, clopyralid and 2,4-D (four sites), for a total of 68 acres of treatments on 24 sites. Herbicides would be applied with backpack or horse-mounted sprayers. There are currently no weeds mapped within the Gates of the Mountains Wilderness, although some do occur in adjacent areas and may move along trails into it. No biological controls would be released in wilderness or recommended wilderness. Under the Adaptive Management Strategy, biological control may be released in IRAs, although none are currently proposed. About 30 acres of the Big Log IRA (recommended wilderness) would have grazing with sheep or goats. In IRAs, both aerial and ground herbicide applications would occur (**Table 4-9**).

Natural Integrity and Apparent Naturalness

Where weed treatment is effective, there would be short-term (two months) evidence, including dead or wilting plants and areas of

TABLE 4-9
Alternative A Herbicide Treatments by IRA

IRA	LA	Aerial	Ground	Total
Anaconda Hill	Blackfoot	0	35	35
Bear-Marshall-Scapegoat-Swan	Blackfoot	32	94	126
Big Log	Belts/Dry Range	38	72	110
Camas Creek	Belts/Dry Range	14	1	15
Cayuse Mountain	Belts/Dry Range	120	48	168
Crater Mountain	Blackfoot	86	2	88
Devils Tower	Belts/Dry Range	35	119	154
Ellis Canyon	Belts/Dry Range	0	2	2
Grassy Mountain	Belts/Dry Range	0	13	13
Hellgate Gulch	Belts/Dry Range	81	96	177
Holter	Belts/Dry Range	0	26	26
Irish Gulch	Belts/Dry Range	0	66	66
Middleman Mountain-Hedges Mountain	Belts/Dry Range	906	122	1,028
Mount Baldy	Belts/Dry Range	0	6	6
Nevada Mountain	Blackfoot/Continental Divide	94	12	106
Odgen Mountain	Blackfoot	96	3	99
Spectmen Creek	Blackfoot	16	0	16
Electric Peak	Blackfoot	0	79	79
Jericho Mountain	Continental Divide	0	0	0
Lazyman Mountain	Continental Divide	75	10	85
Total IRA Herbicide Treatment		1,593	806	2,399

*Trace

disturbed soils where plants have been pulled up or grubbed out. Where plants are dead or dying, most people would not be able to relate what they are seeing to the use of herbicide because they would probably think that the plants have reached the end of their normal life.

Alternative A would be the most aggressive and effective alternative in controlling weeds in the areas where most recreational activity occurs, mainly due to the most acres of weed control. Therefore, it would create the most improvements in natural integrity.

In wilderness, 68 acres of herbicide treatment would occur. The effects on natural integrity would be an overall improvement in the natural integrity of these areas because invading noxious weeds would be excluded from wilderness and replaced with native plants (see the *Vegetation* section). Herbicides would not remain in the environment beyond two to three years. Apparent naturalness of treatment areas would improve as the evidence of noxious weeds decreases and is replaced with native vegetation.

Herbicide treatment would decrease establishment and expansion of aggressive species in wilderness and IRAs, and reduce weed related impacts. The visual impact of spraying would be temporary and on most sites only last a few hours or less. Dying and wilting weed plants following herbicide treatment could be apparent. However, this appearance would be short-lived as surrounding vegetation would screen dead plants or blend in with native vegetation, as it grew dormant.

The effects of the adaptive management strategy would be an increased number of acres treated with herbicides in wilderness and IRAs. The effects would be the same as for the proposed treatment areas.

No grazing to control weeds is proposed in wilderness areas. The 30 acres of grazing in the Big Log IRA is immediately adjacent to the boundary. No additional effects on natural integrity or apparent naturalness would occur from grazing activity because of the small scale and ongoing grazing. Under Adaptive Management, grazing for weed control may occur in the Jericho Mountain IRA.

Some people may notice areas where weeds were pulled or grazed, but it would likely not affect the apparent naturalness of the areas.

Remoteness and Solitude

Aerial spraying of herbicides within IRAs would reduce feelings of remoteness and solitude during the one to three days within each area required to accomplish the work. Aerial spraying would not occur in wilderness areas. Where weeds were pulled by hand, recreationists may happen upon a work crew and have a reduced feeling of solitude. Impacts would be very short-term (one day).

Mechanical treatments within the IRAs should result in minimal recreation effects of short duration. The use of wheeled vehicles would result in short-term visual impacts in the form of tracks created by laying down grasses. In dry years, these could remain visible throughout the season, while in wetter years; they could be "erased" by rains and regrowth before fall.

Grazing as a weed treatment method is only proposed where grazing activities are already occurring. Grazing would not occur in designated wilderness areas. There would be no additional effect on remoteness or solitude from grazing for weed control within proposed wilderness or IRAs.

Primitive Recreation Opportunities

With aerial herbicide application, treated areas would be temporarily closed to public use, thus restricting the overall recreational opportunity during this time. Treatment would most likely occur during spring through fall and the public would be kept out of treatment areas for approximately 24 to 48 hours at a time, reducing opportunities for recreation during those periods. Ground application would require signing, so people are aware that herbicide treatment has occurred, however closures would not occur. Some people may

choose to avoid these areas, reducing their opportunities for a short time.

Mechanical or grazing treatments, because of their limited extent, would only minimally affect opportunities for primitive recreation.

ALTERNATIVE B

There is no difference between Alternatives A and B for the effects on wilderness, because both alternatives have the same activities, including the adaptive management strategy. In IRAs, the acres with herbicide treatments would be reduced in Alternative B by approximately 980 acres (**Table 4-10**). This reduction is due to remoteness or worker safety on steep terrain with loose logs (burned areas, old clearcuts) or loose rocks. These areas would not be treated in Alternative B without aerial herbicide application.

Natural Integrity and Apparent Naturalness

In wilderness areas, the effects would be the same as Alternative A, since the treatments (herbicide and handpulling) would be the same.

In IRAs, fewer acres of noxious weeds would be treated than in Alternative A, with the result that natural integrity and apparent naturalness would not be improved on as many acres as Alternative A (2,399 acres vs. 1,418 acres in Alternative B). Weeds would continue to spread in areas where they are not treated. Approximately 600 of the 981 acres not treated with herbicides in Alternative B occur in the Middleman Mountain-Hedges Mountain IRA and are leafy spurge. With documented spread of leafy spurge over 100 percent per year since 1987 (PF-Purpose and Need), these 600 acres alone could exceed the existing infestation in the IRAs within four years, causing an overall decrease in natural integrity and apparent naturalness in the long-term.

Because Alternative B contains an adaptive management strategy to treat newly discovered weeds and to use improved technology, most new infestations would be treated as they are discovered. However, the areas where weeds would not be treated in Alternative B due to remoteness and worker safety is likely to impact IRAs harder than other areas because they are the most remote (after wilderness).

TABLE 4-10
Alternative B Herbicide Treatments by IRA

IRA	LA	Total
Anaconda Hill	Blackfoot	35
Bear-Marshall-Scapegoat-Swan	Blackfoot	116
Big Log	Belts/Dry Range	88
Camas Creek	Belts/Dry Range	14
Cayuse Mtn.	Belts/Dry Range	147
Crater Mtn.	Blackfoot	74
Devils Tower	Belts/Dry Range	142
Ellis Canyon	Belts/Dry Range	2
Grassy Mtn.	Belts/Dry Range	13
Hellgate Gulch	Belts/Dry Range	122
Holter	Belts/Dry Range	26
Irish Gulch	Belts/Dry Range	66
Middleman Mtn-Hedges Mtn	Belts/Dry Range	259
Mount Baldy	Belts/Dry Range	6
Nevada Mtn.	Blackfoot/Continental Divide	73
Odgen Mtn.	Blackfoot	73
Spectmen Creek	Blackfoot	16
Electric Peak	Blackfoot	79
Jericho Mtn.	Continental Divide	0
Lazyman Mtn.	Continental Divide	67
Total IRA Herbicide Treatment		**1,418**

Remoteness and Solitude

In Alternative B, weed treatment would mostly be through ground application of herbicide, with some handpulling and grazing control. This alternative would have the longest duration of impacts on solitude, due to the increased number of days/personnel that would be required to accomplish the chore. It is estimated that during the initial treatment and follow-up for each area, 55 person days (5 acres/day/person, 4 times per treatment area) would be required to effectively treat weeds within wilderness areas, and 1,056 person days required for treatments within IRAs, within a six-year period.

The effects of handpulling and grazing control are the same as Alternative A.

Primitive Recreation Opportunities

Ground application would require signing, so people would be aware that herbicide treatment has occurred, however, closures would not occur. Some people may choose to avoid these areas, reducing their opportunities for a short time. Compared to Alternative A, there would be nearly twice as many acres of ground application causing this effect.

Mechanical or grazing treatments, because of their limited extent, would only minimally affect opportunities for primitive recreation.

ALTERNATIVE C

Table 4-11 shows the acres of herbicide treatment in Inventoried Roadless Areas.

In wilderness, treatment would only occur at trailheads and portals (estimated to be less than three acres a year) allowing noxious weeds to spread unchecked at varying rates, depending on the weed species, competing vegetation, disturbance history, and presence of vectors. Under this alternative, in the long-term (more than 10 years), noxious weeds would eventually infest nearly all-suitable habitats within wilderness areas, including sites that are presently weed-free.

Natural Integrity and Apparent Naturalness

In wilderness areas, unchecked spread of noxious weeds could result in the unavoidable deterioration of the natural condition of the wilderness and adjoining land diminishing the recreational and wilderness experience for some people. The negative effects noxious weeds would have on use of recreation sites and the wilderness would be greatest under this alternative. People who are aware of noxious weeds would notice their presence and the effect on natural habitats in wilderness areas.

In IRAs, fewer acres of noxious weeds would be treated (**Table 4-12**), with the result that natural integrity and apparent naturalness would not be improved on as many acres as Alternative A (2,399 acres vs. 1,031 acres in Alternative C). In areas where effective weed treatments occur, short-term effects would be the same as those described in Alternative A.

