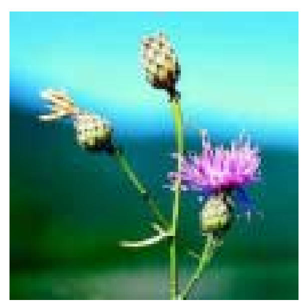
USDA Forest Service
Pacific Southwest Region

Salmon River Knapweed Project Environmental Assessment



Salmon River Ranger District
Klamath National Forest
June 2000

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Chapter 1

Purpose and Need for Action

The Klamath National Forest Land and Resource Management (LRMP) provides management direction, goals, and objectives for meeting desired conditions in the project area. The LRMP (pg. 4-6) requires management for viable, healthy plant populations of native and desirable non-native plant species. The purpose and need for action is to move the existing condition of the project area from that of a spreading infestation of noxious weeds to a desired condition of a healthy, biologically diverse ecosystem.

Spotted knapweed, *Centaurea maculosa*, and diffuse knapweed, *Centaurea diffusa*, have been identified as introduced noxious weeds in the Salmon River drainage. Knapweeds are considered to be a public nuisance by the State of California. They are classified as "Class A" pests; aggressive competitors that are targeted for priority eradication before their numbers are too great to successfully eliminate. Because knapweed is considered a public nuisance and an "A" rated pest, the acceptable tolerance for it to occur is zero. This means the objective for treatment is 100 percent elimination.

Knapweed has tremendous potential to rapidly infest and degrade large areas, as has been documented in Idaho and Montana (Sheley and Petroff, 1999; USDI, 1996) and other areas in the inter-mountain west where millions of acres have been converted to these noxious weeds. Knapweed, an introduced non-native perennial plant species from the European continent does not have natural predators in this area. It can out-compete native vegetation and is adapted to a variety of conditions. When knapweed takes over a site and spreads, it replaces native vegetation and biological diversity is lost. Knapweeds produce a chemical that inhibits growth of native surrounding vegetation. Soil stability is reduced as knapweed has a narrow tap-root with low soil holding capacity. Knapweed has very low value as a forage species or habitat component for wildlife.

Knapweed thrives on disturbance, which is why there is concern along the river bar and floodplain as well as in the upland areas of the Salmon River watershed. Historic and recent fires and flooding have created disturbance regimes conducive to the spread of knapweed. The fact that the major infestations occur along the floodplain is cause for particular concern as the high flows have the potential to spread seed and plant material anywhere down stream in the watershed and beyond. The fact that the upland sites are in close proximity to the Specimen Fire site which burned in 1994, and to the Marble Mountain Wilderness Area, also increases the urgency of the need for prompt treatment as the potential for spread in these areas is high and treatment options are limited due to accessibility and terrain.

The California Department of Food and Agriculture (CDFA) is the lead agency in the State for preventing noxious exotic plants from spreading or becoming established in California through early detection and immediate control or eradication efforts (CDFA Food and Agricultural Code of California, Section 403 and Title 3, California Code of Regulations, Sections 4500). The program is conducted cooperatively between CDFA and County Agricultural Commissioners. The Code (Div. 4, Chapter 1, Section 5004) defines noxious weeds as "any species of plant which is, or is liable to be, detrimental or destructive and difficult to control or eradicate" and rates plant pests into categories (USDA, 1996). Section 5401 states "Any premises, plants, conveyances or things which are infected with any pest or premises where any pest is found, are a public nuisance, and shall be prosecuted as such in all actions and proceedings. All remedies which are given by law for the prevention and abatement of such a nuisance apply to such a public nuisance."

When noxious weed infestations extend onto National Forest Lands, the development of a cooperative agreement allows the State and/or County to extend eradication and/or control activities onto National Forest lands, provided all Federal codes and laws are met (MOU, 1995).

Specific management direction for the control and eradication of noxious weeds is contained in the Forest Service Manual (FSM), Carlson-Foley Act of 1968, and the Federal Noxious Weed Act of 1974. The Carlson-Foley Act of 1968 directs agency heads to enter upon lands under their jurisdiction with noxious plants and destroy noxious plants growing on such land. FSM 2080 states: "The Federal Noxious Weed Act of 1974, as amended (7 U.S.C. 2801, et seq.), requires cooperation with State, local, and other Federal agencies in the application and enforcement of all laws and regulations relating to the management and control of noxious weeds." Forest Service regulations at 36 Code of Federal Regulations (CFR) 222.8 acknowledges the Agency's obligation to work cooperatively in identifying noxious weed problems and developing control programs in areas where NFS lands are located.

When assigning management priorities for the prevention and control measures, the Forest Service is to utilize Noxious Weed Classifications Systems developed at the State or County level to provide a coordinated approach. This is the system that classifies spotted and diffuse knapweeds as Class A pests. The policy of the State of California for spotted and diffuse knapweeds is an eradication program. The spotted knapweed infestation on the Salmon River is one of the largest in the State, and the largest in Siskiyou County.

The objective of this proposed action is to eradicate known populations of the species and prevent the introduction and establishment of the species in other areas of the Forest and adjacent lands.

There is much speculation as to the source of the initial introduction of spotted knapweed in the Salmon River corridor. More than likely it was brought in on vehicles or equipment to the Kelly Gulch river bar and spread from there by high water, vehicles, equipment, animals, and people to other locations during the last 10 to 15 years. In 1997, the increasing number of knapweed plants discovered in the area became recognized as a serious problem.

Starting in 1997, intensive mechanical treatment was initiated to control knapweed in the Salmon River area through a cooperative effort with local community volunteers. Over 300,000 plants (both adults and juveniles) have been pulled and removed. Over 300 gross[2] acres have been treated, inventoried, and/or monitored. The hand pulling effort has been successful in reducing the number of mature plants and in areas of limited plant numbers (25 or less); however, in areas of high plant densities and under challenging conditions (rocky, dry, steep, inaccessible and heavily infested), success has been limited to reductions in numbers of plants and a holding action of preventing flowering and seed set. All sites have experienced increases in seedlings, juvenile plants, and germination enhanced by disturbance.

[2] Gross acres are all inclusive (inventoried and treated).

Research indicates that the most effective means of controlling knapweed is through the judicious use of herbicides at the appropriate stage of plant development. Studies indicate that herbicides were greater than 90% effective in controlling plants, while hand-pulling was 56% effective (reference "Cost and Efficacy of Spotted Knapweed Management with Integrated Methods" Brown, Duncan, Halstvedt, 1999). In all cases, continued monitoring and follow-up treatment is important. Knapweed seed can maintain viability for as long as nine years. Exhausting the current seed bank may take several years.

It is important to act quickly and aggressively in the short term while the population is still relatively manageable and successful treatment is still feasible. ***Not taking action now may preclude any opportunities to effectively eradicate or control this pest.***

Proposed Action - Integrated Pest Management

The Klamath National Forest, Salmon River Ranger District proposes to implement an integrated pest management program to eradicate infestations of spotted knapweed, *Centaurea maculosa* and diffuse knapweed, *Centaurea diffusa* within the Salmon River drainage. The methods include manual and chemical treatments. The project area and areas of known infestations of knapweed are shown on the attached map. Due to diverse geographical and environmental conditions within the project area, the proposed action will provide a range of weed eradication methods appropriate for various site conditions.

The major infestations of spotted knapweed occur in riparian areas along the North Fork of the Salmon River and in upland areas of Kelly Gulch, Little North Fork, and Specimen Creek (refer to the Vicinity Map and Project Area Map enclosed). Currently spotted knapweed has been located on 130 individual sites. Diffuse knapweed has been located on only four sites (one of which contains both species of knapweed) within the project area at this time. Over 300 acres of potential habitat have been inventoried for knapweed; approximately 150 acres of which are mapped sites containing knapweed. Of these treatment acres, individual plants and the immediate vicinity would be treated, rather than entire plant communities. The total estimated treatment area is approximately 15 acres. The proposed action would allow for treatment of up to 30 acres as needed based on on-going inventory. Actual treatment acres proposed are estimated to be 10% of the total infestation acreage figure (personal communication, B. Krebs, CDFA).

The United States Department of Agriculture, Forest Service (USFS) proposes to authorize the Siskiyou County Department of Agriculture (SCDA) and the CDFA to implement weed eradication practices on National Forest System (NFS) lands within the Salmon River District. The California Food and Agriculture Code Sections 403, 482, 5021, and 5405 provide the authority for eradication and/or suppression of noxious weeds within California.

The Klamath National Forest, in cooperation with participants in the Siskiyou County Weed Management Area, will coordinate and conduct weed management practices. This will include on-going inventory of existing and new populations; public education and information on noxious weed identification, methods of spread and prevention measures; and monitoring of treated areas to determine effectiveness of control methods and to identify additional future treatment needs. Temporary road closures and area closures in some infested areas will be implemented during treatment and following treatment to limit potential disturbance and spread of seeds. Road maintenance practices (grading, stock piling of materials, transport of road material, etc.) will also be evaluated and adjusted to limit spread of weeds. Timing and location of livestock use in infested areas will also be adjusted.

The duration of this project is anticipated to be at least five years. Implementation of this proposed action will begin in the spring of 2001. Eradication will only be accomplished after a considerable sustained effort; therefore it is important to evaluate progress on an annual basis. The Siskiyou County Weed Management Area representatives will participate in monitoring and evaluation of the project.

Treatment descriptions:

Manual Treatments

Manual treatment includes the use of simple hand tools such as weeders, picks, screwdrivers, shovels, and mattocks for hand grubbing operations. Plants are then dug or pulled from the soil with as much of their root system as possible to prevent re-sprouting. Hand grubbing is proposed where the soil is loose and there are a limited number of plants in a small area. Hand grubbing will be used in areas of individual, isolated plants and as follow-up to herbicide treatment in areas previously treated where numbers of plants are limited to individuals that can be removed by hand.

Chemical Treatments

Chemical methods will include hand application spot spraying of contact herbicides from backpack sprayers that limits the area sprayed to the target plant. No aerial treatment is proposed. Chemical treatment with Transline™ or Tordon 22K™ will include the area around the plant where viable seeds have been cast. Chemical treatment is planned for larger, densely infested areas where other methods (manual treatment and mulching) are not capable of eradicating the weed population. Chemical treatment is proposed for at least five consecutive years depending on the results of effectiveness monitoring. Individual sites may be treated up to two times in a given season depending on the efficacy of the initial treatment. It is anticipated that after the initial chemical treatment, other methods such as hand grubbing would be adequate to eradicate some populations.

Proposed treatments will be designed that will provide maximum eradication potential while balancing the site-specific resource concerns. Minimizing resource impacts will be the primary criteria for selection of herbicides used. The type of chemical treatments will account for proximity to water and riparian areas, season of use, plant life-cycle stages, and other non-target vegetation concerns.

The proposed herbicides and their maximum application rates are found in Table 1. The herbicides listed in Table 1, with the exception of Tordon 22K™, are approved by the Environmental Protection Agency (EPA) for use on NFS lands in the State of California. Tordon™ (picloram) is currently being considered by the Department of Pesticide Regulations for registration for use on noxious weeds in the State of California. Chemicals may be used alone or in mixtures. Those listed in Table 1 are ones that have been chosen for their effectiveness at controlling knapweed while providing maximum protection of resources. These herbicides will be used as site conditions dictate. On-going effectiveness monitoring will determine the need for follow-up treatments. Chemicals will only be mixed if the mixture is not prohibited by either label and if the ingredients are compatible and enhance the overall efficacy of the treatment.

In addition to the specific herbicides, the additive R-11, and a colorant Hi-Light Blue will be utilized. R-11 is a spreader/activator that improves the activity and penetration of the herbicide by reducing surface tension, allowing the herbicide mixture to spread evenly over the surface of the vegetation. The colorant is added to indicate where the herbicide has been applied.

Table 1. Proposed Maximum Herbicide Application Rates.

Chemical Name	Trade Name	Rate: Active ingredient per acre[1] (a.i./ac). Acid equivalent/acre[2] (AE/ac)	Weeds and/or Areas Treated
2,4-D	Weedone 638™ and Weedone LV-4™ Weedar 64™	2.8 lbs a.i./ac 1.4 AE/ac	Upland and floodplain
Clopyralid	Transline™	0.250 lbs. AE/ac, a.i./ac	Upland
Glyphosate	Rodeo 64™	3.0 lbs AE/ac 4.0 lbs. a.i./ac	Riparian
Picloram	Tordon 22K™	0.025 – 0.05 lbs a.i./ac, AE/ac	Upland[3]

[1] **Active ingredient (a.i.)** – The component in the herbicide formulation primarily responsible for its phyto-toxicity. Identified as such on the label.
[2] **Acid Equivalent (AE)** – The threshold yield of parent acid from the active ingredient that is formulated as a derivative of acid.
[3] The use of picloram is not currently authorized in the State of California. This chemical will be used only if pending registration takes place prior to or during implementation.

The target weeds and the treatment proposed, including optimum growth stage and season of application, are listed in Table 2.

Table 2. Proposed Weed Treatment and Timing.

Weed	Treatment[1] Application rate/acre	Growth Stage	Timing[2]
Knapweeds	Weedone 638™: 4 pt	Bolt to flower	Late spring/summer
	Transline™: 2/3 pt	Mid-bolt to late bud, rosette, active growth	Summer/fall
	Tordon 22K™: 1-2 pt	Bud to full flower	Spring/late summer
	Weedar 64™: 2-4 pt	Active growth	Spring/late summer
	Rodeo™: 6 pt	Active growth	Spring/late summer

[1] Treatment given is for a range of application rates per acre, for the listed Trade Name herbicide and are not to exceed the maximum rates listed in Table 1.
[2] Timing of control will include re-treatment of re-growth.

Selection of herbicides to be used involves a step-by-step process that considers the site conditions (soil properties, rainfall regime, and plant life-cycle) and persistence of the chemical in the soil to effectively control re-growth from seed in the seed bank. Soil active herbicides must incorporate into the seed germination zone of the soil profile to be effective and are generally tied up there by adsorption to fine soil particles and organic matter. The movement of herbicides is influenced by mobility (based on chemical properties), water, and adsorption.

Habitat descriptions and proposed chemical treatment:

Upland Areas

The upland habitat for Knapweeds can be described as those areas upslope from riparian zones of the Salmon River and its tributaries. Within this area the use of more persistent herbicides will be prescribed. Chemicals such as picloram and clopyralid have the necessary persistence and selectivity to be the most effective choice for treatment in upland areas where water and riparian habitats are not affected. The advantages of using these herbicides are that the treatment is more effective and limits the number of times the area will be retreated. Picloram (Tordon 22K™) is specific to knapweed and provides a high level of efficacy. It is effective only on broadleaf vegetation and will not affect native grasses. Clopyralid (Transline™) is also effective on knapweeds and is moderately persistent. The Weedone formulation of 2,4-D (Weedone 638™) is proposed for use in combination with picloram (Tordon 22K™) or clopyralid (Transline™) to enhance the efficacy of the treatment.