TABLE 4-11
Alternative C Herbicide Treatments by IRA

IRA	LA	Total
Anaconda Hill	Blackfoot	35
Bear-Marshall-Scapegoat-Swan	Blackfoot	110
Big Log	Belts/Dry Range	39
Camas Creek	Belts/Dry Range	13
Cayuse Mountain	Belts/Dry Range	154
Crater Mountain	Blackfoot	16
Devils Tower	Belts/Dry Range	152
Ellis Canyon	Belts/Dry Range	2
Grassy Mountain	Belts/Dry Range	13
Hellgate Gulch	Belts/Dry Range	138
Holter	Belts/Dry Range	26
Irish Gulch	Belts/Dry Range	66
Middleman Mountain-Hedges Mountain	Belts/Dry Range	201
Mount Baldy	Belts/Dry Range	6
Nevada Mountain	Blackfoot/Continental Divide	36
Odgen Mountain	Blackfoot	7
Spectmen Creek	Blackfoot	16
Electric Peak	Blackfoot	0
Jericho Mountain	Continental Divide	0
Lazyman Mountain	Continental Divide	8
Total IRA Herbicide Treatment		**1038**

*Trace

In IRAs, the number of infested areas that would go untreated is approximately 1,361acres. This reduction in treated area is due to remoteness or worker safety on steep terrain with loose logs (burned areas, old clearcuts) or loose rocks, and no authority to treat newly discovered weed infestations. Noxious weeds would expand their populations and with them, their negative effects on native vegetation, thus reducing natural integrity and apparent naturalness of areas they take over.

TABLE 4-12
Summary of Herbicide Treatments in IRAs by Alternative

	Alt. A			Alt. B	Alt. C
IRA	**Aerial**	**Ground**	**Total**	**Ground**	**Ground**
Anaconda Hill	0	35	35	35	35
Bear-Marshall-Scapegoat-Swan	32	94	126	116	110
Big Log	38	72	110	88	39
Camas Creek	14	1	15	14	13
Cayuse Mountain	120	48	168	147	154
Crater Mountain	86	2	88	74	16
Devils Tower	35	119	154	142	152
Ellis Canyon	0	2	2	2	2
Grassy Mountain	0	13	13	13	13
Hellgate Gulch	81	96	177	122	138
Holter	0	26	26	26	26
Irish Gulch	0	66	66	66	66
Middleman Mountain-Hedges Mountain	906	122	1028	259	201
Mount Baldy	0	6	6	6	6
Nevada Mountain	94	12	106	73	36
Odgen Mountain	96	3	99	73	7
Spectmen Creek	16	0	16	16	16
Electric Peak	0	79	79	79	0
Jericho Mountain	0	0	0	0	0
Lazyman Mountain	75	10	85	67	8
Total IRA Herbicide Treatment	**1593**	**806**	**2399**	**1418**	**1038**

Weeds would continue to spread in areas where they were not treated. Since acres treated in Alternative C would be less than half of the infested acres, gains in apparent naturalness and natural integrity would be exceeded by the reduction in the short-term. The extent of weed infestations in IRAs that would not be treated could exceed existing infestation within four years, causing an overall decrease in natural integrity and apparent naturalness in the long-term.

Remoteness and Solitude

In Alternative C, weed treatment would mostly be through ground application of herbicide, with some handpulling. Impacts on solitude would be about two-thirds of those described in Alternative B, due to the decreased number of days/personnel that would be required to accomplish the chore.

The effects of handpulling and grazing control are the same as Alternative A.

CUMULATIVE EFFECTS

ALTERNATIVE A, B, AND C

Activities considered in the cumulative effects analysis for wilderness areas and IRAs include: Nevada Dalton project (prescribed fire, noxious weed treatment), prescribed fire, ongoing grazing, motorized and non-motorized recreation (trail riding, mountain biking, hiking, hunting, camping, swimming, boating) and wildfire. Reasonably foreseeable actions include future travel management decisions in the Belts/Dry Range, Blackfoot and Continental Divide LAs. The propose for these future decisions is to have a variety of motorized and administrative use, permitted use, and to access to private lands within the Forest boundary. These decisions will influence the risk of weeds spreading.

Natural Integrity and Apparent Naturalness

Cumulatively, increased use of IRAs by motorized vehicles, grazing, road construction (though limited), logging, and other ground disturbing activities would undoubtedly spread

weeds further into wilderness areas and IRAs. Wildfire and generally increased recreational use of IRAs and wilderness areas would also cause weed populations to spread. Both natural disturbance and disturbances associated with human activity contribute to the establishment and spread of exotics in wilderness areas, including livestock use, trail use, camping and existing roads adjacent to wilderness. Natural disturbances, including gopher pockets, floods, storms and fire also contribute to weed establishment and spread (Marler 2000).

Alternative A includes an adaptive management strategy, which would allow the treatment of weeds as they are discovered in wilderness and IRAs (see Chapter 2). Cumulatively, this alternative has the best chance of maintaining natural integrity and apparent naturalness by controlling weeds within those areas at this early and most effective stage.

Alternative B would be somewhat effective, since it contains the same adaptive management strategy. However, since aerial herbicide application would not be allowed, cumulatively, weed infestations would expand and new infestations would be established without effective treatment. When added to the direct and indirect effects, weed spread outside of effective treatment areas would reduce the natural integrity in wilderness and IRAs. Within five years, the acres infested with noxious weeds in these areas would exceed the current situation.

If currently infested areas are not treated, as in **Alternative C**, the cumulative effect of added disturbance with the aggressive spread of weed species would result in a drastic reduction in apparent naturalness and natural integrity of those areas within five years.

Remoteness and Solitude

In **Alternatives A and B**, additional disturbance and infestation acres would result in additional weed control activities (herbicide, mechanical and biological control) as described under the direct and indirect effects, as cumulative effects activities continue within wilderness and IRAs, with their associated effects on remoteness and solitude described under direct and indirect effects. However, these effects are expected to remain minor during the 12-year period of this project, affecting only a few more additional acres (and consequently) days after the initial treatment. It is anticipated that effective weed treatment at this time would reduce (although not eliminate) the need for weed treatments in the future in wilderness, proposed wilderness and IRAs.

Continued weed spread from cumulative activities, as would occur under **Alternative C** would result in reduce opportunities for remoteness and solitude as people choose to avoid areas of noxious weed spread. Opportunities could be reduced further, if, due to lack of action now, a larger scale treatment and/or closure is required later.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Under Alternative C, once weeds become well established in wilderness and inventoried roadless areas, eradication would probably never occur, resulting in an irreversible loss of natural integrity and apparent naturalness.

CONSISTENCY WITH FOREST PLANS AND OTHER LAWS AND POLICIES

All alternatives are consistent with management direction found in the Forest Plan, the Wilderness Act and proposed Roadless Area Conservation Rule. All alternatives are consistent with FSM 2109.14 (13.4) for pesticide use in wilderness areas as long as the Regional Forester approves the annual pesticide use plan.

WILD AND SCENIC RIVERS

DIRECT AND INDIRECT EFFECTS

ALTERNATIVES A AND B

Within Wild and Scenic River (WSR) corridors, both alternatives have the same activities. Ground herbicide application would occur on all 392 acres currently infested with weeds. In the Beaver Creek corridor, 94 acres would also have biological controls. In the Missouri River corridor and about half of the infested area in the Beaver Creek corridor, grazing would be used to control weeds.

Herbicide Application

Herbicides would not have impact on outstandingly remarkable values of geology and recreation. Directly, wilting plants would be visible but it would not affect the outstandingly remarkable value of scenery. Indirectly, scenery would be improved as noxious weed populations decline and are replaced with native vegetation.

For these river segments, outstandingly remarkable value of wildlife includes elk, grizzly bear, wolves, bald eagles, cutthroat trout, and bull trout (NPS 2001). More detailed effects analysis on these species can be found in the Wildlife and Fish specialist's reports. In summary, herbicide, grazing, biological and mechanical controls of noxious weeds would not adversely affect wildlife, and would, in fact, improve wildlife habitat conditions (PF – Wildlife Specialist Report)

The outstandingly remarkable value of fish would not be directly affected by the proposed activity given the Environmental Protection Measures listed in Chapter 2 (see the *Fisheries and Aquatic Resources* section for more detail on the potential effects on fish). Indirectly, fish habitat would benefit from continued reductions of weed infestations, as native vegetation is restored.

Biological Control

Biological controls would have no effect on the outstandingly remarkable values.

Grazing

Grazing in the locations and as prescribed would have no impact on the outstandingly remarkable values of the Missouri River or Beaver Creek WSRs. No grazing would occur in the other river corridors.

ALTERNATIVE C

Within WSR corridors, Alternative C would include ground herbicide application on 377 of the 392 acres currently infested with weeds. In the Beaver Creek corridor, 94 acres would also have biological controls. No grazing would be used to control weeds.

No additional weed treatments would occur. There would be no direct effect from this alternative. Indirectly, weeds would continue to spread within the corridor, reducing outstandingly remarkable values of scenery, wildlife, and recreation in the Missouri River segment and wildlife in the Copper Creek segment. See the *Wildlife* section for more description of how noxious weeds affect prey species for grizzly bear.

CUMULATIVE EFFECTS

ALTERNATIVES A AND B

The only direct or indirect effects identified for Alternative A and B are beneficial effects on the outstandingly remarkable values for each eligible segment. No cumulative effects activities were identified that would add to the beneficial effects.

ALTERNATIVE C

Cumulative effects include increased recreation (particularly in the Copper Creek segment with the Lewis and Clark bicentennial approaching in 2005) and potential wildfire. These activities would increase the spread of weeds, which, with less treatment, would further reduce the

outstandingly remarkable values of scenery, recreation, and wildlife habitat. Dense infestations of noxious weeds can accelerate erosion (see the soils analysis), which, in the long-term, would reduce the outstandingly remarkable value of fish in all the river segments, particularly because of the close proximity of the weed infestations to the rivers themselves.

CONSISTENCY WITH FOREST PLAN, LAWS AND POLICIES

All Alternatives are consistent with the goals and objectives of the Helena NF Plan for eligible river segments to protect and maintain their potential classification.

RECREATION

DIRECT AND INDIRECT EFFECTS

ALTERNATIVES A AND B

Direct and indirect effects on recreation resulting from implementation would include short-term (one to seven days) encounters with herbicide treatment crews and visual impacts from wilting plants. Additional effects resulting from alternatives would be the protection of adjacent non-infested areas and preservation of intact plant communities, which would enhance the recreation experience. Concern over herbicides may cause some Forest users to choose to recreate in areas that have not been recently treated with herbicides. All weed treatment activities would be conducted in compliance with Helena Forest Travel Plan regulations, which allow for administrative use. When cross-country motorized travel is necessary to facilitate weed control, appropriate signs would be placed in the area of treatment. The use of wheeled vehicles would result in short-term visual impacts in the form of tracks created by laying down grasses. In dry years, these tracks could remain visible throughout the season while in wetter years they could be erased by rains and regrowth before fall.

All known weed infestations in dispersed sites, permitted use sites, special use sites, rental cabin sites and special use cabin sites would be treated in these alternatives.

Release of biological control agents would have no direct impacts on recreational opportunities because the insects would not be apparent to the public. If the treatment method is successful in reducing infestations of noxious weeds, it could have some positive indirect effects on recreational opportunities.

Under Alternative A and B, herbicide treatment would decrease establishment and expansion of aggressive species into non-infested areas and reduce weed-related impacts on recreation. The visual impact of spraying would be temporary and on most sites only last a few hours or less. Dying and wilting plants following herbicide treatment could be apparent. However, this appearance would be short-lived as surrounding vegetation would screen dead plants or blend with native vegetation, as it grew dormant.

Long-term improvements include an overall reduction of stiff plant stalks and sharp bristle and increases in the variety and amount of native flora. Treating noxious weeds would be an improvement in the overall recreational environment, including the desirability and enjoyment of recreational sites, although in Alternative B, not all areas would benefit.

ALTERNATIVE C

All known weed infestations in dispersed sites, permitted use sites, special use sites, rental cabin sites and special use cabin sites would be treated in these alternatives.

Under the No Action Alternative the current weed control program would continue. Spread of noxious weeds could result in the unavoidable deterioration of the natural condition of adjoining land diminishing the recreational experience for some people. The negative effects noxious weeds would have on

use of recreation sites would be greatest under this alternative.

Long-term effects of treating noxious weeds with this alternative would be the same as Alternative A; however, the acres of beneficial effects would be reduced.

CUMULATIVE EFFECTS

Cumulative effects from activities described at the beginning of this chapter would continue to impact recreation, affecting the location where and times when people can recreate at various locations across the Helena NF. Effects on recreation under any of the alternatives would be minor, short-term (one to seven days) displacement of recreational activities. While visitor displacement is the most likely direct effect of weed treatment, short-term (one to three years) visual impacts from cross-country motorized travel are also possible.

CONSISTENCY WITH FOREST PLAN AND OTHERS LAWS AND POLICIES

All alternatives are consistent with the Forest Plan.

RESEARCH NATURAL AREAS

DIRECT AND INDIRECT EFFECTS

ALTERNATIVES A AND B

Within RNAs, these alternatives contain the same proposed weed treatment. Aerial application is excluded from RNAs (Chapter 2 – *Environmental Protection Measures*). Proposed activity within RNAs includes spot application of herbicide, totaling approximately five acres in the Cabin Gulch RNA.

Weed treatment would protect the natural ecological composition of the RNAs, and protect their identified values for research. Since weeds have been located adjacent to the RNAs, effective treatment of those areas would help protect the RNAs by helping to eliminate establishment of noxious and invasive weeds within them. Adaptive management activities proposed include the identification and treatment of weeds that may enter the RNAs through natural sources (e.g. wind, wildlife, fire). Effects from treatment of new locations would be the same as those already identified.

ALTERNATIVE C

The five acres of known weed infestation in the Cabin Gulch RNA have already been treated and are covered under a previous decision for herbicide treatment. The difference between Alternative C and Alternatives A and B is that future weed spread into the RNAs would not be treated. Indirectly, this could lead to larger infestations, although currently, the risk is low.

CUMULATIVE EFFECTS

Under all alternatives, there were no identified activities within RNAs that would increase the risk of noxious weed spread, with the exception of wildfire. Cumulative effects may occur when weed-spreading activities occur next to RNAs. Under Alternatives A and B, ongoing, effective treatments of weeds would maintain the ecological integrity and research value of the areas. Under Alternative C, in the long-term, the lack of treatment of potential new infestations along with the likelihood that weeds would eventually spread from outside the RNAs into them poses a risk that the RNAs would lose their research value.

CONSISTENCY WITH LAWS AND POLICIES

Forest Plan Direction

All of the alternatives are consistent with the Forest Plan. All alternatives are consistent with direction in the Establishment Records by proposing specific control against target organisms, and by taking measures to control or eradicate these populations. In addition, this EIS satisfies the requirement to review the need for, and type of, noxious weed control on a

case-specific basis and covered by an appropriate review under NEPA.

None of the alternatives contains grazing as a weed control method within RNAs, which is consistent with the Forest Plan Management Area N-1 standard.

FSM 4063 – Research

Alternatives A and B would be consistent with Forest Service Manual 4063 by removing exotic plant or animal life. Alternative C would be consistent until a new weed infestation is discovered in an RNA, at which time additional NEPA would have to be completed in order to comply with this manual.

CULTURAL RESOURCES

DIRECT AND INDIRECT EFFECTS

The project file (PF-Heritage) contains sites located during the records search that are within one of the treatment areas under any or all of the alternatives.

ALTERNATIVES A, B AND C

Results of the records review are presented in **Table 4-13**. In addition to previously recorded cultural resources, there are areas slated for treatment that contain historic mining resources not yet recorded. A review of U. S. Geological Survey quadrangles indicates several areas in the Belts/Dry Range and Continental Divide LA treatment areas rich in historic mining resources.

Handpulling, livestock grazing, and mechanical weed control treatments could negatively affect historical resources through disturbance effects (Schiffer 1987, 121). Handpulling of weeds and mechanical treatments, for example, could potentially disturb subsurface components of cultural resources. Disturbance of the subsurface would destroy the archaeological context of the resource, reducing the resource's information potential. The disturbance caused by handpulling or mechanical treatment could result in modification of artifacts or the relocation of artifacts (Schiffer 1987, 121). For this reason, these treatments have been prohibited in sites known to be eligible for NRHP listing, or where eligibility is unknown or unresolved (see

TABLE 4-13
Previously Recorded Cultural Resources Within Treatment Areas

Type of Site/Location	Alt A	Alt B	Alt C
Belts/Dry Range LA			
Sites Eligible	17	16	15
Sites Ineligible	24	23	22
Sites with Unknown Eligibility	8	8	8
Total Number of Cultural Resources	49	47	45
Elkhorn LA			
Sites Eligible	1	1	1
Sites Ineligible	5	5	5
Sites with Unknown Eligibility	0	0	0
Total Number of Cultural Resources	6	6	6
Blackfoot LA			
Sites Eligible	7	7	6
Sites Ineligible	3	3	3
Sites with Unknown Eligibility	2	2	2
Total Number of Cultural Resources	12	12	11
Continental Divide LA			
Sites Eligible	5	5	5
Sites Ineligible	4	4	4
Sites with Unknown Eligibility	7	7	6
Total Number of Cultural Resources	16	16	15
Total	**83**	**81**	**77**

Environmental Protection Measures in Chapter 2 **Table 2-4**). This EPM would ensure that no sites are negatively affected by these treatments.

Driving ATV's across cultural resources for herbicide applications could also disturb the subsurface components of archaeological resources through the disturbance process known as surficial trampling (Schiffer 1987, 126). Surficial trampling could also result in the modification or relocation of artifacts. An EPM has been included in Chapter 2 to prohibit wheeled vehicle traffic across fragile ruins or other significant cultural site if the Forest archeologist deems it necessary. This would avoid impacts on these sites.

Biological control efforts such as the introduction of insects, and aerial application of herbicides would not have any effects on cultural resources.

CUMULATIVE EFFECTS

Cumulative effects of treatments on cultural resources known to be eligible for NRHP listing, or where eligibility is unknown or unresolved may be detrimental to the resource. These effects include degradation or removal of the integrity of the resource and potential to render the resource ineligible for the NRHP. Ongoing permitted grazing of livestock has potential for damage to heritage sites. Trampling of resources by cattle, as described above, could potentially modify or relocate artifacts. Cumulative effects of noxious weed removal and cattle grazing around heritage resources have not been fully explored by heritage resource managers. Removal of noxious weeds might improve visitor access to and enjoyment of historic mining resources. Removal of noxious weeds might increase cattle grazing across and adjacent to heritage resources, thereby increasing trampling effects. The removal or reduction of noxious weeds from heritage resources could also be an expression of good resource stewardship and could result in a reduction in unwanted destructive visitor impact.

CONSISTENCY WITH FOREST PLAN AND OTHERS LAWS AND POLICIES

The National Historic Preservation Act requires federal agencies to consider the potential impacts of undertakings on eligible resources. Avoiding disturbing treatments of the areas where these resources are located is in compliance with the National Historic Preservation Act.

TABLE 4-14
Weed Control Methods and Costs

Method	General Effectiveness	Cost/ Acre*
Ground application of herbicide – vehicle access	High	$24 – 115
Ground application – primarily vehicle access-some backpacking (current Helena NF method)	High	$62
Ground application of herbicide – backpack access	High	$125-350
Aerial application of herbicide	High	$18 – 24
Biologicals (40 insects per acre)	Low - High	$40*
Grazing	Low	$20-48
Handpulling	High for small infestations of taprooted weeds; low for high density infestation > 1 acres or rhizomatous.	$8,800

* Costs per acre for herbicide treatment and handpulling are dependent on the density of the weed infestation.

SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

Costs of the Weed Treatment Program

Table 4-14 presents the estimated cost and effectiveness of noxious weed control methods proposed. Estimated per acre costs were derived from experienced costs on the Helena NF, other forests in Region 1 (Bitterroot and Lolo), and the Missoula Field Office of the Bureau of Land Management (BLM). Strict comparisons between the costs are difficult to make because of the varying types of chemicals used, the varying types of terrain, distance from roads, and the density of weeds.

DIRECT AND INDIRECT EFFECTS

ALTERNATIVE A

A limited number of temporary, seasonal jobs would be created under Alternative A. Local service and retail trade may realize a slight increase in the purchase of goods and services during the short seasonal spraying event. With an average annual budget of $300,000, based on the average cost per acres of treatment, approximately 6,500 acres could be treated each year, allowing the Forest to complete initial treatment of the total acreage in 3 to 4 years (see **Table 4-15**).