Floodplain Zones

Floodplains can generally be described as the area between the stream and its annual high water line. The largest known infestation of Spotted Knapweed within the Salmon River District exists within the floodplain of the North Fork of the Salmon River. The least persistent herbicides (glyphosate (Rodeo 64™) and the amine formulation of 2,4-D) will be used in the floodplain area where the intent is to minimize any opportunity for residual chemicals to be present in the soil and wash into the watercourse during high water flows. Herbicides selected for these areas are those approved for use because they are proven to have the lowest potential impacts to water and aquatic species and related habitat. The application of herbicides in these areas will occur after the last high water event of the season, with ample time allowed for chemical degradation prior to the first high water event of the next year. It is anticipated that chemical treatment in the floodplain zone would occur from May through July. Rodeo™ is a preparation of glyphosate specifically formulated for applications directly over water. It is applied to actively growing plants and will not continue to be present in the soil to inhibit re-growth. It is a non-selective herbicide, and kills or damages most plants it comes in contact with. Mitigation measures during application will minimize exposure to non-target plants. Some formulations of 2,4-D (Weedar 64™) can be used in close proximity to water and have the advantage of being selective for broadleaf plants. 2,4-D (Weedar™) is proposed to be used in combination with glyphosate (Rodeo™) in the floodplain area to enhance the efficacy of treatment

Riparian Areas

Riparian areas occur along the Salmon River and its tributaries. Riparian areas are described as the area between the annual flood zone and permanent upland vegetation occurring approximately 100 feet above the annual flood plain. Because of the close proximity to water only those chemicals described above under floodplain with the short persistence intervals will be used.

Herbicide Transport:

It is estimated that a maximum of 16 days in one season would be required for herbicide treatment. The rate of application will vary by site and accessibility. It is estimated that on any given treatment day, the maximum amount of active herbicide ingredient to be transported in a 300 gallon capacity tank (or smaller depending on the area to be treated and amount of chemical to be used) would be: 2/3 pints of Transline™, 2 pints of Tordon 22K™, 21 pints of Rodeo™, and 12 pints of 2,4-D.

Management Direction:

Management direction relative to this project is located in the LRMP. Specific goals include management for desired compositional, structural, and functional attributes of biological diversity (LRMP pg. 4-6). Applicable Standards and Guideline located in Chapter 4 of the LRMP include 6-1, 6-2, 6-3, 6-7, 6-11, and 6-15 (LRMP pg 4-23,4-24), 21-52, and 21-54 (pg. 4-59).

Decision To Be Made

The Decision to Be Made is whether to authorize weed eradication treatments in the Salmon River drainage and if so, to determine the design of the treatment. The decision-maker is the Salmon River District Ranger.

Public Scoping and Issues

Public scoping was initiated in January 1999. A letter was sent to the Salmon River Ranger District NEPA mailing list. Due to an overwhelming response to the letter, a Knapweed Project mailing list was created, including all respondents to the initial scoping letter. A second letter was sent to this list, which included a question and answer set in response to scoping comments. A public informational meeting was held in Forks of Salmon on February 24, 1999, to provide information on knapweed, the status of the project, and to answer questions. An open house was held in Forks of Salmon River on April 28, 1999, to present alternatives and solicit public input.

Scoping revealed a number of issues. Key issues are most relevant to the analysis and are used to formulate alternatives and analyze environmental effects. Non-key issues are issues that are outside the scope of the analysis or decision to be made. Non-key issues do not drive alternatives and are not carried through the analysis process. Documentation of all comments and issues received in response to scoping is on file at the Salmon River Ranger District office.

Key Issues

1. **Effects to Human Health and Safety**: Concern was expressed that use of herbicides in the Salmon River watershed would have adverse impacts to residents and visitors to the area; chemical herbicides pose health risks that cannot be mitigated.

   Issue Measure: Risk Assessment (risk of exposure, Hazard Quotient (HQ)).

2. **Effects to Water Quality and Aquatic-Related Species**: Concern was expressed that use of herbicides in the Salmon River watershed will adversely affect water quality, fish, and other riparian and aquatic-related species. The concern was for the effects of herbicides entering the watercourse during or after treatment and the effects of herbicides on aquatic species.

   Issue Measure: Risk of exposure; soil adsorption potential; chemical breakdown in the environment, toxicity to fish, and aquatic organisms.

3. **Effects to Non-target species including plants, wildlife, insects, amphibians, fungi, microorganisms, and others:** Concern was expressed that herbicides would have harmful effects to all species other than targeted weeds.

   Issue Measure: Risk of Exposure, Toxicity levels

4. **Effects to Federally listed Threatened, Endangered, Proposed, and Forest Service Sensitive species (TESP):** Concern was expressed that herbicides will adversely affect TESP species.

   Issue measure: Risk of Exposure, toxicity levels

5. **Effects to local community well being and quality of life:** Local citizens expressed concern that their unique rural lifestyles and quality of life would be adversely affected by the use of synthetic chemical herbicides. Most local residents attempt to lead a lifestyle, which is relatively free from synthetic chemicals, and view the Salmon River environment as pristine. Use of herbicides may be perceived as a violation of these lifestyle principles.

   Issue Measure: Does the alternative use chemicals or not? Yes/No

6. **Adverse Effects from the use of 2,4-D: Particular concern was expressed over the use of 2,4-D.** There is strong local opposition to the use of this chemical in the Salmon River watershed because 2,4-D is often associated with 2,4,5-T (both were used in combination as the active ingredients in Agent Orange). Although the contaminant (TCCD) responsible for health risks associated with Agent Orange, is not found in 2,4-D, there is heightened sensitivity to use of this chemical because of the association.

   Issue Measure: Does the alternative use 2,4-D or not? Yes/No

7. **Chemical herbicides should only be used as a last resort:** Many individuals and groups indicated that they were opposed to the use of chemical herbicides until all other reasonable means of eradication had been exhausted. There is disagreement over the determination of the effectiveness of treatment methods. Some members of the public expressed that they would

reluctantly support the use of herbicides if it was shown to be the only effective method of treatment.

Issue Measure: Does the alternative consider alternative approaches to herbicide use and a means of measuring effectiveness? Yes/No

Non-key Issues

1. **Use of herbicides versus other methods is uneconomical:** It was suggested that an economical analysis of alternatives be incorporated into the project that would consider the cost of litigation. Costs of knapweed treatments have been calculated and are disclosed in Chapter 3. The cost of litigation would vary greatly and cannot be reasonably determined.

2. **Use of Herbicides will destroy the biological diversity in the Salmon River watershed:** The proposed level of herbicide use is 15-30 acres (less than .01% of the total watershed area) in which individual plants would be treated. It is not likely that this would have a significant impact on biological diversity within overall watershed. It is anticipated that control of knapweed would retain the biological diversity that is at greater risk if knapweed is allowed to spread uncontrolled.

3. **Consider treating all noxious weeds in the Salmon River watershed; develop a comprehensive plan for weed management in the area:** There is an interest in having the Forest Service treat all noxious weeds in the area as part of this project. This project intentionally is focusing on Knapweeds, as they are relatively newly established and highly aggressive plants. Knapweeds must be treated promptly to prevent them from becoming as prevalent as other weeds have become in California, and as knapweed is in the inter-mountain West. Eradication of knapweed at this stage is feasible, while it may not be for some of the other weeds in the area. The Siskiyou County Weed Management Area group is interested in a larger scale noxious weed management strategy that includes other weeds of concern in the area, such as yellow star thistle, dyer’s woad, and Scotch broom. While treatment of all noxious weeds is a high priority for all participants in the MOU, this project is specific to knapweed. Opportunities exist to amend the Watershed Analyses on the Forest, and to amend the Klamath National Forest LRMP to address noxious weed management at a larger scale. This project is consistent with the overall management direction in the LRMP and the ROD. Development of a larger scale strategy, while desirable by all parties, is outside the scope of this site-specific assessment.

Chapter 2. Alternatives

Alternatives Considered in Detail

Actions common to all action alternatives:

Standard Operating Procedures and Mitigation Measures

a. The Klamath National Forest will issue a letter of authorization to the Siskiyou County Department of Agriculture to conduct weed management practices on NFS lands. The Standard Operating Procedures as described below will be included and strictly adhered to.

b. The Agriculture Commissioner will ensure that all workers are trained in identification of proper growth stage of noxious weeds for treatment.

c. Periodic compliance checks of the weed management activities will be conducted by the Forest Service, especially when they occur around sensitive areas.

d. A monitoring and evaluation program for determining how well treatment objectives are met will be developed by members of the Siskiyou County Noxious Weed Management program to assess the annual progress of the Integrated Weed Management Program.

e. The North Coast Regional Water Quality Resources Control Board (NCRWQCB) will participate in the development of proposed water quality monitoring plans.

f. Applicable Best Management Practices (BMPs) will be implemented and concurrently monitored (see Appendix B).

g. Federal law, regulations, and direction define the management and preservation of historic properties as elaborated in the Antiquities Act of 1906, National Historic Preservation Act of 1966, as amended, National Environmental Policy Act of 1969, Archaeological and Historic Preservation Act of 1974, American Indian Religious Freedom Act of 1978, Archaeological Resources Protection Act of 1979, Native American Graves Protection and Repatriation Act of 1990, and in Executive Orders 11593, 13007, and 13082. Procedures for compliance are given in 36 CFR 60, 61, 63, 67, and 800. All required procedures will be followed in implementing this action. If cultural resources are located during implementation of the project an archaeologist will be notified to address resource protection.

Mitigation Measures Specific To Chemical Methods

a. Ground applications of liquid herbicides in the floodplain will be limited to spraying the target weeds. Application of Transline™ or Tordon 22K™ in upland sites will include and the surrounding ground for approximately 10 feet in diameter. Backpack applications of liquids will occur only at low nozzle pressure and within 2.5 feet of the ground.

b. Environmental conditions will be monitored by USFS, CDFA, or County to insure herbicide placement is on or immediately surrounding the target plant. Spraying shall be terminated if excessive wind speed or temperature inversion conditions develop. Ground applications of liquids or granular material will not be conducted in winds in excess of 5 mph for Rodeo™ and 10 mph for Tordon 22K™ at the point of discharge.

c. Mixing and/or loading of any herbicide is prohibited within one hundred and fifty (150) feet of any body of water. Mixing will take place at the SCDA pesticide facility in Yreka. Mixed products will be transferred to ground sprayers or backpack sprayers at the job-site. Spill kits will available on site. Any unused mix will be returned to Yreka.

d. All herbicide mixing, loading, and application equipment shall be kept in good repair to prevent any spillage. All equipment shall be inspected by the SCDA prior to the first usage of the year, and periodic inspections throughout the application season.

e. Spillage of any dry herbicide formulations shall be immediately cleaned up and placed in the application equipment for application upon the site being treated. Spillage of any liquid herbicide formulations or solutions shall be immediately reported to the USFS and the County Agricultural Commissioner. Spills will be treated according to established protocols. Refer to Spill Plan in Appendix C.

f. All pesticide containers will be triple rinsed at the mix load site, and the rinsate will be added to the mix tank and applied at the job site.

g. Ground equipment for liquid pesticide applications shall have nozzles with an orifice not less than 1/16-inch in diameter (or equivalent) and operated at a boom pressure not to exceed 30 pounds per square inch or low pressure fan nozzles with a fan angle number not larger than 80 degrees and fan nozzle office not smaller than 0.2 gallon per minute flow rate (or the equivalent) and operated at a boom pressure not to exceed 15 pounds per square inch.

h. All applicators will be trained annually by a Certified applicator regarding the safe and proper use of herbicides.

i. All herbicide applications will be made by a Certified Applicator or by persons in the direct supervision of a Certified Applicator.

j. All herbicide label requirements will be followed.

k. All areas treated with chemical herbicides will be posted according to State law. Areas treated with herbicides will be posted during and after application and through the summer season.

l. All applicators will wear protective equipment. Clothing will be washed daily. Clean soap and water will be on site for routine washing of hands and face and for emergencies.

m. Workers will be trained in safety and emergency procedures.

n. A suitable buffer from the edge of the water will be used to prevent water contamination. Spray will not be applied to or allowed to drift onto any water surface at any time during application.

Mitigation Measures Specific To Manual Methods

a. All workers will wear protective clothing appropriate for the elements.

b. Workers will check clothing and footwear prior to leaving infested sites and remove any seed material or soil that may contain seed.

c. Seeded plant material will be bagged and transported to the SCDA disposal site.

Other Actions Common to All Action Alternatives

- Implement appropriate road maintenance practices; evaluating rock, sand, and gravel sources; inspection and appropriate treatment of equipment and crews entering the area from high risk areas; appropriate management of permitted livestock and pack and saddle stock; signing, public information, and education; revegetation, inventory, and monitoring of knapweed sites. Areas will be closed to public use during and following treatment.

Alternative 1. The Proposed Action

The Proposed Action is described in detail in Chapter 1 and summarized below (see Tables 1 and 2).

- Implement an integrated pest management program to eradicate infestations of knapweed in the Salmon River drainage as described previously in Chapter 1.

- Herbicide treatment could potentially be used over all treatment acres, including the floodplain and upland sites. Isolated and individual plants may be removed manually. Up to two treatments in one season on any given site depending on efficacy of initial treatment. Treatment for up to five consecutive seasons depending on efficacy.

- Chemicals to be used may include one or more of the following (see Tables 1 and 2): 2,4-D (Weedar 64™) and glyphosate (Rodeo™) on up to 14 acres on the river bar and clopyralid (Transline™), picloram (Tordon 22K™) and 2,4-D (Weedone™) on up to one acre in the upland. Selection of chemicals will include all label restrictions and requirements, consideration of plant growth stage, season, weather, proximity to water, soil properties.

- All special resource considerations/mitigations identified through the interdisciplinary process and through interagency consultation for aquatic or terrestrial species habitat requirements, cultural/heritage resources, or other special status areas will also be applied as described in Chapter 1.

Alternative 2. Community Based Alternative

This alternative is a community based, cooperative venture proposed by the Salmon River Restoration Council. This alternative proposes an integrated pest management strategy that would emphasize alternatives to the use of chemical herbicide treatment (see Table 4).

- Emphasize mechanical treatment, prevention, monitoring, and inventory and fully explore alternative approaches to chemical treatment on all treatment acres.

- Treatments will include hand grubbing and digging, mulching, propane torching, and establishment of native vegetation. Sites will be inventoried and treated several times throughout the growing season. Live plants will be pulled and left on site if in a vegetative, pre-flowering condition, bagged and removed from the site if seed is present.

- Multiple treatments per site each season depending on efficacy of initial treatments. Inventory and treatment of all sites for at least 12 years to prevent flowering, seeding, re-sprouting, and spread.

- Objectives include: a) prevent at least 95% of adults plants (each year) from seeding (increase this by 1% per year for 5 years). b) eliminate over 95% of all plants at all known satellite population sites (increase by 1% per year) c) remove 75% of plants (adults and juveniles) at the larger, denser, and more populated sites (i.e. Kelly Bar) and increase by 3% per year for 8 years.

- Revegetate 5% of sites annually on appropriate sites with native plants.

- Preventative measures as described in Alternative 1 will be fully explored and implemented.

- Education, monitoring, and inventory will be conducted cooperatively with all parties involved.

- Citizens may "adopt a site" for long-term control and monitoring to ensure areas are "knapweed-free" over time.

Table 3. Alternative 2 Mechanical Treatment.

Method	Growth Stage	Timing	Areas Treated Acres
Hand pulling, digging, etc.	Rosette to early bolt; bolting stage and flowering stage	Spring/early summer	Riparian and Upland 15-30 acres
Mulching	Rosette	Spring/early summer	Riparian 0.03 acres
Re-vegetation		Spring/late summer	Riparian and Upland 1-5 acres

Alternative 3. Modified Proposed Action

This alternative was developed in response to public input on the Proposed Action. This alternative responds to Issue Number 7; there is disagreement over the determination of effectiveness of treatment methods and support for herbicides being used only as a last resort after exhausting all non-chemical methods (see Table 4). This alternative proposes use of mechanical treatment of knapweed on all sites unless any one of the established evaluation criteria (see below) is not met. If evaluation criteria are not met, herbicide treatment will commence on any site.

- Manual treatment of knapweed on all sites. Treatments will include hand grubbing, digging, mulching, and establishment of native vegetation. Sites will be inventoried and treated several times throughout the growing season. Live plants will be pulled and left on site if in a vegetative, pre-flowering condition, bagged, and removed from the site if seed is present.

- Multiple treatments per site each season depending on efficacy of initial treatments. Inventory and monitoring of selected sites annually to determine efficacy of treatment. Non-chemical manual methods will be utilized unless it is determined that objectives cannot be met using established criteria. Treatment for up to 10 consecutive seasons depending on efficacy of treatment.

- Evaluation criteria are: a) All established evaluation sites must show a decrease of greater than, or equal to, 60% in the number of plants from the previous year; b) No plants at any site (evaluation sites and all others) will be allowed to flower and produce seed; c) Mapped populations will not increase in size through spread of seed from adjacent sites.

- An independent contractor following protocol developed by University of California, Davis Agricultural Extension will conduct evaluation of treatment effectiveness to determine if evaluation criteria are met. District Ranger will make the final determination based on site evaluation results provided by the contractor.

- Evaluation sites may not be manipulated prior to May 15 of each year or evaluation will be invalidated and chemical use may proceed.

- Herbicide treatment may be used on any site if one or more of the eradication criteria are not met on any site after the first year.

- Chemicals to be used may include (see Tables 4 and 5): glyphosate (Rodeo™), clopyralid (Transline™), or picloram (Tordon 22K™). Selection of chemicals will follow all label restrictions and requirements, consideration of plant growth stage, season, weather, proximity to water, and soil properties.

- In addition to the specific herbicides, the additive R-11, and a colorant Hi-Light Blue will be utilized. R-11 is a spreader/activator that improves the activity and penetration of the herbicide by reducing surface tension, allowing the herbicide mixture to spread evenly over the surface of the vegetation. The colorant is added to indicate where the herbicide has been applied.

- Up to two chemical treatments may occur in one season on any site depending on efficacy of initial treatment. District Ranger and Siskiyou County Agricultural Commissioner will determine initial treatment efficacy.

- Standard Operating Procedures and Mitigation Measures as described in Alternative 1.

Table 4. Alternative 3 Treatment of Knapweeds				
Trade Name (chemical)	**Treatment[1]**	**Growth Stage**	**Timing[2]**	**Areas Treated**
			No. of treatments	**Acres**
	Mechanical	Rosette to early bolt	Spring/early summer	Riparian
			3/year	15-30 acres
Transline™	2/3 pts 0.25 AE/ac 0.25 lbs a.i./ac	Mid-bolt to late bud; active growth	Late spring/summer	Upland
			2/year	1 acre
Rodeo™	7.5 – 6 pts 3.0 AE/ac 4.0 lbs a.i./acre	Active growth	Spring/early summer	Riparian
			2/year	15-30 acres
Tordon 22K (picloram)	1 –2 pts .5 AE/ac 0.5 lbs a.i./ac	Bud to full flower	Spring/late summer	Upland
			2/year	15-30 acres
	Re-vegetation		Spring/fall	
			1/year	Up to 30 acres

[1] Treatment is for a range of application rates per acre for the listed Trade Name herbicide and all rates are less than maximum rates listed on the herbicide label.
[2] Timing of control will include treatment of re-growth.

Alternative 4. No Action Alternative

No action will be taken to reduce or eliminate knapweed in the project area.

Comparison of Alternatives

Refer to Tables 5 and 6 for a comparison of the Alternatives.

Table 5. Acres By Treatment Type.

Alternative	Glyphosate (Rodeo™)	Clopyralid (Transline ™) or Picloram (Tordon 22K™)	Glyphosate (Rodeo™) & 2,4-D (Weedar™)	Clopyralid (Transline™) or Picloram (Tordon 22K™) & 2,4-D (Weedone™)	Manual Treatment (Grubbing, digging, mulching, and revegetation)
1			15-30 acres	1 acre	< 1
2					Up to 30 acres
3	Up to 25 acres	Up to 5 acres			Up to30 acres
4					

Table 6. Alternative Comparison.

Issue (Meas-ure)	Human Health and Safety (Risk/Toxicity)	Water Quality Aquatic Effects (Risk/Toxicity)	Non-Target Species and TESP (Risk/Toxicity)	Use of 2,4-D (Yes/No)	Community Life-style Impacts (Yes/No)	Duration of Time to meet Eradica-tion	Meets Purpose and Need Potential for eradication (High/Med/ Low)
1	Slight to Moderate	None to Slight	Slight to moderate	Yes	Yes	4 years	High
2	None to Slight	None to Slight	None to Slight	No	Yes	10 years	Low
3	Slight	None to Slight	None to Slight	No	Possible	4-10yrs	Med
4	None	Slight	None to slight	None	Yes	N/A	Not at all

Alternatives considered, but not in detail:

Alternative 5. Non-synthetic herbicides - corn gluten

Corn gluten meal is a by-product of corn that was discovered at the University of Iowa as a non-synthetic herbicide treatment that suppresses emergence of some plants at certain application rates. Studies indicate that up to 500- 800 pounds per acre (20 to 60 lbs or more/1000 sq. ft.) of the product is necessary to achieve desired results. Literature on the product indicates that it is approximately 10% nitrogen (N) by weight. There is no post emergence control of weeds. If plants have germinated or formed roots, they will not be controlled by corn gluten.

Corn gluten has been used in limited applications and appears to be best suited for lawn and turf management. Corn gluten has not been tested on knapweed or in wildland conditions such as those present in the Salmon River area. The efficacy of treatment on established plants of this species in meeting objectives is questionable at this time. Further more, there is concern that the high application rates and the nitrogen content would have adverse effects on aquatic habitat if used in the floodplain area. Suppressing establishment of desired native plants does not meet LRMP goals for biological diversity.
This alternative does not meet purpose and need of eradication.

Alternative 6. High temperature steam treatment.

High temperature steam machines have been used in some areas to kill undesirable live plants in conjunction with railroad right-of ways and in nursery situations. This technique was designed more for roadside eradication in areas of easy vehicle access. The large equipment required is not suited for off-road or mountainous terrain. This alternative was not considered to be practical or effective to meet the objectives at this time.
This alternative does not meet purpose and need of eradication.

Alternative 7. Biological control

Biological control is not a method used for eradication of noxious weeds and is not considered effective at the known level of infestation at this time. The purpose of introducing biological controls to infestations of noxious weeds is to reduce those infestations to tolerable levels. Since knapweed is considered a public nuisance and an "A" rated pest, the acceptable tolerance is zero. Biological control is used to attempt to contain large infestations of pests and prevent the rate of spread from increasing.
This alternative does not meet the purpose and need of eradication of this knapweed at this time.

Chapter 3. Environmental Consequences

Issue-Related Consequences

Issue 1 - Effects to Human Heath and Safety

Environmental consequences relative to this issue will be discussed for each alternative. This issue will be evaluated through a hazard analysis and an exposure analysis. Hazard will be measured in terms of a Hazard Quotient (HQ) which compares estimated doses to an established reference dose. The analysis will consider the risk of exposure to the public and to workers applying herbicides and the anticipated dose levels the public and workers might be exposed to given the proposed rates of application and the dosages likely to result from the estimated exposures.

A Human Health and Safety Risk Assessment (Bakke, 2000) was completed for this project to assess the site-specific risks to human health and safety from using the herbicides proposed for use (Appendix A). The analysis is based on the actual planned herbicide application rates shown in Table 1. The site-specific risk assessment uses standard methodology widely accepted by the scientific community, regulatory agencies, and the Forest Service (USDA, 1989, referred to as FEIS, pages 4-62 to 4-122 and Appendix f; National Research Council (NRC), 1983; United States Environmental Protection Agency (EPA), 1986; Syracuse Environmental Research Associates, SERA 1996; 1997, 1999a, 1999b). In essence, the risk assessment compares herbicide doses that people might receive from applying the herbicides (worker doses) or from being near an application site (public doses) with doses shown to cause no observed ill effect (No Observed Effect Levels, NOEL) in test animals and long-term laboratory studies. The risk assessment examines the chance, based on site-specific herbicide use levels, that exposures from these herbicide formulations would result in acute, systemic, or reproductive effects. The site-specific risk assessment also examines the potential for these effects to cause synergistic effects, cumulative effects, and effects on sensitive individuals including women and children.

Herbicides are intended to be toxic to plants. They are intended to interfere with vital plant processes that do not occur in animals: seed germination, hormone-mediated growth and development, and photosynthesis. Basic biological and physiological differences between plants and animals partly account for the relatively low toxicity of most herbicides to animals.

The main impacts on human health from chemical treatments depend upon the toxicity of the chemical and the level of human exposure. All chemical effects of biological systems follow a dose-response relationship; as dose increases so does effect and vice versa. The chemicals proposed for use in this assessment have not been found to cause significant mutagenic or carcinogenic effects.

Hazard Analysis

Hazard analysis requires gathering information to determine toxic properties of each herbicide. Human hazard levels are primarily derived from results of lab experiments on animal models, supplemented where appropriate with information on human poisoning accidents, epidemiological studies, and data on chemical structure.

The types of toxicity levels generally considered are systemic and reproductive. Systemic toxicity is observed as acute through chronic. **Acute** toxicity studies are used primarily to determine the toxicity reference point (i.e. lethal dose) of a given substance. **Chronic** toxicity studies are designed to characterize dose-response relationships resulting from repeated exposure to a compound over time. **Reproductive** and developmental studies are conducted to determine the effect of a chemical on reproductive success. Reproductive studies are most often multi-generational.

Toxic effect levels (acute) are often expressed as LD_{50}, the dosage of toxicant (expressed in milligrams of toxicant per kilogram of animal body weight) required to kill 50 percent of the animals in a test population when given orally. Toxicity of herbicides and other substances is displayed for information purposes in Table 7. Toxicity (chronic) can also be expressed in terms of NOELs defined as: (1) the lowest dose of a substance by any route other than inhalation that has been found by experiment with animals to have no toxic effect on the animals, or (2) the lowest concentration of a substance in the air that has been found by experiment with animals to have no toxic effect on the animals exposed for a defined time.

Chemical exposure may be brief (acute) or prolonged (chronic). The terms acute and chronic may be used to describe duration of effect as well as duration of exposure. The kind of response (acute or chronic) observed in organisms depends on the route of intake (oral, dermal, inhalation) and frequency of exposure, coupled with the specific mechanisms of toxicity. A chemical of high toxicity may represent no or limited hazard if exposure and dose are low, just as a chemical of limited toxicity may be hazardous if exposure is high.

Extensive studies of the absorption, distribution, metabolism, and excretion of herbicides in animals (SERA, 1996, 1997, 1999a, 1999b) have shown that the herbicides in this document and their metabolites are rapidly eliminated from most animals and do not substantially accumulate in animal tissues. These traits further reduce the possibility that exposure will result in harmful adverse consequences.

Of concern is the probability that the use of a chemical will result in an irreversible effect such as reproductive or genetic effects. Reproductive effects include infertility miscarriage, general fetal toxicity, and birth defects (teratogenesis). Almost all chemicals will produce reproductive effects in the laboratory at some dose.

Table 7. Acute Toxicity Classification Acute Toxicities of the Four Herbicides and Other Chemicals.

Toxicity Category	Herbicide or Other Chemical Substance	Oral LD_{50} for Rats (mg/kg)	Equivalent Human Dose
Very Slight		**5,000 – 50,000**	**More than 1 pint**
	Sugar	30,000	
	Kerosene	28,000	
	Ethyl Alcohol	13,700	
	Diesel Oil	7,380	
	Simzine	>5,000	
Slight		**500 – 5,000**	**1 ounce to 1 pint**
	Glyphosate	4,320	
	Clopyralid	4,300	
	Picloram	4,012	
	Table salt	3,750	
	Bleach	2,000	
	Aspirin, Vitamin E	1,700	
Moderate		**50 - 500**	**1 teaspoon to 1 ounce**
	2,4-D	375	
	Caffeine	200	
Severe		**0 – 50**	**1 teaspoon or less**
	Nicotine	50	
	Parathion (insecticide)	13	

	Botulinus Toxin	0.00001	
Reference: R-5 FEIS (USDA, 1989)			

All anticipated herbicide exposures in the analysis will be compared to a reference dose (RfD). Exposure to hexachlorobenzene, an impurity contained in two of the herbicides proposed for use, is compared to a Minimum Risk Level (MRL). The U.S. Environmental Protection Agency establishes an oral RfD for registered pesticides that is an estimate of a daily dose to a human that is likely to be without appreciable risk of deleterious effects during a lifetime (EPA 1989). It uses the lowest systemic NOEL from the most relevant species and studies. The NOEL is divided by a factor (usually 100) to determine RfD to account for variation in species.

The risk assessment compares herbicide doses expected from application (worker doses) or from being near the site (public doses) with doses shown to cause no observed ill effect (NOEL). The risk assessment examines the chance, based on site-specific herbicide use levels, that exposures from these herbicide formulations would result in acute, systemic, or reproductive effects. The risk of threshold effects was evaluated in terms of a HQ, which compares the expected doses to the RfD. If the HQ is less than one, it indicates a low human health risk. The site-specific risk assessment also examines the potential for these treatments to cause synergistic effects, cumulative effects, and effects on sensitive individuals, including women and children.