ALTERNATIVE B

A limited number of temporary, seasonal jobs would be created under Alternative B. Local service and retail trade may see a slight increase in the purchase of goods and services during the short seasonal spraying event. With an average annual budget of $300,000, based on the average cost per acre of treatment, approximately 4,500 acres could be treated each year, allowing the Forest to complete initial treatment of the total acreage in 4 to 5 years (see **Table 4-16**).

ALTERNATIVE C

No changes in the present weed management program on the Helena NF would occur under the No Action Alternative. With an average annual budget of $300,000, based on the average cost per acre of treatment, approximately 4,800 acres would be treated

TABLE 4-15
Alternative A Costs

Landscape Area/Treatment Type	Acres Treated	Cost per Acre	Total Cost*
Aerial	5,817	$18-24	$104,706 – 139,608
Ground	4,086	$62	$253,332
Grazing	1,330	$20-48	$26,600 – 63,840
Belts/Dry Range - Total	9,903		$384,636 – 456,780
Aerial	710	$18-24	$12,780 – 17,040
Ground	808	$62	$50,096
Ground/Biological	274	$102	$27,946
Elkhorn- Total	1,792		$90,824 – 95,082
Aerial	1,664	$18-24	$29,952 – 39,936
Ground	2,811	$62	$174,282
Ground/Biological	1,170	$102	$119,340
Grazing	26	$20-48	$520 – 1,248
Continental Divide - Total	5,645		$324,094 –334,806
Aerial	2,895	$18-24	$52,110 – 69,480
Ground	2,433	$62	$150,846
Blackfoot- Total	5,328		$202,956 – 220,326
Alternative A Total	22,668	Ave/acre	$1,002,510 = $44.23/ac- $1,106,994 = $48.84/ac

* Total cost would be spread over the years necessary to provide initial treatment.

TABLE 4-16
Alternative B Costs

Landscape Area/Treatment Type	Acres Treated	Cost per Acre	Total Cost**
Ground	7,917	$62	$490,854
Grazing*	1,330	$20-48	$26,600 – 63,840
Belts/Dry Range - Total	7,917		$517,454 – 554,694
Ground	1,482	$62	$91,884
Ground/Biological	274	$102	$ 27,946
Elkhorn- Total	1,756		$119,830
Ground	4,132	$62	$256,184
Ground/Biological	1,170	$102	$119,340
Grazing*	26	$20-48	$520 – 1,248
Continental Divide - Total	5,302		$376,534 – 377,262
Ground	3,938	$62	$244,156
Blackfoot- Total	3,938		$244,156
Alternative B Total	18,913	Average/acre	$1,257,974 = $66.51/ac $1,295,942 = $68.52/ac

* Grazing is also counted in "Ground" acres

** Total cost would be spread over the years necessary to provide initial treatment.

each year, allowing the Forest to complete initial treatment of the total acreage in 3 to 4 years (see **Table 4-17**).

CUMULATIVE EFFECTS

Travel management decisions made at the project and Forest level may affect management access to weed treatment areas. If access is made more difficult, treatment costs per acre would increase. This would be most notable in Alternative B, which has the most ground treatment acres. Costs for Alternative A could increase slightly, depending on location of ground based weed treatments and changes in

access. Effects of Alternative C would be reduced over Alternative B, since fewer acres would be affected by changes in access.

CONSISTENCY WITH FOREST PLAN, LAWS, AND POLICIES

By considering the cost of the proposed project and alternatives, the project is in compliance with the Forest Plan goal for economics. Forest Plan direction does not dictate that economic efficiency is the overriding consideration in selecting management actions.

Present and reasonably foreseeable activities that affect the economic issues are limited to the ongoing weed treatment activities on the Helena NF.

EO 12898 - Environmental Justice

No minority or low-income communities would be disproportionately impacted by any of the

TABLE 4-17
Alternative C Costs

Landscape Area/Treatment Type	Acres Treated	Cost per Acre	Total Cost*
Belts/Dry Range - Total			**$448,880**
Ground	7,240	$62	$448,880
Elkhorn- Total			**$91,326**
Ground	1,473	$62	$91,326
Continental Divide - Total			**$184,264**
Ground	2,918	$62	$184,264
Blackfoot- Total			**$262,880**
Ground	4,240	$62	$262,880
Alternative C Costs	**15,871**		**$987,350**

* Total cost would be spread over the years necessary to provide initial treatment.

alternatives. Implementing any alternative would not alter opportunities for subsistence hunting by Native American tribes.

HUMAN HEALTH AND SAFETY

DIRECT AND INDIRECT EFFECTS

ALTERNATIVES A, B AND C

Mechanical Treatments

Potential risks to human health from mechanical weed control methods are very low and include emissions from gasoline or diesel powered equipment and cuts, burns, allergies, and skin irritation from direct contact with plants by individuals doing the work.

Some invasive weed species can cause allergies and minor skin irritations in a few individuals. Some species of invasive weeds, such as thistles, cause minor scrapes and irritations, and there are other more serious complications that may result from hand pulling. For example, leafy spurge contains a latex-bearing sap that irritates human skin and rarely causes blindness in humans upon contact with the eye (Callihan *et al.* 1991). There have also been claims (not medically supported) that hand pulling of knapweed may result in the formation of tumors on the hands. Highly allergic individuals can have serious complications when exposed to allergens (weeds or pollen), including constriction of the airway and anaphylactic shock, the significance of which should not be underestimated since forest workers would be working some distance from medical assistance.

Approximately 10 to 15 percent of the U.S. population suffers from allergy symptoms from invasive weed species such as knapweed. Knapweed is a common and powerful allergen that peaks in August (Gillespie and Hedstrom 1979). Allergies to weeds such as knapweed may complicate or trigger asthma. It may take up to two years after getting a person's allergies under control to see a benefit in reduced asthma symptoms (Nielsen 1999).

While there is some potential for health effects associated with mechanical treatment of weeds, required personal protective equipment (PPE) such as gloves, long sleeved shirts, boots, and safety glasses along with personal hygiene, would prevent injuries or irritations, and therefore, no human health effects are anticipated by mechanical removal of weeds.

Cultural Treatments

Potential human health risks associated with cultural control methods include exposure to dust and chaff during seeding operations. Allergic reactions can result from the exposure of seed/chaf when handling seeds; however, gloves, long sleeved shirts, boots, and other PPE, as needed, would prevent injuries or irritations. Therefore, no human health effects are anticipated by cultural control methods.

Biological Treatments

Biological treatments would result in no known risks to human health.

Herbicide Treatments

The following primary referenced literature was used to analyze potential human health risks associated with ground and aerial application of herbicides:

- The Risk Assessment for Herbicide Use in Forest Service Regions 1,2,3,4 and 10 and on Bonneville Power Administration Sites (USFS 1992) (referred to as RAHUFS). This analysis was developed for the Forest Service specifically to address human health issues raised by use of herbicides.
- Assessing the Safety of Herbicides for Vegetation Management in the Missoula Valley Region – A Question and Answer Guide to Human Health Issues, referred to as ASH (Felsot 2001).
- Risk Assessments completed by the Forest Service under contract with

Syracuse Environmental Research Associates for 2,4-D, picloram, clopyralid, dicamba, hexazinone, sulfometuron methyl, metsulfuron methyl, triclopyr, imazapic, and imazapyr. (USFS 1995d; USFS 1996c; USFS 1996d; USFS 1997d; USFS 1997c; USFS 1998b; USFS 1998c; USFS 1999b-d; USFS 2002; USFS 2001)

Three levels of analyses were used in the above risk assessment processes: 1) a review of toxicity test data (i.e., acute, chronic, and sub-chronic) for herbicides proposed for use on the Project to determine dosage that could pose a risk to human health; 2) an estimate of exposure levels to which workers (applicators) and general public may be exposed during treatment operations; and 3) comparison of dose levels to toxicological thresholds developed by EPA to determine potential health risks.

Toxicity test data on laboratory animals is available for herbicides proposed for use in this analysis. Most tests have been conducted under EPA pesticide registration/re-registration requirements for use in the United States. The EPA uses test data to determine conditions for use of herbicides in the United States.

Label restrictions on herbicides are developed to mitigate, reduce, or eliminate potential risks to humans and the environment. Label information and requirements include: PPE; User Safety; First Aid; Environmental Hazards; Directions for Use; Storage and Disposal; General Information; Mixing and Application Methods; Approved Uses; Weeds Controlled; and Application Rates.

Analysis of herbicide use in this EIS assumes compliance with the product label during handling and application. Additional environmental protection measures are typically developed by Forest resource specialists to further reduce potential risks to human health and the environment during application of herbicides. These measures are implemented during analysis and at time of application to ensure mitigation is greater than required by USEPA label requirements.

Factors Affecting Hazard of Herbicide

Method of Application

How herbicides are applied can have a direct impact on the potential for human health effects. According to risk assessments completed on herbicide usage on forest lands (USFS 1995d; USFS1996d; USFS 1996c; USFS 1997d; USFS 1998b; USFS 1998c; USFS 1999b-d; USFS 2000; USFS 2001), herbicide applicators are at a higher risk than the general public from herbicide use. The risk assessments compared risks to workers for all types of application, including aerial, backpack, ground-mechanical, and hand applications. Lower risks were estimated for aerial and ground mechanical application as compared to other methods, even though the total amount of herbicide applied in a given day was higher. Risks associated with backpack and hand application of herbicides were estimated to be the highest, due to workers being closer to the nozzle and to the containers from which the herbicides were sprayed. Backpack and hand application was also reported to increase the likelihood of a worker receiving repeated exposures that may remain on the worker's skin for an extended time period.

The USEPA, in its re-registration of picloram (USEPA 1995), also noted that the highest risk for herbicide applicators was for those using the backpack application method. The lowest risk was for aerial and ground-boom applicators.

Length of Exposure

The magnitude of a dose that is hazardous to health depends on whether a single dose is given all at once (acute exposure); multiple doses are given over longer periods (chronic exposure); or, regularly repeated doses or exposures over periods ranging from several days to months (sub-chronic). The USEPA develops Reference Doses (RfDs), which are an estimate of a daily dose over a 70-year life span that a human can receive without an appreciable risk of deleterious effects (USEPA 1989). RfDs include a "safety factor" where the No Observable Effect Level (NOEL) is divided by a

factor, usually 100, to account for uncertainty and hypersensitive individuals. The 100 value is derived by including a safety margin of 10 for extrapolating study results from mammals to humans, and an additional safety factor of 10 for variation in population response to a particular compound.

The RfD is a conservative threshold of toxicity relative to this analysis because it assumes daily exposure over a 70-year life span. Actual worker exposures for herbicide treatments in this project would typically be between 20 and 80 days each year for substantially less than 70 years. The RfD is also calculated from the NOEL, assuming humans are 100 times more sensitive than animals to the chemical tested.

Potential doses to workers or the public from application of herbicides would be transitory. Lifetime RfDs are used here as a convenient and conservative comparison for determining significance of human doses. Lifetime RfD values are based on daily feeding studies, whereas workers and the general public would not be exposed daily over a lifetime. Maximum duration of exposure for workers on a yearly basis was estimated in the range of 10 to 40 days for commercial applicators (USEPA 1995). This may be on the lower end of the range as treatments of weeds in spring and fall have become more popular.

Route of Exposure

Substances tested for acute toxicity are usually administered by pumping a chemical down a tube into an animal's stomach. From this route of exposure, an oral LD_{50} (lethal dose that kills 50 percent of a test population, measured in one milligram of herbicide per kilogram of animal weight) can be estimated. Exposure during chronic testing usually involves placing the chemical in the animal's food, and then measuring the amount of food eaten during each 24-hour period (USEPA 1996a,b).

Test substances are also applied to the shaved skin of an animal to estimate a dermal LD_{50}. About 10 percent of the animal's body surface is exposed to a chemical covered by a patch for 24 hours. In acute exposure studies, whether by oral or dermal routes, animals are monitored for a range of adverse responses for 14 days following dosing (USEPA 1996c).

Skin acts as a protective barrier to limit and slow down movement of a chemical into the body. Studies of pesticides applied to the skin of humans indicate that for many only about 10 percent or less passes into the blood. In contrast, absorption of chemicals from the small intestine is quicker and more complete than from the skin (Ross *et al.* 2000). For this reason, dermal LD_{50}'s are usually much higher than oral LD_{50}'s. A person can tolerate greater doses of a substance without becoming sick when exposure is through skin contact rather than through ingestion (Hayes 1991).

Test organisms are also administered substances in air to estimate an inhalation LD_{50}. In this case, exposure units are expressed as milligrams of test substance per unit of volume (usually a liter of air, which is equivalent to 0.035 cubic feet). The onset of illness can occur more quickly by inhalation exposure than by oral or dermal contact due to rapid entry of the substance into the blood stream. However, studies with pesticide applicators (who receive higher exposures than the general public) indicate dermal exposures are greater than inhalation exposures (Ross *et al.* 2000).

Required personal protective equipment (PPE) used by workers during pesticide application (gloves, waterproof boots etc.) is designed to reduce exposure to sensitive areas on the body. Use of PPE as required by the Forest Service job hazard analysis would protect worker health.

Toxicity of Herbicides

A comparison of toxicity for typical herbicides is shown in **Table 4-18.** Toxicological studies using animals typically involve purposeful exposure to dosages required to cause an effect (i.e. tumors, changes in immunity, etc.), or to establish a Lowest Observed Effect Level, known as a (LOEL) or a No-Observed-Effect-Level (NOEL). This often requires

TABLE 4-18
Comparison of Herbicide Toxicity

Herbicide	Carcinogenic[1]	Estimated Exposure to Public[2]	Estimated Exposure to Worker[2]	RfD (mg/kg/day)	Mutagenic and Reproductive[3]	Acute oral LD50 for rats (mg/kg/day)
Glyphosate	E	<RfD	<RfD	0.1	No	2,000 - 6,000
Picloram	E	<RfD	<RfD[6]	0.2	No	3,000 - 5,000
Hexazinone	D	<RfD	below to slightly above RfD[7]	0.03/0.05[4]	No	1,690
Clopyralid	E	<RfD	<RfD	0.5	No	2,675 - 5,000
2,4-D	D	<RfD	below to slightly above RfD[8]	0.01	No	100 - 1,800
Dicamba	D	<RfD	<RfD	0.03	No	757 - 1,701
Chlorsulfuron	E	<RfD	<RfD	0.05	No	>5,000
Metsulfuron methyl	E	<RfD	<RfD	0.25	No to slight	>5,000
Triclopyr	E	<RfD	<RfD	0.005	No to slight	630 - 729
Sulfometuron methyl	E	<RfD	<RfD	0.02[5]	No	>5,000
Imazapyr	E	<RfD	<RfD	2.5[5]	No	>5,000
Imazapic	E	<RfD	<RfD	0.05	No	5,000

RfD = Reference Dose; Units expressed as milligrams of herbicide per kilogram of body weight = mg/kg; LD_{50} = lethal dose in milligram of herbicide per kilogram of animal weight that kills 50 percent of a test population.

[1] EPA carcinogenicity classification based on daily consumption for a 70-year life span. D = Not Classifiable as to Human Carcinogenicity; E = Evidence of Non-Carcinogenicity

[2] Exposures under typical exposure scenarios. Accidental and extreme exposure scenarios may exceed the RfD.

[3] Unlikely that compound is mutagenic or would pose a mutagenic risk to humans at expected exposure levels.

[4] Two RfDs reported.

[5] Provisional RfD, USEPA has not derived RfD for this compound.

[6] USFS (1999b) reports that worker wearing contaminated glove may received an absorbed dose greater than the RfD.

[7] USFS (1997a) reports that over a range of plausible application rates, workers may be exposed to hexazinone at levels that exceed the RfD.

[8] USFS (1998) reports that worker involved in ground or aerial application of 2,4-D may be exposed to levels above the RfD if effective methods to protect workers and minimize exposure are not employed.

Source: Infoventures 1995a-j; OSU 1996a-h; USEPA 1990; USEPA; 1990a; USFS 1995; USFS 1996a; USFS 1997a; USFS 1997c; USFS 1998; USFS 1998d; USFS 1999c-d; USFS 2000; USFS 2001; USFS 2001b.

administration of relatively high doses of a chemical in order to document an effect or lack thereof. The causal dose in many toxicological studies is significantly greater than what an applicator might be exposed to while applying herbicides or the public may be exposed to walking through a treated field or living adjacent to treated land. Therefore, concluding that an applicator may experience neurological effects because a study in rats showed such connection, may lead to an erroneous conclusion because the dose administered to the rat is in no way representative to what an applicator may be exposed to when applying a herbicide. In addition, the method of exposure to herbicides in animal studies is uniquely different than that of a worker or person of the general public, possibly leading to a causal effect. In animal studies, herbicides are commonly pumped into stomachs (gavage), put directly into food, or placed directly on shaved skin. Herbicide applicators and the general public are clothed and do not purposely ingest herbicides under the same conditions as animals studies of toxicological significance.

Estimates of exposure to workers and the general public of herbicides applied to forest lands have been reported under various conservative exposure scenarios (USFS 1995; USFS 1996a; USFS 1997a-c; USFS 1998; USFS 1998d; USFS 1999c; USFS 1999d; USFS 2000;

USFS 2001). The most reasonable interpretation of the risks associated with application of most herbicides on forest lands is that, except for accidental exposures or extremely atypical and perhaps implausible exposures scenarios (i.e. acute direct spray entirely covering a naked child), the use of herbicides on forest lands would not pose an identifiable risk to workers or the general public. Exposures under typical exposure scenarios (those following guidelines on the label) would be below the RfD, a dose level determined to be safe by USEPA over a lifetime of daily exposure.

There are exceptions worth noting that may help identify protective measures that could be instituted when applying herbicides. USFS (1997d) reports that over a range of plausible application rates, workers may be exposed to hexazinone at levels that exceed the RfD. Likewise, there is reasonable concern that workers applying triclopyr over a prolonged period of time in the course of a single season and/or several seasons may be at risk of impaired kidney function. (USFS 1996d) USFS (1998b) reports that if 2,4-D were applied directly to fruits and vegetables at anticipated application rates, the consumption of vegetables would be undesirable and could lead to health effects. They point out; however, that the likelihood of such an exposure seems remote when applying on forest lands. USFS (1998b) also reports that exposure levels for workers involved in ground or aerial application of 2,4-D may exceed the RfD slightly, based on central estimates of exposure, or substantially, based on upper limits of exposure. They go on to indicate that 2,4-D can be applied safely, (exposure doses below the RfD) if effective methods are used to protect workers and minimize exposure (personal protective equipment). USFS (1999b) also reported that there is no evidence that typical exposures to picloram would lead to a dose level that exceeds the RfD or level of concern with the exception of wearing contaminated gloves for one hour, which results in estimates of absorbed doses that exceed the RfD.

Acute Toxicity

Acute toxicity is measured by the LD_{50}, defined as the dosage of toxicant expressed in milligrams per kilogram of body weight, which is lethal to 50 percent of animals in a test population within 14 days of administration (USFS 1992). Since potential exposure levels to workers and the general public associated with use of herbicides on forest lands have been estimated to be at or below USEPA RfDs, dosages would not exceed acute toxicity dose levels when applying herbicides on forest lands.

Sub-Chronic and Chronic Toxicity

There is considerable information on sub-chronic and chronic effects due to exposure to herbicides in controlled animal studies. The information suggests that the herbicides proposed for use by the forest are not carcinogenic, and there is no evidence to suggest that the herbicides proposed for use by the forest would result in carcinogenic, mutagenic, teratogenic, neurological or reproductive effects based on anticipated exposure levels to workers and the public (Arbuckle 1999; Charles *et al.* 1996; Faustini 1996; Ibrahim, et.al 1991; Mattsson 1997; Mustonen 1986; Infoventures 1995a-j; OSU 1996a-h; USEPA 1990; USEPA; 1990a; USFS 1995; USFS 1996a; USFS 1997a; USFS 1997c; USFS 1998; USFS 1998d; USFS 1999c-d; USFS 2000; USFS 2001; USFS 2001b).

Synergistic Interactions

Concerns are occasionally raised about potential synergistic interactions of herbicides with other herbicides in the environment or when they are mixed during application (tank mixing). Synergism is a special type of interaction in which the combined impact of two or more herbicides is greater than the impact predicted by adding their individual effects. The RAHUFS addresses the possibility of a variety of such interactions. These include the interaction of the active ingredients in an herbicide formulation with its inert ingredients, the interactions of these herbicides with other herbicides in the environment, and the cumulative impacts of spraying as proposed with

other herbicide spraying to which the public might be exposed.