Risk Analysis

Those potentially at risk fall into two groups: workers and members of the public. The most likely individuals to be exposed to herbicides during and after the project are the backpack applicators applying the treatments; residents who live near the treatment areas and visit the sites; hikers and backpackers; hunters; fishers; nature students; native plant materials collectors; swimmers and rafters; and firewood gatherers. Dispersed use in the area would range from 5 to 20 people per year in some of the remote upland sites, to up 200 or more people per year on the accessible river bar sites.

There are 7 occupied residences within ¼ mile of any of the proposed treatment units (the Relative Toxicity Level of Herbicides is listed in Table 8). Drift of spray when using backpack sprayers to spray individual plants under the specified wind conditions (less than 5 mph) will not reach the residences and effects are expected to be negligible. Herbicide application equipment is designed to cover target plants with a minimum of off target spray movement, or drift. Despite the effectiveness of application equipment used, some small fraction of the droplets may break into smaller droplets that the wind could blow off-site. Hand application techniques proposed are not broadcast sprays and will not produce any appreciable herbicide drift. Granular and pelletized formulations are also associated with little drift. Several studies have been conducted to determine spray drift; various sources for assumptions and methods of calculations have been consulted (USDA 1984). In the studies, spray drift at distances downwind of the application site was determined for aerial, backpack, and ground mechanical application equipment. Spray drift from hand application equipment was determined to be negligible.

Specific mitigation measures are planned for the project alternatives that will further reduce risks to workers and the public. These include use of protective clothing, washing clothes daily. Clean soap and water for routine washing of hands and face and for emergencies will be on site. Workers would be trained in safety and emergency procedures.

In addition, risk of exposure is relatively low due to several other factors including protective buffers, wind restrictions for spraying, signing and posting areas that are sprayed, using a colored dye in the spray, and restricting access to units that have been treated.

In addition to the site-specific risk assessment in Appendix A, discussion of effects of alternatives to human health and safety incorporates by reference information contained in several documents that were used as a basis for analysis. These documents are available in the project file at the Scott River Ranger Station in Fort Jones, CA. Toxicity information for the herbicides being considered for use is summarized in the Pesticide Background Statements, Volume 1 Herbicides (Forest Service Agricultural Handbook, No. 633 (USDA, 1984)), in the FEIS and in risk assessments completed for the proposed herbicides by the (SERA, 1996; SERA, 1999a, SERA 1999b.). Risk Assessment For Herbicide Use In Forest Service Regions 1,2,3,4, and 10 and On Bonneville Power Administration Sites (USDA, 1992).

Table 8. Relative Toxicity Level of Herbicides.

	Glyphosate	**2,4-D**	**Picloram**	**Clopyralid**
Trade Name	Rodeo™; Roundup™	Weedar™, Weedone™	Tordon 22k™	Transline™
LD50 (mg/kg) [1]	2,000 –6,000	300 - 2000	3,000 – 5,000	27 - >5,000
Commonly Used [2] **Terms/Toxicity Category**	Slightly toxic	Moderately to slightly toxic	Slightly toxic	Slightly toxic
Activity in soil	Inactivated upon contact with the soil.	Leached in sandy soil; breakdown depends on microbial activity.	Sorption by organic matter and clays; may leach in sandy soils.	Active in soil; not absorbed, highly soluble. Rapid breakdown by soil microbes.
Hazard Quotient (HQ)[4]	0.014	2.9	0.030	0.006
Systemic/Repro-ductive NOEL[3] **(mg/kg/day)**	20/50	31/3	7/50	15/75

1 Most LD_{50} values are expressed as a range to account for differences in experimental conditions, the type of carrier the toxicant is dissolved in, or the species of test animal used.

2 Severely Toxic is LD_{50} less than 50 mg/kg, Moderately Toxic is 50–500 mg/kg; Slightly Toxic is 500-5,000; Very Slightly Toxic is 5,000-15,000 mg/kg (or higher); relatively non-toxic is more than 15,000 mg/kg in a single oral dose to rats based on EPA toxic categories (Maxwell 1982).

3 The highest dosage level at which no reproductive effects have been observed in test animals, including decreased fertility, reduced litter size, reduced offspring, size or poor viability (reproductive) and fetus malformations during development; not associated with genetic change (teratogenic).

4 The Hazard Quotient is the estimated dose divided by the RfD. An HQ < 1 indicates a low human health risk. HQs shown here are for worker doses. Exposure to the general public would be expected to be less. See the Risk Analysis in Appendix A for all public exposure scenarios and associated HQs.

Characteristics of Proposed Herbicides in Alternatives 1 and 3

Glyphosate

The toxicity of glyphosate is relatively well characterized in humans and experimental mammals. The acute toxicity of glyphosate is relatively low, with LD_{50} values in experimental mammals ranging from 2,000 to 6,000 milligrams/kilogram of body weight (mg/kg). Most of the data regarding human exposure to glyphosate involves consumption of large quantities of glyphosate during attempted suicide studies. Glyphosate is not a primary skin irritant and is only minimally irritating to the eye. There is no evidence that glyphosate is a teratogen (causes birth defects) (SERA, 1996). Some formulations of glyphosate contain an impurity, N-nitrosoglyphosate (NNG), considered a nitrosamine. EPA concluded that the NNG content of glyphosate was not toxicologically significant in terms of carcinogenicity. NNG is not present in the formulation (Rodeo™) proposed for use in this project.

Two general exposure assessments were used in the SERA Risk Assessment (SERA, 1996): job-specific assessments and incident assessments. Job-specific assessments estimate the absorption associated with relatively complex job activities, such as mixing, loading, and applying glyphosate. All of the assessments give a range based on application rates, empirical observations of variability in exposure rates, and number of acres estimated to be treated per hour.

Workers, compared with the general public, are exposed to greater levels of glyphosate. Typical ground workers are exposed to 0.0005-0.073 mg/kg. Members of the general public are usually exposed to only extremely low levels of glyphosate (0.00012-0.007 mg/kg), except for accidental exposures scenarios when exposure levels may approach levels for occupational exposure (0.007-0.019 mg/kg).

The current RfD for glyphosate is 2.0 mg/kg/day (U.S. EPA 2000), which is based on a NOEL of 175 mg/kg/day with an uncertainty factor of 100 used to account for species-to-species extrapolation and sensitive subgroups.

Clopyralid

Clopyralid (Transline™) has a low order of acute toxicity, with acute LD_{50} values in the range of 2,700 to greater than 5,000 mg/kg. After direct instillation into the eye, clopyralid (Transline™) can cause persistent damage to the eye (redness, swelling opacity of the iris). Clopyralid is neither a skin irritant nor a skin sensitizer. Studies have shown no systemic toxic effects from dermal exposure. On chronic or sub-chronic exposures, no effects have been observed in laboratory mammals at doses of 50 mg/kg/day or less, which EPA has identified as the systemic NOEL. The RfD for clopyralid (Transline™) is 0.5 mg/kg/day. Studies have not shown any reproductive or teratogenic effects at levels below that which would be maternally toxic. Clopyralid (Transline™) is not a mutagen and studies have shown it not to be a carcinogen.

There are two impurities in the clopyralid (Transline™) formulation: hexachlorobenzene [nominal concentrations of less than 2.5 parts per million (ppm)] and pentachlorobenzene (nominal concentrations of less that 0.3 ppm). Hexachlorobenzene has been identified by the EPA as a probable human carcinogen, and is a persistent environmental contaminant. The RfD is established as 0.0008 mg/kg/day. Data on pentachlorobenzene is insufficient to classify as a potential carcinogen.

According to the SERA Risk Assessment (1999), the amount of hexachlorobenzene released each year in Forest Service programs nationally is about 0.0034 kg. It concluded that Forest Service programs contribute very little to background levels of hexachlorobenzene in the environment (approximately one part in one-hundred million parts). In normal applications of clopyralid (Transline™), workers will be exposed to greater amounts of hexachlorobenzene than the general public. Nonetheless, the central estimates of worker exposure under normal conditions to hexachlorobenzene are below the background levels of exposure by factors of about 3 to 5. The report concluded that there is no basis for asserting that the use of clopyralid (Transline™) by the Forest Service will result in substantial increased in the general exposure of either workers or members of the general public to hexachlorobenzene.

Picloram

Picloram (Tordon 22K™) has a low order of acute toxicity, with acute oral LD_{50} values in the range of 3,000 to 5,000 mg/kg. Picloram (Tordon 22K™) is classified as a moderate eye irritant, but as a non-irritant to the skin. The systemic NOEL is 20 mg/kg/day. This is the basis for EPA's calculated RfD, which is 0.2 mg/kg/day. The low chronic toxicity may be due in part to the fact that picloram (Tordon 22K™) is rapidly excreted from the body. Picloram is not a mutagen, and EPA has classified picloram (Tordon 22K™) in Group E (no evidence of carcinogenicity) based on the lack of such activity in tested rats and mice.

There is an impurity in the picloram (Tordon 22K™) formulation, hexachlorobenzene, which has been identified by EPA as a probable human carcinogen (see discussion above).

2,4-D

2,4-D can be classified as moderately toxic in rats with an oral LD_{50} of 375 mg/kg (EPA 1987). The acute dermal LD_{50} of 2,4-D in rabbits is greater than 3,980 mg/kg (EPA 1987). Several primary eye irritation studies in rabbits have been conducted with various 2,4-D products. Toxic effects range from severe to slight. EPA (1990) established an RfD for chronic oral exposure to the herbicide 2,4-D of 0.01 mg/kg/day, with a NOEL of 1.0 mg/kg/day.

2,4-D ingestion or skin exposure in humans can cause irritation of the gastrointestinal tract, chest pain, and muscle twitching. Ingestion of large does of 2,4-D causes gastroenteritis, skeletal and cardiac myotonia (abnormal muscular movement), and central nervous system depression in humans. A human dose of 80 mg/kg of the dithylamine salt of 2,4-D caused congestion of all organs, degeneration of nerve cells, and death. Accidental swallowing of 110 mg/kg of the isooctyl ester of 2,4-D caused muscle twitching and paralysis, although the individual recovered in 24 hours (cited in USDA 1984).

Toxicological and Epidemiological Studies of 2,4-D

The toxicology of 2,4-D has been extensively investigated, primarily because 2,4-D was used in combination with 2,4,5-T as the active ingredients in Agent Orange. A major issue is the contamination of Agent Orange with TCDD, which is a contaminant of 2,4,5-T. There are no reports in the literature that 2,4-D contains TCDD as a contaminant. While 2,4-D and 2,4,5-T are structurally similar (differing by one chlorine atom), the difference is extremely important making the probability of 2,4-D containing TCDD remote.

The two formulations proposed for use in Alternatives 1 and 3 are an ester amine salt (Weedar™) and an ester formulation (Weedone™). The ester formulation contains 2,4-D concentrations that are higher than those found in the salt formulation. There is substantial uncertainty in the exposure assessments and risk characterizations for the different formulations of 2,4-D. There is less uncertainty of the dose-response relationships for the acid salts and esters.

Several epidemiological investigations have been conducted to examine the link between human exposure to phenoxy acid herbicides and cancer. In the mid and late 1970s, Hardell and colleagues (Hardell and Sandstrom 1979; Eriksson et al. 1981; Hardell et al. 1981) conducted a series of case-control studies in rural Sweden. These studies found a significant increase (five- to six-fold) in the relative risk of soft tissue carcinomas, Hodgkin's disease, and non-Hodgkin's lymphoma among farmers using various herbicides. However, many experts have questioned the validity of the studies' results because of possible selection bias, observation bias, and uncontrolled confounding variables. A Swedish study found no significant increase in the relative risk of soft-tissue sarcomas in agricultural and forestry workers exposed to phenoxy herbicides (Wilklund and Holm 1986). A case-control study in New Zealand found no increased relative risk of soft tissue carcinomas (Smith et al. 1984). A multitude of studies has been conducted investigating this link. These studies were reviewed thoroughly by the U.S. EPA and are undergoing additional review as part of the re-registration process for 2,4-D scheduled for the year 2000. The cancer risk assessment for 2,4-D should be examined after the re-registration process is completed.

Effects of Alternatives

Effects to human health and safety will be disclosed by alternative and by herbicides used in Alternatives 1 and 2. The data used is taken from the Human Health and Safety Risk Assessment prepared for this project (Appendix A). Herbicide doses were calculated for the Proposed Action for workers and potentially exposed members of the public. For analysis purposes in this EA, the worker doses and associated HQs are used as a basis of comparison of alternatives. Under normal situations (i.e. non-accidental) risks to applicators are higher than risks to the general public because workers have a greater potential for exposure to the herbicides. In the Risk Assessment, HQs were calculated for a number of scenarios. Many of the scenarios are accident scenarios that do not approximate expected doses estimated in the proposed action and alternatives. They are analyzed in the risk assessment to display a relative range of effects under varying conditions. A Hazard Quotient less than one is considered to be an acceptable risk. HQ is based upon a comparison of a single daily exposure with an acceptable lifetime daily exposure level.

Alternative 1

This alternative proposes the use of up to four herbicides: glyphosate (Rodeo™), 2, 4-D (both an amine and ester form), clopyralid (Transline™), and picloram (Tordon 22K™; soluble concentrate) on 15 to 30 acres. All sites could potentially be treated with herbicide application. The majority of herbicide treatment sites (80% or more) occurs in the river bar and would be treated with a combination of glyphosate and 2,4-D. The upland sites would be treated with picloram or clopyralid. Based on the Risk Assessment (Appendix A), 2,4-D poses a moderate risk to human health and safety; glyphosate, picloram, and clopyralid pose slight risks. HQs for each proposed chemical are displayed below. **This alternative poses a moderate risk to human health and safety**.

Glyphosate (Rodeo™)

The estimated worker dose[1] for this alternative is: 0.018 mg/kg/ of body weight/day.
The RfD is: 2.0 mg/kg/day.
The HQ is: 0.009

At the estimated rate, the HQ for workers is considerably less than one. General public exposure would be less than that. Use of glyphosate in this alternative represents little risk of acute or chronic effects. It poses a very slight risk to human health.

Clopyralid (Transline™)

The estimated worker dose for this alternative is: 0.002 mg/kg/day.
The RfD is: 0.5 mg/kg/day
The HQ is: 0.004 mg/kg/day

At the estimated rate, the HQ is considerable less than one. Use of clopyralid in this alternative represents little risk of acute or chronic effects. It poses a very slight risk to human health.

Picloram (Tordon 22k™)

The estimated worker dose for this alternative is: 0.004 mg/kg/day.
The RfD is: 0.2 mg/kg/day.
The HQ is: 0.020 mg/kg/day

At the estimated rate, the HQ is considerable less than one. Use of picloram in this alternative represents little risk of acute or chronic effects. It poses a very slight risk to human health.

Hexachorobenzene[2]

The estimated worker dose for this alternative is: .000000036 mg/kg/day
The RfD is: 0.0008 mg/kg/day
The HQ is: 0.000006 mg/kg/day

At the estimated rate, the HQ is considerably less than one. Use of hexachlorobenzene in this alternative represents little risk of acute or chronic effects. It poses a very slight risk to human health.