No one can guarantee the absence of a synergistic interaction between herbicides and/or other chemicals to which workers or the public might be exposed. For example, exposure to benzene, a known carcinogen that comprises 1 to 5 percent of automobile fuel and 2.5 percent of automobile exhaust, followed by exposure to any of these herbicides could result in unexpected biochemical interactions (USFS 1997b). Analysis of the infinite number of materials a person may ingest or be exposed to in combination with chemicals is outside the scope of this analysis. That being said, there is some indication that the co-exposure to 2,4-D and picloram may induce effects not associated with exposure to 2,4-D or picloram alone (USFS 1998b; Cox 1998; OSU 1996a).

Impurities, Adjuvant and Inert ingredients in Herbicide Formulations

During commercial synthesis of some pesticides, byproducts can be produced and carryover into the product eventually formulated for sale. Occasionally byproducts or impurities are considered toxicologically hazardous, and their concentrations must be limited so that potential exposures do not exceed levels of concern (Felsot 2001).

Technical grade picloram (prior to mixing with other inerts) and clopyralid contains hexachlorobenzene (HCB) as a byproduct of the synthesis of the active ingredients (USFS 1999c). HCB is also a byproduct of chlorinated solvents used extensively in industry and occasionally around the home. HCB was registered as a fungicide until banned by EPA over concerns that it may be carcinogenic. As a result, EPA has imposed a limit of 100 parts per million (ppm), HCB in Tordon®. The manufacturer of Tordon® has set its own manufacturing standard even lower and reportedly maintains HCB levels in formulated picloram at 50 ppm or less (i.e. 50 milligrams per liter of formulation). Average concentrations of HCB in picloram have been estimated at 8 ppm (USEPA, 1995). Therefore, HCB comprises only 0.000005 percent of the Tordon® formulation, which is then further diluted when the spray solution is prepared in accordance with the label.

Given the dilution of formulations by water in the final spray solution, estimates of HCB exposure from use of picloram or clopyralid-containing products have shown that resulting residues in the environment and bystander exposure levels do not exceed current background levels. Longer-term dose estimates for the general public exposed to HCB in clopyralid were below the general background exposure to HCB in the environment by factors of about 25,000 to several million (USFS 1999c). The central estimates of worker exposure to HCB under normal conditions were estimated to be lower than the background levels of exposure by factors of about 1,000. Likewise, the exposure assessments based on the use of picloram by the USFS have been estimated to result in long-term predictions for the general public that are below background doses of HCB due to environmental contamination by factors of about 1,400 to seven million (USFS 1999b). Thus, for commercially sold products which are more dilute than technical grade products, there appears to be no basis for asserting that the use of clopyralid or picloram in accordance with the label by the USFS would result in substantial increases in the general exposure of either workers or members of the general public to HCB.

Another concern is potential presence of dioxin in formulations containing chlorinated chemicals. Dioxins are a group of chemicals involving 76 different types of related molecules called congeners, each having from two to eight chlorine atoms. The toxicity of each of the types of dioxin molecules is different. The toxic potency is determined by spatial arrangement of the chlorine atoms in a molecule rather than mere presence of chlorine. Of all of the congeners, one—TCDD (2,3,7,8-tetrachloro-para-dibenzodioxin), is the most potent. All other congeners are considered 10 to 10,000 times less potent than TCDD. Congeners with

the greatest number of chlorine atoms are the least potent (Van den Berg *et al.* 1998).

TCDD and a few other dioxin congeners are byproducts of the synthesis of trichlorophenol. Most of the other dioxin congeners contain more chlorine than TCDD but are byproducts of the combustion of biomass (e.g., wood) and municipal waste. Dioxin congeners have always been in the environment as a result of natural fires and volcanic eruptions, and burning coal, wood, and gasoline (Alcock *et al.* 1998, Gribble 1994). Thus, dioxin congeners are ubiquitous, but with the exception of TCDD, their potency is quite low and not of much toxicological concern (Safe 1990).

TCDD is a byproduct of the active ingredient in 2,4,5-T. This herbicide was used as a mixture with 2,4-D to defoliate vegetation during the Vietnam War. In the past, a few imported formulations of 2,4-D were shown to contain some highly chlorinated dioxin congeners, the same congeners found in the environment and believed to be primarily the result of combustion processes. Compared to TCDD, their biological activity of the other congeners is low, and absent direct ingestion of these compounds in the diet, they are unlikely to be absorbed through the skin. Current quality control procedures during manufacturing have essentially eliminated any dioxin congeners of concern from domestic 2,4-D formulations. Thus, use of 2,4-D products manufactured in the U.S., whether at home or in agriculture and forestry, do not contaminate the environment with the dioxin congener of greatest regulatory concern, TCDD (USEPA 2000, Chapter 8 of the Draft Dioxin Assessment).

The proprietary nature of herbicide formulations limits the understanding of the risks posed by inert ingredients and adjuvant in herbicide formulations. Unless the compound is classified as hazardous by the USEPA, the manufacturer is not required to disclose its identity. It could be suggested that the inert ingredients in these herbicides are not toxic, or their toxicity would be reported to the EPA. This would hold true if considerable toxicological testing of inert ingredients has been done. That, however, has not been the case. USEPA is increasing the testing requirements for inert ingredients, but in many cases, the inert ingredients currently in use have not been tested rigorously and their toxicity is not well characterized. That being said, studies on the toxicity of technical grade formulations, which often contain the inert ingredients, account for the toxicity of the inert ingredients, and as has been reported here, these studies show that the use of herbicides by the Forest would not expose workers or the public to levels of concern.

Literature does report considerable information on types of inert ingredients and adjuvants present in herbicides proposed for use by the forest. As noted in USFS (1997a), Velpar L®, the trade name for hexazinone, contains 40-45 percent ethanol, an eye irritant and a considerable toxin if ingested. It has been reported the most common impurities of technical grade 2,4-D include other phenoxyacetic acids, a variety of chlorinated phenols, and possibly low levels of nitrosamines in amine salts (Ibrahim *et al.* 1991). Transline, the commercial formulation of clopyralid contains clopyralid as the monoethanolamine salt and isopropyl alcohol, an approved food additive (USFS 1999). Both Tordon 22 and 22K contain the potassium salt of picloram (24.4%), the remaining consisting of polyglycol 26-2, the DOW name for polyethylene glycol, a widely used family of surfactants, considered to have low toxicity and frequently used in the formulation of ointments and cosmetics (MCCHB 2001).

USFS (1996c) reports that Garlon® formulations of triclopyr contain ethanol and kerosene. Technical formulations of imazapyr contain isopropyl alcohol and isopropanolamine salts of imazapyr (USFS 1999e). Glyphosate has been reported to contain small amounts of nitrosamine, and N-nitroglyphosate (USFS 1996b). Roundup, a formulation of glyphosate, contains the surfactant polyoxyethyleneamine (POEA), and contains 1,4-dioxane, classified by the USEPA as a probable human carcinogen. However, carcinogenic studies of Roundup by

the USEPA have shown the herbicide to be non-carcinogenic (USFS 1996a). USFS (2000) reports the inert ingredients in Escort®, which contains metsulfuron methyl, are confidential. They do report; however, the inert ingredients in Escort® are not classified by USEPA as toxic.

Many herbicide formulations contain dyes. The use of dyes can be beneficial in that they can color vegetation, making it less likely for an individual to inadvertently or intentionally consume contaminated vegetation. The presence of a dye in herbicide formulations may also make it easier for workers to see when they have been contaminated and allow for prompt remedial action.

Significant technological advances have been made with respect to dyes available for pesticide applicators. Several water soluble dyes of low toxicity are available now, and their use can provide an added level of safety for the worker and the public. One such dye Hi-Light™ is currently used by the forest. This dye is non-toxic, dissolves quickly and thoroughly in water-based pesticides, and breaks down in sunlight or dissipates in rain, and therefore does not appreciably migrate from the point of use (Becker Underwood 2003).

Surfactants are also commonly used in herbicide formulations. Surfactants are added to herbicides to improve herbicide mixing and the absorption or permeation of the herbicide into the plant. Like dyes and other inert ingredients, there is often limited information on the types of surfactants used and the toxicity of surfactants, especially since the industry considers the surfactant to play a key role in the effectiveness of the herbicide formulations. Most knowledge of surfactants is kept as proprietary information, and not disclosed. This is not always the case. USFS (1997c), which attempted to assess the effects of surfactant formulations on the toxicity of glyphosate, reported that the toxicity of glyphosate alone was about the same as the toxicity of the glyphosate and surfactant mixed and greater than the toxicity of the surfactants alone. Whether this same pattern would hold true of other herbicides having the same or different surfactants is unknown. If so, the toxicological studies performed on herbicide formulations (which contain the inert ingredients and surfactants) may accurately portray the toxicity and risks posed to humans by the surfactant.

The Helena NF currently uses Phase-II™ as a surfactant for application of herbicides. Phase II™ is a high-quality methylated seed oil derived from oilseed rape (95% by weight), formulated as an emulsified concentrate. (Loveland 2003). It is an alternative to mineral oil, recommended for use with herbicides. According to the manufacturer, it has a minimal impact on the environment due to its excellent degradation characteristics, but should not be used with pesticides applied in or near water (Loveland 2003).

Endocrine Disruption

The endocrine system includes tissues and hormones that regulate metabolism, growth, and sexual development. The Food Quality Protection Act (FQPA) requires that EPA develop tests to screen for chemicals with the potential to mimic hormones. Chemicals that do mimic hormones and cause biochemical changes in tissues are called endocrine disrupters or hormonally active agents (HAAs).

The concern over HAAs is due to the fact that the endocrine system is intimately linked with the brain and the immune system. All three systems communicate with one another to affect body development and functioning. Adverse effects on this network have been blamed for a variety of maladies ranging from cancer to infertility to behavioral problems (Felsot 2001).

Chemicals, other than our own hormones, can interact with components of the endocrine system. Scientists have discovered that many kinds of chemicals, including natural food biochemicals as well as industrial chemicals and a few pesticides, can mimic the action of the hormones estrogen or testosterone. Concern has also been expressed about potential effects on the thyroid hormone during early development (Felsot 2001).

Two general types of tests are used to screen chemicals for endocrine disrupting abilities. The most widely used tests are in-vitro tests. These tests are conducted in a test tube or dish using cells and in some cases the actual protein receptors, enzymes, and genes involved in the biochemistry of the endocrine system. In-vitro tests can be used to quickly screen large numbers of chemicals for their ability to interact with different biochemical components of the endocrine system.