2,4-D (Weedar 64, Weedone638)

The estimated worker dose is: 0.02 mg/kg/day.
The RfD is: 0.01 mg/kg/day.
The HQ is: 2.0 mg/kg/day.

[1] Uses an established absorbed dose rate times the application rate.

[2] Hexachlorobenzene is an impurity found in both Clopyralid and Picloram

At the estimated rate, the HQ is greater than one. Use of 2,4-D in this alternative represents some risk of acute or chronic effects. It poses a moderate risk to human health.

Alternative 2

This alternative does not propose the use of any chemical herbicides for treatment of knapweed. The threat of risk to human health and safety from use of herbicides is eliminated.

There is some risk of injury to workers in this alternative due to extensive use of manual methods of removal of knapweed. This could be in the form of back injury from prolonged bending and digging, over-exposure to sun and other elements, tripping and falling and cuts or abrasions from use of hand tools. This risk would be slightly higher than in Alternatives 1 and 3 due to the more extensive and repeated treatment required when using manual methods only to eradicate knapweed. It is expected that these risks would be minimized with the use of protective clothing and gloves and by implementing standard safety precautions during field work. **This alternative poses a very slight risk to human health and safety.**

Alternative 3

This alternative proposes the use of up to three herbicides: glyphosate (Rodeo™), clopyralid (Transline™) and picloram (Tordon 22K™; soluble concentrate) if manual methods are determined not to meet established evaluation criteria. 2,4-D will not be used in this alternative. For purposes of analysis of the effects of this alternative, it was assumed that up to 30 acres could be treated with herbicides.

Use of glyphosate, clopyralid, and picloram represents little risk of acute or chronic effects.
The discussion of the effects of the three chemicals to be used in this alternative and their effects to human health and safety is the same as discussed in Alternative 1.

There is some risk of injury to workers in this alternative due to the use of manual methods of removal of knapweed as discussed in Alternative 2. **This alternative poses a slight risk to human health and safety.**

Alternative 4

No action would be taken in this alternative, and workers and the public would not be exposed to chemical herbicides or manual labor. **This alternative poses no risk to human health and safety.**

Effects Common to Alternatives 1 and 3

Synergistic Effects

Synergistic effects (multiplicative) are those effects resulting from exposure to a combination of two or more chemicals that are greater than the sum of the effects of each chemical alone (additive). Instances of chemical combinations that cause synergistic effects are relatively rare (FEIS, pg 4-112). Synergism has not been observed in toxicological effects involving combinations of commercial pesticides.

The herbicide mixtures proposed in Alternatives 1 and 3 have not shown synergistic effects in humans who have used them extensively in forestry and other agricultural applications. However, synergistic toxic effects of herbicide combinations, combinations of the herbicides with other pesticides such as insecticides or fertilizers, or combinations with naturally occurring chemicals in the environment are not normally studied. In one study, a mixture of 2,4-D and picloram produced skin irritation in test animals while neither herbicide alone has been shown to cause this effect (USDA, 1989).

Based on the limited data available on pesticide combinations, it is possible, but quite unlikely, that synergistic effects could occur as a result of exposure to the herbicides considered in this analysis. Even if synergistic effects or additive effects were to occur as a result of treatment, these effects are dose responsive (Dost, 1991). This means that exposures to the herbicide plus any other chemical must be significant for these types of effects to be of biological consequence.

Based on the very low exposure rates estimated for the alternatives, any synergistic or additive effects are expected to be insignificant.

Cumulative Effects

The proposed use of herbicides in the two alternatives could result in cumulative doses of herbicides to workers or the general public. Cumulative doses to the same herbicide result from (1) additive doses resulting from various routes of exposure from this project, and (2) additive doses resulting from various routes of exposure to other herbicide treatments. Each of the hazard quotients summarized in Table 8 involves a single exposure scenario. In some cases, individuals could be exposed by more than one route, and in such cases can be quantitatively characterized by simply adding the HQs for each exposure. The risk of this is greater for workers than for the general public, unless the public is using significant amounts of herbicides for home use. There are no major adjacent landowners in the Salmon River area that have used herbicides or plan to use herbicides in the future. The Forest Service has not used herbicides in the area for over 10 years.

Since these herbicides persist in the environment for only 1 to 12 months (FEIS, 4-9), do not bioaccumulate, and are rapidly eliminated from the body (SERA, 1996, 1997, 1999a, 1999b), it is not anticipated that any additive herbicide doses from re-treatment in following years would occur.

Even in the unlikely event of multiple exposures to the herbicides proposed for use over a period of one day or for several months, the associated HQs when added together would remain below one and therefore pose a low health risk to those individuals.

Cumulative effects from the herbicides proposed in Alternatives 1 and 3 will not result in substantial cumulative effects to human health and safety.

Sensitive Individuals

The margin-of-safety (MOS) used in the development of the RfD takes into account much of the variation in human response. The normal MOS of 100 is sufficient to ensure that most people will experience no toxic effects (R5 –FEIS, pg.4-114). “Sensitive” individuals are those that might respond to a lower dose than average, which includes women and children. Factors affecting individual susceptibility to the herbicides include diet, age, heredity, preexisting diseases, gender, and life-style. Individual susceptibility to the herbicides proposed in this project cannot be specifically predicted. Unusually sensitive individuals may experience effects even when the MOS is equal to or greater than 100. Both alternatives require the posting of sprayed units and area closures to avoid contact during and immediately after spray. This should effectively prevent adverse effects to sensitive individuals. Because these chemicals rapidly decay in the environment, and because they will not be applied to water or move substantially through the air or soil, the probability of exposure is low and the time frame for risk of exposure would be limited to several months.

Because only a very small portion of the public is likely to be exposed to these applications, and because except in extremely unlikely public exposure scenarios analyzed in the Risk Assessment, the HQ values are generally much less than 1 for public exposure, adverse effects to the public are not expected.

Inert Ingredients, Impurities, Additives, and Metabolites

The toxicity data are based on the active ingredients found in the herbicide formulations. The formulations also include chemicals, called inert ingredients, which act as carriers for the active ingredients and facilitate the effective application of the herbicides. Other spray additives such as surfactant R-11 and/or colorants may be added to mixtures prior to application. Concern was expressed about the possible toxic properties of the inert ingredients and the full formulations during public scoping.

Inert Ingredients

Table 9 lists the percentages of inert ingredients found in the herbicide formulations being considered for use in the alternatives. The primary ingredient in Rodeo™ is water; in Transline™ is isopropyl alcohol; and in Tordon 22K™ is Polyglycol 26-2. There is little published information on the impurities in commercial formulations of 2,4-D. Studies conducted in the 1970s (SERA, 1997) reported that commercial samples contained concentrations of monochlorophenoxyacetic acid (0.1%), dichlorophenoxyacetic acid (2.3%), 2,4,6-trichlorophenoxyacteic acid (0.2%), and bis (2,4-dichlorophenoxy) acetic acid (0.7%).

Table 9. Percentage of inert ingredients present in herbicide formulations.

Chemical	Formulation	EPA Reg. #	% Inert
Glyphosate	Rodeo™	534-343	46.2 (water)
Clopyralid	Transline™	62719-259	59.1 (isopropyl alcohol)
Picloram	Tordon 22K™	62719-6	75.6 (polyglycol 26-2)
2,4-D	Weedar 64™	71368-1-264	53.2 (none on EPA list)
2,4-D	Weedone 638™	71368-3-264	61.7 (petroleum distillates/xylene)

The EPA has categorized approximately 1,200 inert ingredients into four lists (FEIS, 4-116; Fed Reg. 54:48314-16). For a more detailed discussion of the inert ingredients and their potential effects see the Risk Assessment in Appendix A. Lists 1 and 2 contain inert ingredients of toxicological concern. List 3 includes substances for which EPA has insufficient information to classify as either hazardous (List 1 and 2) or non-toxic (List 4). Use of formulations containing inert ingredients on Lists 3 and 4 are preferred Forest Service policy. The inert ingredient in Transline™ is on list 4. The inert ingredient in Tordon 22K™ is on List 3. The lack of information on this compound and with the inert ingredients contained in the Weedone formulation of 2,4-D adds an element of uncertainty to the Risk Assessment (SERA, 1999b, Bakke 2000).

Comparison of acute toxicity (LD_{50} values) data between formulated products (including inert ingredients) and their active ingredients alone shows that the formulated products are generally less toxic than their active ingredients (FEIS, USDA 1984).

While these formulated products have not undergone chronic toxicity testing like their active ingredients, the acute toxicity information on the inert ingredients in each product leads to the conclusion that the inert ingredients in these formulations do not significantly increase the health risk over the risks identified for the active ingredients. **Health risks from inert ingredients and the full formulations of the proposed treatments are low; some uncertainty exists in the Weedone formulation of 2,4-D.**

Impurities

As stated above, both picloram and clopyralid contain the impurity hexachlorobenzene. In addition, clopyralid contains the impurity pentachlorobenzene. Glyphosate contains the impurity N-nitroglyphosate (NNG) and 2,4-D may contain impurities discussed above. As stated in SERA 1996, 1997, 1999a, 1999b, concern for impurities in technical grade products is reduced by the fact that the existing toxicity studies on these herbicides were conducted with the technical grade product. **The carcinogenic risk of the impurity hexachlorobenzene as shown above is very low.**

Additives

The surfactant R-11® is a spreader/activator that improves the activity and penetration of the herbicide by reducing surface tension, allowing the herbicide mixture to spread evenly over the surface of the vegetation. A colorant, Hi-Light Blue™, is used to mark the areas sprayed and maximize the efficiency of application. The ingredients in these products are considered proprietary. The Superfund Amendments and Reauthorization Act (SARA) list none of the ingredients as hazardous. The dye is commonly used in toilet bowl cleaners and as a colorant for lakes and ponds. Information in the site-specific Risk Assessment for this project (Appendix A) was obtained from EPA and the manufacturers. Based on the chemical nature of the ingredients, the risk assessment concludes only very slight toxicity is expected. **The use of additives in the formulation would result in almost no increase in risk to the health and safety of the workers or public.**

Metabolites

Metabolites are compounds formed as a result of metabolism or biochemical change. The assumption is that the toxicological consequences of metabolism in the species on which toxicity studies are available will be similar to those in humans. Uncertainties in this assumption are encompassed by using an uncertainty factor deriving the RfD and may sometimes influence the selection of the study used to derive the RfD (SERA, 1999a).

Clopyralid (Transline™) has been shown to not be extensively metabolized in rats, with most of the dose being excreted unchanged in the urine within 24 hours. Similarly in plants, clopyralid remains unchanged in the plant. (SERA 1999a).

The primary metabolite of glyphosate (Rodeo™) is aminomethylphosphonate (AMPA). In mammals, only a very small amount of AMPA, less than 1% of the absorbed dose, are formed. AMPA is poorly absorbed in the gastrointestinal tract and is eliminated primarily in the urine (SERA, 1996**).**

As reviewed by the EPA, there is no indication that picloram is extensively metabolized (SERA, 1999b).

2,4-D does not appear to be metabolized extensively in mammals; however, the compound degrades in the environment to form the metabolite 2,4-dichlorophenol, which is a toxic metabolite. The RfD for 2,4-dichorophenol is 0.003 mg/kg/day. Because there is no indication that workers or the general public will be exposed to substantial amounts of 2,4-dichorophenol, the formulation of this compound in sediment as part of the environmental degradation process does not contribute substantially to risks associated with the use of 2,4-D in the alternatives (SERA, 1997).

One study done in the Pacific Northwest Region on National Forest lands, found that of 254 samples representing 133 sprayings of 2,4-D, 117 had no confirmable residues, 13 had residues less than 5 ppb, two had residues of 5-10 ppb, and one had a residue of 40 ppb (Neisess 1983 as cited by USFS 1984). All of these are well below public health goals.

Issue 2 - Effects to Water Quality and Aquatic-Related Species.

This section will discuss and analyze the potential effects of the alternatives on watershed conditions and processes using measures of risk and toxicity. Of specific concern are the effects of herbicides on soil and water quality, the potential for water contamination and impacts on aquatic-related resources. One specific objective is to determine whether this project will comply with the NCRWQCB's "Water Quality Control Plan for the North Coast Region" (3/24/1994). This will be discussed further at the end of this section.

The riparian areas proposed for treatment are the alluvial flats and gravel bars along the Salmon River. Overall, these units are underlain by sand and gravel alluvium deposited by the Salmon River. A few of the units have some soil development on old sand bars.

The Kelly Gulch units are located along and just below the top of a rocky ridge. These units are underlain by forest soils that contain fine particles and organics. There is no surface water near any of these treatment units.

Water Quality Effects

The potential impact of herbicide treatment of knapweed on water quality and fisheries is a major concern. Although in the past improper application of insecticides have generally caused substantially more fish and wildlife concerns, careful analyses of herbicide application projects and their effects is an important consideration in water quality protection.

Characteristics of Proposed Herbicides in Alternatives 1 and 3

The chemical structure of each herbicide is important because it influences whether the chemicals would be immobilized, degraded, or possibly transported into the aquatic environment. The behavior of a chemical in soil is determined by a number of properties related to both the chemical and the soil environment. Chemical substances that are adsorbed to soil particles are mostly degraded in place and resist leaching. Adsorption of chemicals to soil particles depends primarily on the clay and organic content, temperature and pH of the soil.

Chemical substances in the soil are subject to degradation by sunlight, chemical, and biological means, and movement by diffusion, dissolution, or vaporization. Many soil organisms are capable of metabolizing chemical substances. Biological degradation is an important means by which substances are removed from the soil.

Glyphosate (Rodeo™):

Glyphosate adsorbs strongly to fine particles in the soil (Monsanto, 1997; EPA, 1993; SERA, 1996), and is not expected to move vertically below the six-inch soil layer (EPA, 1993). It has a half-life of 30 to 40 days in the soil. Soil microbes readily break down glyphosate to AMPA, which is degraded to CO_2 (EPA, 1993). AMPA also strongly absorbs to soil particles (EPA, 1993). If glyphosate were to reach surface water, it would not be broken down readily by water or sunlight (EPA, 1993); however concentrations in natural water will diminish rapidly due to microbial degradation, binding to suspended particulates, or dispersion (SERA, 1996). Monsanto (1997) states on the label that the biological degradation process will occur under both aerobic and anaerobic conditions by soil microflora.

The NCRWQCB has not established a water quality standard for Glyphosate. However, the California Department of Public Health has established a standard of 700 PPB for drinking water. Although the Salmon River is not used for drinking water, all waters of the state are considered to have this beneficial use and so this standard applies.

Clopyralid (Transline™):

Clopyralid is applied as a liquid spray to foliage. The proposed formulation, Transline™, contains clopyralid plus a surfactant. Transline™ is active in the soil, is not absorbed by the soil, and is highly soluble. Its propensity for leaching is offset by the fact that it is broken down very rapidly by soil microorganisms. Transline™ has an average half-life in the soil of 25 days (SERA, 1999).

Several studies have looked at leaching, runoff, and degradation of clopyralid in soil (Baloch and Grant 1991a, Baloch and Grant 1991b, Smith and Aubin 1989, Pik et al. 1977, Elliott et al. 1998, Baloch-Haq et al. 1993 Bergstrom et al. 1991, as cited by SERA 1999). The most relevant study for quantitatively assessing runoff and leaching potential appears to be Elliott et al. (1998, as cited by SERA 1999). The Elliott et al. study was designed as a worst-case scenario of clopyralid mobility. In the period between day 9 and 35, only 1.5% of the applied amount was washed off. The predominant factor in the functionally low rate of both leaching and runoff is rapid degradation in the soil column (Baloch-Haq et al. 1993, Bergstrom et al. 1991, as cited by SERA 1999). Woodburn and French (1987 as cited by SRA 1999) also found that the potential for clopyralid to runoff from surface erosion with rains is relatively low.

As discussed in the Human Health and Safety section above, clopyralid contains a trace contaminant, hexachlorobenzene. In most formulations of Transline™, it is present in very small amounts. Hexachlorobenzene is a known carcinogen that is ubiquitously present in the environment.

The potential for adverse effects on non-target aquatic species appears to be remote (SERA 1999). Research suggests that no adverse effects are plausible using the typical, or even worst-case, exposure assumptions. Neither the NCRWQCB nor the California Department of Public Health (CDPH) has established a water quality standard for Transline™.

Picloram (Tordon 22K™):

Picloram (Tordon 22K™) will be applied as a foliar spray on and around the target plants and in the immediate area of seed cast.

Picloram is another chemical that is highly soluble in water, however unlike clopyralid, it is resistant to both biotic and abiotic degradation processes (EPA 1995). Picloram is stable to hydrolysis and anaerobic degradation and degrades very slowly with half-lives ranging from 167 to 513 days (EPA 1995). However, Wauchope et al. (1992 as cited by EXTOXNET 1996) found field half-lives from 20 to 300 days, with an estimated average of 90 days. In some soils, picloram is almost completely resistant to all degradation processes.

Photodegradation is one form of degradation picloram can go through; however, it is only significant on the soil surface (Weed Science Society of America 1994, as cited by EXTOXNET 1996). In laboratory studies, picloram in water was readily broken down by sunlight, with a half-life of 2.6 days (Howard 1991, and Weed Science Society of America 1994, as cited by EXTOXNET 1996, EPA 1995). Picloram is expected to be persistent in surface water except in clear shallow water with substantial mixing, or with waters with short hydraulic residence times (EPA 1995), such as the Salmon River.

The NCRWQCB has not established a water quality standard for Tordon 22K ™. The CDPH has established a public health goal of 500 parts per billion (ppb) for picloram. This goal applies to water that is being consumed daily by humans.

2,4,D (Weedar™, Weedone™):

In soils, 2,4-D generally has a short (1 month or less) persistence (Ashton 1982 as cited by USFS 1984). It tends to be mobile and is primarily degraded by microbial activity. In the aquatic environment, 2,4-D is readily degraded by microbial activity, which, along with dilution, is the major means for its loss of activity in aquatic systems (USFS 1984).

In general, 2,4-D is relatively mobile in soil, although this mobility is strongly influenced by various factors such as water solubility of the specific formulation and organic content, and pH of the soil. Despite its relative mobility, 2,4-D is not thought to leach into streams (Norris 1981 as cited by USFS). In two separate studies, Norris et al. (1982) and Suffling et al. (1974) found less than 0.02% of the 2,4-D applied to a watershed appeared in stream flow (Norris et al. 1991).

The half-life of 2,4-D in soil is less than seven days (EXTOXNET, 1996). It is also taken up from the soil by plants for a short period, further reducing its potential to contaminate ground water.

Weedar™ is the formulation proposed for application to the populations of knapweed along the Salmon River, in combination with glyphosate (Rodeo™). The upland sites, where the ester formulation Weedone™ would be applied, are limited in number and are well removed from any water sources.

The CDPH has established a public health goal of 70 ppb for 2,4-D. This goal applies to water that is being consumed daily by humans. The NCRWQCB Basin Plan, Action Plan for Control of Discharges of Herbicides Wastes from Silvicultural Applications, establishes a water quality goal for the ester formulation of 2,4-D. It prohibits an instantaneous concentration of 2,4-D PGBE ester greater than 40 ppb acid equivalent or a 24-hour average of 2 ppb acid equivalent.

Alternative 1

This alternative proposes to accomplish eradication of knapweed with herbicides. In terms of water quality, treatment of the river bar sites is of primary consideration. Direct and indirect effects were analyzed and determined to be minimal for all chemicals proposed for use on river bars and uplands. Chemicals proposed for used in the uplands pose little probability of leaching or runoff into surface water.

Effects of Glyphosate (Rodeo™) and 2,4-D (Weedar™) in the Riparian Area:

Glyphosate (Rodeo™) and 2,4-D (Weedar™) will be applied by hand with backpack sprayers to approximately 15-30 acres of knapweed plants that occur within a total treatment area of about 150 acres. Applicators will walk to each individual plant and spray the leaf surface. Herbicide will not be applied if wind speed is in excess of 5 mph. There will be a small amount of over-spray and drip from the plant that will fall on the soil surface. Siskiyou County Department of Agriculture estimates that 50-80% of the applied herbicide mix will strike the foliar surface and be absorbed by the plant. It is also possible that a very small amount of Rodeo™ and Weedar™ can volatilize from the leaf surface and travel through the air to adjacent plants or the ground surface. It is not anticipated that there will be any spray that reaches the Salmon River. In addition, spraying will be ceased if there is a predicted Lightning Activity Level (LAL) of 2 or greater for that day.[1]

Direct Effects:

Direct watershed effects would be the application or spillage of herbicide into any body of water within the project area at a level greater than the applicable water quality standard. No herbicide will be applied directly to the water. It is possible that an applicator applying herbicide could trip and fall during application. The spray tank is made of durable plastic and will not normally rupture from this kind of impact. The only herbicide that could be leaked before the operator picked up the tank would be a small amount through the pinhole air vent in the lid. As an emergency precaution, the Forest Service inspector and the county crews will carry spill equipment.

For this alternative, the hand application of glyphosate (Rodeo™) and 2,4-D (Weedar™) has a very low risk of producing any contamination of groundwater or surface water. This is based on the following facts 1) a very small amount of herbicide will be applied, 2) glyphosate (Rodeo™) and 2,4-D (Weedar™) decay very rapidly, and 3) water sampling on other National Forests in California from

[1] Most rainfall in the summer occurs as isolated thundershowers. The only useful predictor of a thundershower is the lightning advisory issued by KNF dispatch. The indicator selected is a Lightning Activity Level (LAL) of 2 or greater.

projects with much higher application rates has not detected herbicide in the samples. **Direct effects from this alternative are expected to be minimal.**

Indirect Effects –Runoff from a severe summer thundershower:

The only way that herbicides proposed for use in Alternative 1 will reach the water system would be in a worst-case scenario situation. Under typical weather conditions in an average weather year, there is very little probability of glyphosate (Rodeo™) or 2,4-D (Weedar™) being transported from the application site to a water body. In a normal weather year, it is usually 60 to 90 days before significant rain occurs from fall storms. According to weather statistics from the Western Regional Climate Center for the Sawyer's Bar Ranger Station, the probability of greater than 0.1 inches occurring in May is 10%, June is 8%, July is 2 %, and August is 5%. Thus, there is little probability of rainfall occurring that would be significant enough to create surface runoff during the period of herbicide application. However, the Salmon River basin experiences infrequent and unpredictable thundershowers during the summer. An analysis of the probable concentration of glyphosate (Rodeo™) and 2,4-D (Weedar™) in the Salmon River that might be produced from an intense summer thundershower that occurred directly over some of the application units soon after herbicide application is described in Appendix E. This analysis is based on a worst-case scenario, which describes a series of highly improbable circumstances under which herbicides could be transported into the water. This analysis indicates that this severe scenario could result in a concentration of about 2 ppb in the Salmon River. The minimum detection level (MDL) for glyphosate (Rodeo™) is 5 ppb. Thus, even in a worse case, low-probability scenario, there is very little chance of a detectable level of herbicide being introduced into the Salmon River. **The risk of occurrence of indirect effects from implementation of this alternative is minimal.**

Clopyralid *(Transline™)* and Picloram *(Tordon 22K™)*

Application of Clopyralid (Transline™) and Picloram (Tordon 22K™) to upland sites:

If Tordon 22K™ becomes approved for application in California, it will be used on the upland knapweed sites. Most of these sites are located near the top of the ridge and are underlain by normal forest soils containing fine particles and organics. These knapweed sites are located a long distance from any surface water. Due to the small amount of applied herbicide, the scattered distribution of the application sites and the long distance to any surface water, there is almost no risk that application of Tordon 22K**™** will result in water contamination.

For Transline™, the small amount of applied clopyralid that contacts the soil surface will be adsorbed by particles in the soil. Microbiological activity in the soil will rapidly degrade it to CO_2 (SERA, 1999) by the time rains occur the following fall.

Due to the small amount of herbicide being applied, and the fact that it is being applied a long distance away from any surface water, there is very little probability of any of the herbicide leaching into groundwater or running off into surface waters. Direct and indirect effects are anticipated to be minimal.

Cumulative Effects of all Herbicides:

The only potential cumulative watershed effect is from herbicides used in this project in combination with other herbicide use in the Salmon River basin. Based on statements made by many local residents at public hearings and in scoping letters, there is little or no herbicide use by private residents. It is possible that residents could use commercially available pesticides on their private property. The relative amount of chemical applied around a few homes in the approximately 200,000-acre watershed is very small. The Forest Service has not used any herbicides in the Salmon River watershed since 1983. **Cumulative effects are expected to be negligible.**

Water Quality Effects of Additives and Inert Ingredients:

R-11® Surfactant

Wilbur-Ellis manufactures the surfactant R-11®. It is used in the Forest Service Region-5 (the State of California) as a surfactant for glyphosate (Rodeo™) applications. R-11® will be added to glyphosate (Rodeo™) to aid in the dispersal and adsorption of the active ingredient when it contacts the foliar surface of the plant. Use of R-11® in the mix increases the efficacy of the herbicide, allowing an approximate 50% reduction in the amount of applied herbicide (Stephen Wratten, Monsanto Corp, personal communication). Approximately 1 quart of R-11® will be added per 100 gallons of herbicide mix; i.e. R-11® comprises approximately 0.25 % of the applied mix, by volume. R-11® also contains silicates. Silicate is a naturally occurring substance that is non-toxic. The essential chemical ingredient in R-11® is nonylphenol polyethoxylate (NPE). Research has shown that in the presence of oxygen, NPE quickly biodegrades, with a lab-tested half-life of a few to several days (C. Naylar, Chemist, Hunstman Chemical Co., personal communication, 1999). In the presence of oxygen, NPE is rapidly broken down into other components, primarily carbon dioxide and water. **In summary, based on the small amounts of applied R-11® and the probability that it will break down rapidly in the environment where it is being applied, it is very improbable that R-11® would be present in large enough concentration after herbicide application to either enter a water body or create adverse water quality effects.**

HI-LIGHT™ Blue Dye

Blue dye will be added to all of the herbicide mixes so that the applied herbicide is visible. This will aid in assuring that the herbicide is applied correctly to the target plants. The exact chemical composition of the commercial formulation, HI-LIGHT™, is not known; however, the label states that there are no reportable quantities of hazardous ingredients or toxic chemicals present. Only very slight toxicity is expected. Based on the small amounts of dye proposed for use and the absence of toxic substances present in the blue dye, no direct, indirect, or cumulative water quality effects are expected.

The primary inert ingredient in glyphosate (Rodeo™) is water, in clopyralid (Transline™) is isopropyl alcohol, and in picloram (Tordon 22K™) is polyglycol 26-2. Although these products have not undergone detailed testing like their active ingredients, concern for environmental effects is reduced by the fact that the existing toxicological studies on these herbicides were conducted with the technical grade product that includes the impurities. **Effects to water quality are expected to be none to slight.**

Impurities

Both picloram (Tordon 22K™) and clopyralid (Transline™) contain the impurity hexachlorobenzene. In addition, clopyralid (Transline™) contains the impurity pentachlorobenzene. Glyphosate (Rodeo™) contains the impurity N-nitroglyphosate. Concern for impurities in technical grade products is reduced by the fact that the existing studies on these herbicides were conducted with the technical grade product. **Effects to water quality are expected to be none to slight.**

Alternative 2:

There are minimal direct effects to water quality as a result of this alternative.. Based on field observations, the mechanical treatment results in a small area of disturbed soil. Generally, the manual technique used disturbs a very localized site around the target plant. Usually a metal probe is used to loosen the soil/rock around the plant so the entire root can be extracted. The use of larger tools, such as a Pulaski, is discouraged but can be utilized if the probes are not available or there is a very localized spot of several plants. The physical watershed effect of this soil disturbance is not significant.

Alternative 3

The direct effects of manual treatment will be the same as those described in Alternative 2 would not change for this alternative. The water quality effects of herbicide use in this alternative will be the same for glyphosate, picloram, and clopyralid as discussed in Alternative 1. Though 2,4-D will not be used, the effects to water quality are expected to be similar to Alternative 1 because soil residence times of both glyphosate and 2,4-D are similar.

Glyphosate (Rodeo™)

Refer to the discussion under Alternative 1 for the effects on water quality. The potential watershed effects are similar to that under Alternative 1; there is a very low probability of water contamination.

Picloram (Tordon 22K™) and Clopyralid (Transline™)

Under this alternative, the treatment and effects to water quality of the upland sites in Kelly Gulch with either picloram (Tordon 22K™) or clopyralid (Transline™) would be the same as in Alternative 1.

Alternative 4 – No Action:

There are no direct effects to water quality as a result of this alternative. Indirect effects may occur if eradication of knapweed is not achieved. Cumulative water quality effects could occur if knapweed were to spread and occupy significant acreage in the watershed. If no action is taken to remove knapweed plants, knapweed could eventually cover most of the area on the open gravel bars. Native grasses, forbs, and wildflowers will be displaced by the knapweed. The watershed implications of this ecological change are that knapweed will change the composition of the riparian vegetation along the zone and impact water quality by increased erosion resulting from decreased soil holding capacity of the root system (taproot).