Positive in-vitro tests, however, do not necessarily indicate that a substance would actually disrupt hormone functioning in a whole organism. In-vitro screening tests are properly used to determine which chemicals should be subjected to a second type of test, the in-vivo or "live animal" test. In-vivo tests use whole animals that are fed various doses of chemical. In some cases, the chemical is injected beneath the skin or directly into the body cavity. Developmental and reproductive toxicity studies with live animals over several generations are especially useful for determining if a substance adversely affects the endocrine system.

With one exception, the drug DES (diethylstilbesterol), all chemicals that have been tested in-vitro are thousands to millions of times less potent than the natural estrogen hormone (estradiol) (Felsot 2001). Also, as exhibited by estradiol, all chemicals tested in-vitro, appear to show definitive threshold effects (i.e., NOELs) for estrogenic activity. No pesticides, food biochemicals, or other synthetic chemicals have definitively shown greater and/or different in-vitro effects at low doses as compared to higher doses. Although our natural hormones function at very miniscule levels in the body, endocrine disrupter tests have shown that interactions of hormone receptors with natural and synthetic chemicals are still related to dose during exposure. Even chemicals capable of interacting with the endocrine system at sufficiently high doses have not been found biologically active at low doses (USEPA 1997a).

In the in-vivo (live animal) studies to date, only a handful of chemicals, including natural food biochemicals, a few pesticides, and several industrial chemicals show endocrine disrupting effects (Felsot 2001). The in-vivo experiments usually involve feeding pregnant rats or mice one or more doses of a chemical. With one exception, the drug DES, any effects that have been observed were in tests with doses at least thousands of times greater than environmental or dietary concentrations.

In virtually all published cases where a series of doses are tested in-vivo, endocrine effects did not occur below some threshold dose (USEPA 1997a). The EPA (1997a) concluded with few exceptions (e.g. diethylstilbestrol) a causal relationship between exposure to a specific environmental agent and an adverse effect on human health operating via an endocrine disruption mechanism has not been established.

Chemically Sensitive Individuals

A small percentage of the population may have a hypersensitivity to a wide variety of pesticides, perfumes, household cleaners, construction products or industrial chemicals, including the herbicides proposed for use by the Forest. These people are generally aware of their sensitivities and would not be allowed to work on herbicide spray crews or in treated areas until either safe re-entry periods, or a period they feel is adequate based on their personal knowledge of their sensitivity, has passed. (Safe re-entry in areas where herbicides have been applied is when the herbicide has dried on the leaf surface). Hypersensitive individuals may also be subject to effects from gasoline engine exhaust, gasoline powered weed mowers, and automobiles used for invasive weed control and public use both in and outside the Project areas.

Uncertainty

With the exception of accidental exposures or exposures under very conservative and somewhat implausible exposure scenarios, workers and the general public should not be exposed to a herbicide at concentrations that result in an adverse health effects. This conclusion is predicated on forest service

employees wearing appropriate personal protection, applying herbicides in accordance with the label, and implementing the job hazard analysis program to be used on this project. By doing so, possible exposure by contact or through drift would result in a potential dose below that determined to be safe by the EPA over a lifetime of daily exposure. It is also predicated on the findings, back by toxicological studies, that a person can be exposed to some amount of a contaminant and not have an adverse effect (i.e. the dose determines the effect.)

All of the herbicides proposed for use by the Forest must be registered for use by the USEPA and the Montana Department of Agriculture. Registration of these herbicides and Federal regulations adopted to protect workers and the general public has required more scientific information and justification for use of herbicides. Nevertheless, there are many reports in the scientific literature and sections of this report that document associations between herbicide exposure and alterations of the immune system, autoimmune disorders, and increases in the probability of carcinogenesis. MCCHB (2001), Citron (1995), USEPA (1995) Glover-Kerkvliet (1995) are just a few references that provide information on such effects. The body of literature on herbicide effects raises concerns about additive and synergistic effects of exposure to more than one herbicide, unstudied or unknown consequences of low-level chronic exposures, toxicity of inert ingredients, by-products or contaminants of herbicides, and uncertainties about the health effects of sensitive populations. There is also the realization that it is difficult, if not impossible, for government or any scientific agency to fully evaluate a chemical and all the potential combinations of them to ensure that there would not be an adverse effect.

It would be inappropriate to suggest that use of herbicides to control noxious weeds is without risk to workers and the general public. If herbicides are used, there is the possibility of worker and general public exposure, no matter how many mitigation measures are implemented. All chemical exposure results in some level of health risk, the risk primarily being a function of the dose, or amount a person or organism is exposed to over a period of time.

It is equally inappropriate to conclude that any exposure, regardless of dose, would result in an effect. It is easy to find a report showing a health effect caused by the exposure to a herbicide or any other chemical. The toxicological studies are purposely done using high doses to demonstrate an effect. It is the herbicides that show effects at low levels of exposure or those levels anticipated when in use that should raise concern. With respect to this project, the potential dose received by the worker or person of the public does not approach the exposure levels shown to cause acute or chronic toxicity in the literature. Acute effects occur at doses thousands to tens of thousands of times higher than those estimated for the worker or public for this project. Likewise, chronic effects reportedly occur at doses significantly higher than that expected for this project.

There are simply too many variables (receptor sensitivity, dose received, use of personal protection, etc.) for anyone to predict with 100 percent certainty the potential health risk of herbicide use and exposure. What is known is that through a process of continual review of toxicological data on herbicides, the EPA, using very conservative assumptions, has determined a dose they believe would not result in an adverse health effect for herbicides proposed for use on this project. We know that there are studies which show that exposure to the herbicides proposed for use at high doses can cause deleterious effects. We also know that risk assessments have been completed to determine the estimated dose a worker or person of the general public might be exposed to under varying exposure scenarios. Most important, we know through a comparison of EPA established safe doses and estimated exposures that the estimated dose that a worker or person of the general public may be exposed to through use of a herbicide on this

project would be below that determined to be safe by the EPA for a lifetime of daily exposure. Therefore, no health effects and risks to workers and the general public are anticipated by the use of herbicides by the Forest.

Herbicide Drift

Dynamics

Spray drift is largely a function of droplet particle size, release height, and wind speed (Teske and Thistle 1999). Other factors that control drift to a lesser degree include the type of spray nozzle used, the angle of the spray nozzle, and the length of the boom. The largest particles, being the heaviest, would fall to the ground sooner than smaller sizes upon exiting the sprayer. Medium size particles can be carried beyond the sprayer swath (the fan shape spray under a nozzle), but all particles would deposit within a short distance of the release point. The physics of sprayers dictates that there would always be a small percentage of spray droplets small enough to be carried in wind currents to varying distances beyond the target area. Because the small droplets are a minor proportion of the total spray volume, their significance beyond the field boundary rapidly declines as they are diluted in increasing volumes of air (Felsot 2001).

Drift characteristics differ between pesticides. With herbicides proposed in this analysis, it is not critical to coat the entire leaf since some of the products can be absorbed by the plant roots and good efficacy can be achieved by larger droplets on leaves to the target plant. Therefore, herbicide drift can be intentionally reduced by generating larger droplets without reducing efficacy.

Spray nozzle diameter, pressure, amount of water in the tank mixture, and release height of the spray are important controllable determinants of drift potential by virtue of their effect on the spectrum of droplet sizes emitted from the nozzles (Felsot 2001; Teske and Thistle 1999). Meteorological conditions such as wind speed and direction, air mass stability, temperature and humidity and herbicide volatility also affect drift.

Commercial drift reduction agents are available that are designed to reduce drift beyond the capabilities of the determinants previously described. These products create larger and more cohesive droplets that are less apt to break into smaller particles as they fall through the air. They reduce the percentage of smaller, lighter particles that are the size most apt to drift off the treatment area.

Wind speed increases the concentration of drifting droplets leaving the treated area if the wind is adverse (blowing away from the release point in the treatment area). If the wind is favorable (blowing into the treatment area) drift can be reduced. Numerous studies have shown that over 90 percent of spray droplets land on the target area, and about 10 percent or less move off-target, and that the droplets that move off-target most typically deposit within 100 feet of the target area (Felsot 2001; Yates *et al.* 1978; Robinson and Fox 1978; Teske and Thistle 1999).

Herbicide Drift from Aerial Applications

Drift deposition on surfaces measured downwind from aerial spray sites is typically less than 1 percent, and often less than 0.1 percent, of on site deposition (Yates *et al.* 1978; Robinson and Fox 1978; Teske and Thistle 1999). Drift deposition from ground equipment can be one-tenth of that from aerial application at comparable distances from a spray site (Yates *et al.* 1978).

Less information is available on the concentrations of herbicides that remain airborne at greater distances from application sites. Robinson and Fox (1978) measured airborne concentrations of herbicides at various distances from aerial spray plots. Under conditions designed to reduce drift, these researchers did not detect airborne levels of herbicides beyond 100 feet downwind of 500-foot wide spray plots (detection limit of 0.1 microgram - there are about 28 million micrograms in an ounce).

These researchers also measured ambient air concentrations of 2, 4-D at seven stations in eastern Washington where several million acres of wheat are treated with herbicides annually. Ambient concentrations of non-volatile fractions of 2, 4-D typically averaged 0.1to 0.2milligrams/cubic meter during periods of heavy application. Picloram and clopyralid, the herbicide most like to be used by the Forest, are also non-volatile herbicides, and the long-range drift of these compounds may exhibit similar dynamics as the non-volatile fractions of 2, 4-D. Therefore, the ambient concentrations of picloram or clopyralid from the proposed projects may be similar to the concentrations measured by Robinson and Fox.

Numerous investigations of factors affecting drift from aerial applications are reported in scientific literature (DiTomaso 1999; Yates *et al.* 1978; Robinson and Fox 1978; Teske and Thistle 1999; Thistle 2000; Teske *et al*, 2000; Maybank *et al.* 1978). Three of the most comprehensive studies are discussed below.