Water Quality Control Board Basin Plan

The following discussion applies to Alternatives 1 and 3:

The Water Quality Control Plan for the North Coast Region, March 1994 (Chapter 4 - Implementation Plans) addresses the use of herbicides in silvicultural applications. Refer to The "Action Plan for Control of Discharges of Herbicides wastes from silvicultural Applications" (pg. 4-32.00) for detailed description of objectives. The Plan does not mention either hand-application of herbicides or the control of noxious weeds. However, based on the assumption that this silvicultural plan will apply to noxious weed eradication projects, it establishes a basic framework for meeting the Clean Water Act through the authority of the NCRWQCB. This basic framework includes submittal of project information and a monitoring plan, a spill plan, and a BMP implementation plan to the Board.

The Salmon River Knapweed Project differs from silvicultural projects to control competing vegetation for the following reasons:

- The target vegetation, a noxious weed, actually occurs and is being spread, within the stream side zone;
- The herbicides being proposed for application to this weed in the floodplain are actually EPA and label-approved for direct water application;
- The herbicides will be applied by hand rather than aerially, resulting in much less herbicide being applied per acre.
- With hand application by certified and experienced applicators, the application of the herbicide can be controlled to specifically isolate treatment to hit only the target plant.

Summary of Potential Watershed Effects From Herbicide Application (Alternatives 1 and 3):

The potential risk that this project will produce water quality contamination can best be understood by examining in detail the specific watershed processes that might transport herbicide from the application site to a water body. Those processes are:

1. Accidental application by the applicator directly to the surface of water.
2. Transport of herbicide vapor by air currents from the application site to a body of water.
3. Some of the herbicide that drips onto the soil surface is leached through the soil column and into groundwater.
4. Some of the herbicide that drips onto the soil surface is eroded during a rainstorm and the soil particles are transported into a water body.
5. During the winter after herbicide application, the groundwater table next to the Salmon River rises and encounters soil under a treated plant that has a glyphosate residual.
6. Dead knapweed plants with an herbicide residue are carried by high water into the Salmon River.

(See Appendix E for a more detailed discussion of the above).

In summary, the only process that has any probability of transporting herbicide into the Salmon River is number 4, the risk that some of the herbicide (glyphosate and 2,4-D, or glyphosate alone) that drips onto the soil surface will be eroded during a rainstorm and the soil particles transported to the Salmon River. It is extremely unlikely that any herbicide could be delivered to the water. Even in a worst-case summer thundershower, based on some very conservative assumptions, the amount would be below the detection limits.

Effects to Aquatic Species

Direct effects to aquatic species could occur during the treatment of the floodplain zone, possibly during the riparian area treatment. As discussed above under water quality, the likelihood of any of the alternatives to adversely affect water quality and subsequently impact aquatic-related resources is very low.

The herbicides proposed for use in Alternatives 1 and 3 are characterized by relatively low aquatic toxicity. None of the compounds bioaccumulate in fish tissues, nor is there bio-magnification to higher trophic levels. Ingested herbicides are rapidly excreted.

The potential impact of the herbicides being proposed on fish and other aquatic organisms is a function of two factors: 1) the toxic characteristics of the compound, and 2) the concentration to which the organism is exposed. The 96-hour LC_{50} refers to the concentration that is lethal to 50% of the fish exposed at that level for 96 hours. The lower the LC_{50} the more sensitive the species is to the herbicide.

Alternative 1

The direct and indirect effects analysis pertains to all the anadromous fish found in the Salmon River Sub-basin. The effects to coho salmon are potentially less than other species, due to the lower probability of coho currently occurring in the North Fork Salmon River where the majority of infested sites currently exist.

In general, for aquatic organisms lethal effects (LC_{50}) at concentrations below 1 part per million (ppm) are considered indicative of highly toxic substances; effects at concentration of 1 to 10 ppm are considered indicative of slightly toxic compounds (Clarke et al, as cited by USFS 1984).

At the proposed application rate, no effect on fish, aquatic invertebrates, macrophytes, and most species of algae would be expected from the application of glyphosate. Clopyralid, picloram and 2,4-D would all have slight or no effects on these aquatic organisms.

Glyphosate (Rodeo™)

The characteristics of glyphosate (Rodeo™) are discussed above under Water Quality. Glyphosate (Rodeo™) is practically non-toxic to fish and aquatic invertebrates (see Table 10). The toxicity of glyphosate (Rodeo™) to aquatic species depends on the acidity (pH) of the water. Glyphosate (Rodeo™) is more toxic in relatively acidic waters by as much as a factor of 10. In general, LC_{50} values for aquatic animals range from approximately 10 to 400 mg/L, depending on species and water pH.

Table 10. Observed 96-hour LC_{50} Values For Glyphosate.

Fish species	Water pH 6.3	pH 7.2	pH 8.2

Coho salmon	27 mg/L	36 mg/L	210 mg/L
Chinook salmon	19 mg/L	30 mg/L	220 mg/L
Rainbow trout	10 mg/L	22 mg/L	220 mg/L
Wan et al. 1989, as cited by SERA 1996.			

Daphnia are significantly more sensitive to glyphosate than other invertebrates. The LC_{50} for daphnia is 218, mg/L, about the same as that reported for fish at comparable pH (SERA 1996).

At the proposed application rate, no effect on fish, aquatic invertebrates, macrophytes, and most species of algae would be expected from the application of Rodeo™ (SERA 1996). **Since the proposed rate will be less than the maximum allowed under the label, there should be no direct or indirect effects to aquatic organisms from the use of glyphosate for this alternative.**

Clopyralid (Transline™)

The potential adverse effects to fish from the use of Transline™ appear to be remote (SERA 1999). Research suggests that no adverse effects are plausible using typical, even worse case scenarios.

For fish, only standard 96-hour acute toxicity bioassays are available. The lowest reported LC_{50} for trout is 103 mg a.e./L. At least for aquatic species, the monoethanolamine salt form of clopyralid appears to be substantially less toxic than the technical clopyralid. The Transline™ formulation of clopyralid is the salt. 96-hour LC_{50} values for the monoethanolamine salt range from 700 (rainbow trout) to 1,645 a.e./L. The lowest reported LC_{50} for aquatic algae is 6.9 mg a.e./L. No chronic studies for fish are available. A chronic reproductive NOEL for Daphnia has been determined at approximately 20 mg a.e./L (SERA 1999). Clopyralid does not bioaccumulate in fish tissues. **Direct and indirect effects to aquatic species from the use of clopyralid are expected to be none to slight.**

Picloram (Tordon 22K™)

Picloram (Tordon 22K™) is slightly to moderately toxic to freshwater fish and is lightly toxic to aquatic invertebrates. Significant bioaccumulation in aquatic organisms is not expected to occur (EPA 1995). Acute LC_{50} values for rainbow trout and Daphnia are 13 mg/L and 68.3 mg/L respectively. The maximum accepted concentration (MATC) for early life stage of rainbow trout is 0.88 mg/L (EPA 1995). Acute risk for rainbow trout (steelhead trout), coho salmon, and chinook salmon is not low; however, the studies conducted assume a lentic water body. With the dilution factor of a lotic system, such as the Salmon River, the risk would be assumed to be lower. Because the sites selected for use of picloram are far removed from any water bodies, and as stated above, the anticipated runoff to any stream system is negligible. **Effects, both direct and indirect, to aquatic species from the use of picloram (Tordon 22K™) are expected to be none to slight.**

2,4-D (Weedar 64™ and Weedone ™)

Table 11 displaying the 96-hour LC_{50} values and No Effect Concentration level for 2,4–D.

Table 11. 2,4-D Toxicity Values For Aquatic Organisms.		
2,4-D formulation/species	**96-hour LC_{50} mg/L (ppm)**	**NOEC* mg/L (ppm)**
Dimethylamine salt liquid		
Rainbow trout**	100	10
Chinook salmon+	100	
*Daphnia***	4	0.4
2,4-D acid		
Pink Salmon fry#	10	
Chum salmon fry#	50	10 (NOEL)
Coho salmon fry#	50	10 (NOEL)
Butyl Ester		
Cutthroat trout**	0.9	0.09

* No Observed Effect Concentration
* Norris et al. 1991
\+ Johnson and Finley 1980 as cited by USFS 1984
\# Meehan et al. 1974 as cited by USFS 1984

LC_{50} values for rainbow trout and chinook (100mg/L) represent that the Weedar 64™ formulation that would be combined with glyphosate and applied along the Salmon River is less than slightly toxic (10 mg/L). Since coho salmon have similar physiologies to chinook salmon, this should also hold true for coho. Due to the rapid degradation of 2,4-D in soil, very negligible amounts, if any, will be left on site once rainfall commences in the fall. There is very little chance of stream contamination occurring. **Effects, both direct and indirect, to aquatic species with the use of the amine formulation of 2,4-D are expected to be none to slight.**

The formulation of 2,4-D to be used on upland sites is Weedone LV4™, a butoxy ethanol ester. As with the amine form of 2,4-D (Weedar 64™), there should be very negligible to no herbicide available in/on the soil to runoff by the time fall rains begin. The very short residence time, buffer distance to water bodies, and its very strong adsorption properties to organic material, would result in very negligible to no amount available for runoff. **Therefore, the greater toxicity of the butoxy ethanol ester formulation would not affect the anadromous fish species of the Salmon River.**

An indirect effect that could occur with the use of herbicides is removal of vegetation. However, due to the application technique being individual plant and not aerial, negligible non-targeted vegetation removal will occur. Therefore, shade and large woody material recruitment will not be affected by this action. In addition, negligible incidental removal of vegetation may occur in the uplands. Therefore, no additional sedimentation will occur due to the removal of excessive vegetative cover. Even if vegetative over-story were removed, the protective duff layer would still be in place.

R-11® Surfactant

The label for R-11® states it may be used with aquatically labeled glyphosate at 2 quarts per 100 gallons of spray solution.

R-11® has a nonylphenol polyethoxylate (NPE) ingredient that puts it in a broad class of chemicals known as alkylphenol ethoxylates (APEs). A raw material used to make NPE is nonylphenol (NP). NP has been shown to exhibit weak estrogenic properties in laboratory tests. In comparison to the natural estrogen 17-β-estradiol, NP is approximately 100,000 times weaker in eliciting estrogenic responses. NPE has also been found to be weakly estrogenic through lab tests, but less potent than NP by an order of magnitude (EPA 1996). The NPE used in R-11 has about nine ethoxylate groups attached (referred to NP9E) making it highly water soluble (Bakke 1999).

Research has shown that in the presence of oxygen, NPE biodegradation is rather quick, with lab-tested half-life of a few to several days. In aerobic conditions NP9E is broken down by removal of the ethoxylate groups as a result of microbial action, into shorter-chain ethoxylates. These short-chain ethoxylates can further be broken down into nonylphenol ether carboxylate (NPEC) (APE Research Council 1999; EPA 1996, Maguire 1999, as cited in Bakke 1999). The basic aromatic ring at the center of the NPE molecule appears to break apart prior to the loss of the final ethoxylate groups, therefore the formation of NP is not likely (APE Research Council 1999, as cited by Bakke 1999).

In anaerobic conditions, NP would be produced from the breakdown of NPE. However, NP is adsorptive to soil organic carbon, and therefore would not likely move through the soil or stream sediments (EPA 1996).

If the 24 hr $LC_{50} \div$ 96 hr LC_{50} for a particular chemical is ≥ 2, it indicates the chemical may cause chronic effects (Zeeman 1995, as cited in EPA 1996). The sensitivity of rainbow trout to NP is 300 μg/l for the 24 hr LC50 and 190 μg/l for the 96 hr LC50. Therefore, NP will not have chronic effects on rainbow trout, having a 24 hr/96 hr value of 1.6 (Dwyer et al. 1995 as cited in EPA 1996). The LC50 for all fish for NP9E ranges from 1,300 – 1,000,000 μg/l (1.3 – 1,000 ppm). The concern concentration of NP for rainbow trout is 3 μg/l. This is also the concentration of the No Observable Effect Concentration (NOEC).

In a nationwide 30-river study done by a panel of manufacturers under EPA's recommendation, no concern concentrations for pelagic organisms were exceeded with any of the measured concentrations. The highest measured concentration was 0.64 μg/l of NP, which came from the highly polluted Grand Calumet River in Indiana. From this study it was determined that nationwide, there appears to be a low risk posed by NP to pelagic organisms.

Toxicity of NP9E, the ingredient in R-11®, is 1-2 orders of magnitude less than NP, while toxicity of the intermediate breakdown products, NPEC and shorter chain NPEs, are intermediate between NP and NPE (EPA 1996). Bioconcentration of NP in freshwater fish appears to be low to moderate (EPA 1996).

It is assumed insignificant effects will occur as a result of using the R-11® surfactant. This is due to NP9E being less potent than NP by an order of magnitude in estrogenic effects, the short half-life (few to several days), it is adsorptive to stream sediments and solid organic carbon, and heavily polluted rivers were under the concern concentration of NP for rainbow trout. In addition, this is a single plant spray operation, few plants near the stream are expected, and for those that are, special precautions are in place.

HI-LIGHT™ Blue Dye

A colorant, Hi-Light™ manufactured by Becker-Underwood, will also be used to show the applicators where they have been. The Material Safety Data Sheet indicates there are no reportable quantities of hazardous ingredients present, and no toxic chemical(s) subject to reporting requirements. This colorant is short-lived, and breaks down in a matter of days.

Alternative 2

The manual technique of removing the knapweed will have negligible direct effects on the anadromous fish species of the Salmon River sub-basin. **The manual technique would be implemented over a limited number of acres, reducing the physical disturbance to a negligible direct effect.**

Alternative 3

The indirect and direct effects to aquatic species of the manual treatment portion of this alternative are the same as in Alternative 2 discussed above. The effects of the herbicide portion of this proposal would be the same for glyphosate, picloram, and clopyralid and additives as discussed Alternative 1.

Alternative 4

If no treatment of the knapweed were to occur, negative effects to the riparian vegetation would occur. It is well-documented that the knapweed takes over ecosystems in the intermountain west. With its capacity to inhibit other vegetation growth in its vicinity, no or little riparian vegetation would be able to compete or fill the interstitial bare areas of soil/cobble bar. Although the native riparian vegetation growing on the river bars has evolved within the current disturbance regime of high flows and scour, it cannot out-compete the knapweed. Because of this, riparian vegetation will decrease over time as it is out-competed by the knapweed. **Direct effects would include a reduction in shade along the margins of the river, and a possible greater instability of the cobble bar margins**. Cobble bars move as part of the river process; however, the root structure of the riparian vegetation does add some structure so that the banks can stand up to the lower flows and move at the higher flows. In addition, the riparian vegetation does add margin cover for newly emerging/hatching fish. Small branches that overhang into the margin water of the river provide excellent cover for the newly emerged/hatched fishes of the Salmon River. This cover is very important during this early life-stage of salmonids, providing cover from predators in a flow velocity that is conducive to their being able to maintain their station. The margin habitat is very important early on as the fish do not have the ability to swim in the faster intermediate and thalweg currents**. Indirect effects of not treating knapweed may negatively affect fisheries if riparian habitat is degraded over time. Cumulative Effects may occur if additional habitat is degraded elsewhere in the watershed from spreading noxious weeds, fire, flooding, and other disturbances.**

Issue 3 - Effects To Non-Target Species Including Plants, Wildlife, Insects, Amphibians, Fungi, and Microorganisms.