RAHUFS Drift Estimations

The 1992 Risk Assessment for Herbicide Use in Forest Service Regions 1,2,3,4 and 10 and on Bonneville Power Administration Sites, or RAHUFS, determined spray drift distances downwind of an application site for aerial, backpack, and ground mechanical application equipment. The detailed methodology used in this study is included in USFS (1992). The results of the RAHUFS spray drift analysis indicates "low" health risk to the public from ground and aerial applied herbicides (USFS 1992). "Low risk" was defined in the study as drift from the herbicides that presents a less than one in a million systemic, reproductive or cancer risk. Spray drift from hand application equipment was found to be negligible.

AGDRIFT / Felsot Drift Estimations

Felsot (2001) used the EPA/USDAFS AGDRIFT model to simulate herbicide sprays for several application scenarios, including a truck mounted spray boom set at two heights and a helicopter at two heights. These simulations included crosswinds blowing at ten and six mph. The model output was an estimated amount (percent of that applied) that deposited a defined distance from the edge of a spray swath. A spray deposition curve was developed to calculate a dose that a bystander could potentially receive if standing within the drift zone of an application. The whole body surface area was assumed exposed to a drifting spray (highly conservative), and the bystanders were assumed to be an adult weighing 70 kg and a child weighing 10 kg. Absorption of the depositing dose was assumed to be 10 percent. Calculations were made to determine the percentage of the depositing spray that a child could be exposed to on a daily basis over a 70-year life span and be within the EPA safety guidelines as defined by the RfD (i.e., the "safe dose"). The study estimated that for aerial application, the equivalent safe deposits corresponded to distances from the edge of the spray field of 0, 0, and about 60 feet respectively, for clopyralid, picloram, and 2,4-D. For a ground application, the child would receive a safe dose of 2,4-D at 27 feet from the sprayed field edge.

Mormon Ridge Field Drift Monitoring

In this study, herbicides were aerially applied with aircraft to the Mormon Ridge winter range in 1997 and 1999. Mormon Ridge presented a difficult treatment scenario in that it is extremely steep, has rolling topography, considerable microclimate variability and aerial application occurred upslope of Mormon Creek, a bull trout-spawning stream. Mormon Creek flows along the bottom of the roughly three miles by ½- to ¾-mile wide treatment area.

Picloram was aerial applied on Mormon Ridge in 1997. Buffer zones and water quality were monitored and continuous automated water samples collected. Analysis of the water samples (conducted by the Montana Department of Public Health and Human Services Chemistry Lab) indicated no herbicide entered the stream to a detection level of 0.1 parts per billion (USFS 1996b). The Maximum Contaminant Level (MCL) as set by the EPA for picloram in drinking water is 500 parts per

billion (Dow AgroSciences 1999). No picloram was detected in Mormon Creek when tested at a level *5,000 times* lower than the EPA MCL. Drift cards were also placed along Mormon Creek to monitor drift. The cards indicated no detectable drift reached the creek.

The Mormon Ridge pilot project area was also aerial treated with picloram three growing seasons after the initial application to control invasive weeds that germinated from the soil seed bank after the herbicide decomposed. Drift cards used during this subsequent treatment did not detect picloram in the riparian aerial spray buffer.

Spray Drift Summary

Based on the above information, aerial herbicide applications would have a short-term, very localized impact as a result of drift. Most of the drift would settle to within 100-200 feet of the point of release in adverse conditions. Herbicide spray drift from aerial treatments under Alternative A would not significantly affect the health of the general public or adversely affect water quality, provided environmental protection measures are implemented to avoid drift toward persons and sensitive resources. Applications should be made when there is an organized wind less than 6 mph blowing *away* from sensitive areas. This practice combined with a buffer adjacent to sensitive areas and a drift reduction agent would likely result in no significant offsite drift. Significance in this context refers to concentrations above USEPA established "safe" levels.

ALTERNATIVE A

Potential for public exposure to herbicides under Alternative A is low since most project areas are remote and away from population centers and concentrated public recreation areas. Exposure to the public and sensitive areas is also limited for this alternative by implementation of several mitigation measures, including the use of buffer zones. Other mitigation measures include submitting press releases to local Newspapers indicating the potential windows of aerial treatment for specific areas. Signs would be placed at trailheads to notify the public of spraying two weeks before spraying and after the herbicide has been applied.

Aerial application would be prohibited when winds were blowing toward sensitive areas or private lands. Plastic spray cards would be placed within buffer zones to monitor herbicide drift along creeks and near sensitive resources. Even without the above mitigation measures, herbicide treatments (aerial and ground) under Alternative A would occur infrequently (every 2-3 years on an acre basis) and the public would not receive daily exposures above the USEPA RfDs, a dose level considered safe by the USEPA over a lifetime of daily exposure. Therefore, no adverse health effects are anticipated for the general public based on estimates of exposure, estimates of drift, and the mitigation measures that would be implemented under this alternative.

Under Alternative A, approximately 50 percent of the project areas would be treated by aircraft delivery systems. Potential human health risks to workers from aerial application of herbicides would be lower than other delivery systems because aircraft application requires less herbicide handling and fewer workers, reducing the potential for exposure, particularly to the skin during repeated handling. The duration of direct herbicide mixing would also be very short as compared to ground application, thereby reducing worker exposure time and the potential for an accident or spill to occur. Workers would not receive daily exposures above the USEPA RfDs, provided the herbicides are applied according the label, personal protective equipment is used, and the USFS job hazard analysis program is implemented. Therefore, health risks are not anticipated for workers applying herbicides.

Risks to human health from mechanical noxious weed control measures are minor and may include cuts, burns, repetitive motion injuries, back and knee strain, allergies, and skin irritation to individuals doing the work. The direct effects on human health would be

greatest to allergy and contact dermatitis sufferers who are sensitive to invasive weeds or other wild land vegetation. Skin irritations may result from reaction to the sap of various invasive weeds on contact, such as spotted knapweed and leafy spurge, or to the physical parts of the plant itself, such stickers in thistles. Gloves, long sleeved shirts and boots would prevent injuries or irritations, and therefore, no human health effects are anticipated by mechanical removal of weeds.

Past experience on the Forest indicates biological and cultural management would not impose a risk to human health of workers wearing appropriate personal protection or the general public.

ALTERNATIVE B

Potential human health risks for the worker and the public from herbicides would be the greatest under Alternative B because more ground application would be done compared to Alternative A. The health risks not related to herbicide exposure would also be greatest under this alternative due to an increase in trips, slips, and falls associated with ground application in rough terrain. While risks to human health are greatest under this alternative, exposures to workers and the general public would be below a level considered to be safe by the EPA for all herbicides proposed for use by the Forest. Under this alternative, all project areas would be treated by backpack, OHV, and truck mounted herbicide delivery systems. Backpack applications have the greatest potential for worker exposure to herbicides. More handling and mixing of the herbicides, and more work in close proximity to the spray nozzle would result in greater exposure and significantly greater health risk to the worker. The duration of application and number of applications needed to treat the areas would also be the greatest under Alternative B, and would increase worker exposure. Backpack sprayers can treat about one to two acres per day on rugged, steep, and remote terrain. Therefore, treatment of large areas would likely require more applications over a period of 10 to 12 weeks in the spring and fall. The duration and number of applications needed would also increase the chance of the general public encountering a spray operation.

The more time spent applying herbicides increases the risk of a spill, accident, or mishap. Therefore, the risk of a herbicide spill or accident would be greatest under Alternative B. The general public may be secondarily exposed to a spill or release should it reach surface or ground water. The indirect effects of a spill in the form of public exposure and disruption would be commensurate with the proximity of the spill area to the public and public exposure pathways.

Indirect effects on human health would increase as invasive weeds spread and affect those persons sensitive to them, although to a lesser degree than Alternative C.

As in Alternative A, there would be no impacts associated with mechanical, biological, and cultural treatment of weeds for workers and the public.

ALTERNATIVE C

Under this alternative, weeds would continue to spread on the Forest and impact individuals affected by allergies, asthma, and minor skin irritations caused by certain noxious weed species. Approximately 10 to 15 percent of the United States population suffers from allergy symptoms from noxious weed species such as knapweed. Knapweed pollen is a common and powerful allergen that peaks in August and produces strong allergy symptoms. Knapweed pollen has been implicated in causing allergic rhinitis (Gillespie and Hedstrom 1979). Allergies to airborne seeds may also complicate or trigger asthma that may take up to two years to get completely under control (Nielsen 1999). Indirect effects on human health would increase as invasive weeds spread and affect those persons sensitive to them.

As in Alternative A, there would be no impacts associated with mechanical, biological, and cultural treatment of weeds.

CUMULATIVE EFFECTS

Past, present and reasonably foreseeable activities that may have cumulative effects on human health include weed control efforts (aerial and ground application of herbicides) on private and public lands in central Montana.

Based on the results of risk assessments performed by the Forest Service, the ongoing and future activities are not expected to result in exposures to workers and the general public at doses that exceed the RfD. Therefore, under Alternatives A and B, no cumulative adverse health effects are anticipated for workers and the general public, provided herbicides are applied in accordance with the label as proposed. Alternative C proposes no additional herbicide use, so there are no anticipated cumulative human health effects associated with potential exposure to herbicides under this alternative. There are no anticipated cumulative health effects associated with biological, mechanical, or cultural treatment of weeds.

Inherent to having confidence in these conclusions is an understanding of what an RfD is (how safe it is) and how it is determined. The EPA develops RfDs for chemicals including the herbicides proposed for use by the Forest. The RfD is defined by the USEPA (1989) as an estimate of a daily dose over a 70-year life span that a human can receive without an appreciable risk of deleterious effects. A reference dose is determined by subjecting animals to exposures of a substance and determining the LOEL and the NOEL from the entire body of scientifically supportable animal studies performed for that substance. The NOEL represents the dose the USEPA believes would not result in an effect. RfDs are calculated by dividing the NOEL, a level or dose already thought to not cause and effect, by a "safety factor," usually 100, to account for extrapolation of animal data to humans and sensitive individuals. Therefore, the RfD for a chemical is a dose at least 100 times lower than that shown to have an effect in any animal study performed with the subject chemical. With respect to herbicide applications, it has been estimated in nearly all cases (see **Table 4-19**) that the dose a worker or a person of the general public would be exposed to would be below the RfD, except for somewhat implausible exposure scenarios (spray over entire naked body, wearing heavily contaminated gloves for an extended period).

CONSISTENCY WITH FOREST PLAN, LAWS, AND POLICIES

All alternatives are consistent with EPA, OSHA and FS regulations regarding pesticide use and worker safety.