Environmental consequences relative to this issue will be discussed for each alternative. The discussion will also include effects to the target species, spotted and diffuse knapweeds. This section will include a discussion of general effects to potentially affected species, including those with special management status, i.e. federally listed and Forest Service Sensitive species and Survey and Manage Species (SM). Specific analysis of effects to TESP species are disclosed in the Biological Assessments and Evaluations prepared for the proposal and summarized in the discussion of effects to alternatives relative to Issue 4 below (TESP). This issue will be measured by risk of exposure and toxicity.

Botanical Analysis

Non-target plant species are all species of plants other than the target species, which include Klamath National Forest Sensitive and "Watch List" species, SM species, and other vascular plants, and microorganisms (bacteria, yeast and fungi) that may be affected by the project. Habitat does not occur within the project area for botanical SM or Watch List species and surveys are not required. Forest Service Sensitive species will be addressed in the Biological Evaluation for this project. The remaining non-target plants are addressed below.

Wildlife Analysis

Non-target wildlife species considered in the analysis include SM amphibians and mollusks, as well as TESP species. In addition, consideration was given to representative species selected from lists developed in the LRMP. Many of the species listed are not present within the vicinity of the project area during the time of proposed treatment. Additionally, the habitat types represented (river bar, roadside, and upland plantations) and the total areas (15 acres) involved in treatment comprise a very small percentage (less than 0.0001%) of the total landscape utilized by wildlife species in the Salmon River Watershed.

No adverse effects to the two Federally listed bird species (northern spotted owl and bald eagle; peregrine falcons are delisted) are anticipated as a result of the project as the probability of occurrence or risk of exposure in the area is low to non-existent (Wildlife Biological Assessment). Habitat for SM species of concern, Del Norte salamander, and several mollusk species does not occur within sites proposed for treatment, therefore no surveys are required.

Few of the species considered in the analysis are expected to be present in the areas proposed for treatment. The most likely species to be present and potentially affected by the project are black bear, blacktailed deer, pallid bat, Townsend's big-eared bat, western pond turtle, and foothill yellow legged frog. Potentially, but less likely, willow flycatcher could occur as well. The analysis will focus on potential effects to these species.

Any potential effects from the proposed or modified proposed action would be indirect through the ingestion of sprayed vegetation or secondary effects from consuming prey that had ingested or been sprayed with herbicide. There are no direct or cumulative effects to wildlife. The anticipated risk of exposure and the level of toxicity available to wildlife are very low.

Alternative 1

Botanical Effects

The direct effects on target and non-target plant species in the Proposed Action will come from the use of herbicides to treat the target plants, and from follow up treatment which will include various manual methods of removal. Both methods of treatment are expected to have short-term impacts within a very limited area. Four factors determine plant responses to use of chemicals: chemical type, rate, frequency, and method of application. Low rates will generally have less effect on most plants. More frequent and higher rates of applications would be expected to have greater effects. Use of backpack sprayers will selectively treat plants and minimize exposure to non-target species. Literature indicates (Rice et al, 1997; Sheley, 1999) re-treatments of herbicides within five years would be necessary to achieve eradication.

Direct effects of glyphosate (Rodeo™) on non-target plants and microorganisms, are expected to be slight, with no indirect effects. Some broad-leaved non-target species, if present in close proximity to target plants may be affected more with the combination of 2,4-D and glyphosate than with glyphosate (Rodeo™) alone. Picloram and clopyralid effects on non-target plants and microorganisms are expected to be slight to none. Effects to target species are expected to be highest in this alternative due to the application of herbicides on all sites.

Glyphosate (Rodeo™)

Glyphosate (Rodeo™) is in the class of herbicides that inhibit amino acid synthesis. It is taken up rapidly by leaves, and not at all by roots due to its binding properties in the soil. Ultra-violet light and soil microorganisms break down glyphosate (Rodeo™) in 3 to 130 days (Info. Ventures, Pesticide Fact Sheets). Plants cannot uptake glyphosate (Rodeo™) from the soil because it binds tightly to the soil, and is not available in solution once contact with the soil has been made. The only route of exposure to plants is through direct contact. Glyphosate (Rodeo™) is a non-selective herbicide. Most plants that come in contact with it are killed or damaged, depending on the rate and timing of application. Residues of glyphosate (Rodeo™) on selected plant species can be detected in small amounts for up to 36 weeks after treatment (Segawa, 1998); however, these residues on dead and/or decaying plant material are not dislodgeable residues, and cannot re-enter the system via water (S. Thornhill, SCDA, personal communication, 2000**).**

Glyphosate (Rodeo™) is not the most widely used herbicide to treat knapweed because: 1) it is non-selective, 2) it has a limited time-frame during which it is effective, and 3) it has no residual effect on the seed bank necessitating annual treatments of seedlings. However, it is proposed for use in the riparian area because of its low ecological risks. Glyphosate (Rodeo™) has an excellent rating for effectiveness on spotted knapweed if used on seedlings, rosettes, and leafy re-sprouts as proposed (BLM, 1985).

Non-target plants on the river bar consist of non-native annual grasses, perennial native grasses, sedges, scattered conifers and alders, willow, big-leaf maple, cottonwoods, non-native blackberries, and forbs. Where the knapweed is growing among other vegetation, particularly dense grass and forbs, some loss of non-target vegetation is expected from the use of glyphosate (Rodeo™). Application on mid-season germinants, re-sprouts, and/or missed juveniles from earlier applications, after most grasses have gone dormant for the season, will limit the effect on grasses. Since plants do not uptake glyphosate (Rodeo™) from the soil, it is not possible for vegetative blackberry bushes to accumulate the chemical in the fruit. Aquatic plants can only be affected by glyphosate (Rodeo™) if the above water portions come into contact with it. There are no aquatic plants that would be affected in the project area. Most algae are unaffected by glyphosate (Rodeo™) (SERA, 1996). **Direct effects of glyphosate (Rodeo™) on non-target plants are expected to be slight, with no indirect effects.**

There are a number of studies on the effects of glyphosate (Rodeo™) and microorganisms. Some laboratory studies show that there is some short-term decrease in some microorganisms associated with the use of glyphosate at various dosages (SERA, Appendix 2-2, 1996). **Direct effects on microorganisms from the use of glyphosate (Rodeo™) in the field are expected to be slight to none, with no indirect effects.**

Glyphosate (Rodeo™) + 2,4-D (Weedar™) – The addition of the amine formulation of 2,4-D to glyphosate (Rodeo™) enhances the foliar action of the glyphosate (Rodeo™) on broadleaved species. Effects on non-target plants would be equal to that of glyphosate (Rodeo™), as it is a non-selective chemical, and the addition of 2,4-D to the mix does not negate that property. **Some broad-leaved non-target species, if present in close proximity to target plants may be affected more than with glyphosate (Rodeo™) alone.**

2,4 – D (Weedar™ and Weedone™)

2,4–D (Weedar™ and Weedone™) is in the class of growth regulating herbicides that affect broadleaf plants through a multitude of physiological processes. Uptake is primarily from leaf surfaces, and briefly from the roots. 2,4-D is rapidly (one month) degraded in the soil by microorganisms and has no residual effect on plants. The one formulation (Weedar™) is an amine formula, low in volatility. It is formulated for use in or near water. This formulation would be combined with glyphosate (Rodeo™) for added efficacy.

The ester formula (Weedone™) is proposed for use in combination with other chemicals to enhance efficacy through increased foliar uptake in the upland areas away from water. Discussion of effects of 2,4-D in combination with glyphosate (Rodeo™), clopyralid (Transline™), or picloram (Tordon 22K™) will be discussed in the analysis of those chemicals.

Picloram (Tordon 22K™)

Tordon 22K™ (picloram) is the most effective herbicide for control of knapweeds, and provides excellent (nearly 100%) control of both species of knapweed at low rates for two years or more (Sheley, 1999).

Picloram (Tordon 22K™) is in the class of growth regulating herbicides that are selective to broadleaf plants. It has a residual soil activity for two to three years depending on the rate of application, soil conditions, and weather.

Effects to non-target plants from picloram (Tordon 22K™) will vary depending on situational variability (soil, climate, slope), off-site movement, and/or direct contact. Of all the herbicides analyzed for this project, picloram (Tordon 22K™) has the highest potential to affect non-target broadleaf vegetation, for a period of approximately two years (Rice et. al.). The sites proposed for picloram (Tordon 22K™) treatment have a very dense cover of knapweed that has already out-competed the native vegetation**. The effects on the minor amounts of other broad-leaved species present due to picloram (Tordon 22K™) will be slight. The most advantageous effect of picloram (Tordon 22K™) on non-target vegetation is the increase in grass cover in direct relation to the decrease in knapweed cover (Rice, 1998).**

Picloram (Tordon 22K™) has very low toxicity to microorganisms at up to 1,000 ppm in laboratory studies (USDA, Rogue River NF, 1999). Most herbicides are broken down by microbial action in the soil, the rate at which is governed by population levels. The sites proposed for treatment with picloram (Tordon 22K™) vary in levels of organic matter and hence the levels of microorganisms that usually occupy that layer in the soil. **Effects on microorganisms in the field application of picloram (Tordon 22K™) are expected to be slight to none (SERA, 1999).**

Clopyralid (Transline™)

Clopyralid (Transline™) is in the class of growth regulating herbicides that act as a synthetic hormone, altering the plant's metabolism and growth characteristics, ultimately affecting the plant's ability to transport nutrients. It is relatively non-toxic to grasses and some broadleaf plants.

Transline™ provides nearly 100% control of spotted knapweed for about two to three years when applied before flowering and longer if applied at the rosette stage (Rice, et al., 1997). Clopyralid (Transline™) is also effective for treatment of diffuse knapweed, and may also require multiple treatments in subsequent years to be most effective.

Effects to non-target plants will result from unintended direct deposition, or spray drift. Since clopyralid (Transline™) is selective, most species of grasses, conifers, and other trees and shrubs will not be affected by direct application or drift. For broadleaf plants directly sprayed, effects will vary with the timing of exposure. The sites proposed for treatment with clopyralid (Transline™) are the same sites as addressed in the picloram (Tordon 22K™) discussion above. The same conclusion applies: **the direct effect to non-target broadleaf plants is expected to be slight, due to the low levels present on the sites now.** As knapweed cover decreases, grass cover is expected to increase.

Clopyralid (Transline™), at concentrations of 1-10 ppm in soil, had no effect on decomposition (hence microorganisms) or spore germination (SERA, 1999).

Clopyralid (Transline™) + 2,4-D

The combination of these two chemicals create different effects on both target and non-target plants. Data indicates that for spotted knapweed, early applications (at bolt and bud stages) of the mix had slight additional benefits to knapweed control than the clopyralid (Transline™) alone (Rice et al, 1997). At later stages, the combination was less effective. There is no data with regard to treatment of diffuse knapweed with this combination.

Early application of this combination can have a greater effect on non-target plants than with clopyralid (Transline™) alone, if they are present on the site. A decrease in non-target forbs can be expected, for approximately one year. Later applications have no effect on abundance or richness of most non-target forbs (Rice and Toney, 1998).

Wildlife Effects

Potential effects of implementing the alternatives to wildlife include: (1) direct toxic effects on growth, health, behavior, or reproduction; physical injury; or death from consumption of an herbicide; (2) a secondary toxic effect due to the consumption of a prey which has had direct consumption of an herbicide; (3) effects on wildlife species habitat due to vegetative changes; and (4) disturbance to wildlife from the eradication activity. **Under Alternative 1 direct and indirect effects to wildlife from the use of glyphosate are expected to be minimal. Effects from use of 2,4-D in combination are variable among species ranging from slight to moderate. Use of clopyralid and picloram in the uplands poses a very low risk to wildlife species in the project areas.**

The Region 5 FEIS (USDA, 1988) analyzed the effects of 2,4-D, glyphosate (Rodeo™), and picloram (Tordon 22K™) on wildlife. Information on the effects of clopyralid (Transline™) is included in the SERA Risk Assessment (SERA, 1999). Numerous studies are cited in these and other documents that indicate there is little direct danger to wildlife when chemicals are applied at the recommended rates. When herbicide doses exceed $1/5^{th}$ of the LD_{50} values, most wildlife species are considered to be at risk of mortality or lesser toxic effects. The proposed rates are also well below the $1/5^{th}$ LD_{50} criterion. Expected doses from this alternative are up to 100 times lower than the laboratory test levels that demonstrate acute or chronic toxicity.

Research has shown that wildlife are not at risk from label recommended herbicide doses, particularly when they consume only a portion of their diet as contaminated food items. A few species, particularly small birds and mammals, were found to be at risk under worst-case conditions, where animals were directly sprayed (dermal effects) and consumed only contaminated food items (ingested effects). Direct spraying of individual animals would not likely occur with hand spraying. Wildlife will move away or seek cover from the activity. The potential for consuming contaminated vegetation as a part of their diet would be negligible for most wildlife species, with the possible exception of small rodents living on site.

Of the species of concern, the foothill yellow legged frog, the Western pond turtle, and willow flycatcher could be present in the river bar portions of the project area. A suitable buffer from the edge of the water will minimize potential exposure to spray. Spray will not be applied to, or allowed to drift onto, any water surface. Both frogs and turtles forage in the water, so they would not be directly ingesting herbicide. Flycatchers are insectivorous and do not consume vegetation. Indirect exposure to herbicide could occur through ingestion of prey species, wasps, bees, moths, caterpillars, flies, and grasshoppers.

Townsend's big-eared bat and the pallid bat are carnivorous. They could also be potentially indirectly exposed to herbicides through prey species. Because the herbicide chemicals are not stored in plant tissue or body tissue, doses received via the food chain are expected to be negligible.

Black bear and blacktailed deer are both habitat generalists and do use river bars and are commonly seen along roadways and in plantations. It is not expected that they would utilize the target vegetation being sprayed.

Glyphosate (Rodeo™)

Glyphosate (Rodeo™) does not bioaccumulate; there is rapid elimination of the residues and it is not retained in the tissues of mammals, birds, and fish (Risk Assessments Region 1,2,3,5, etc. 1992, SERA 1996, and Info. Ventures 1999). Research on mammals has shown that very high doses of chemical are needed to cause acute oral toxicity. The LD_{50} for rats is 4320 mg/kg/day of body weight and 3800 mg/kg/day for rabbits. Levels greater than 2000 mg/kg/day are considered to be practically non-toxic (RAs, 1992, 1996).

Potential effects of glyphosate (Rodeo™) on the riparian related species, pond turtle, yellow-legged frog and willow flycatcher are very low. The chemical is easily diluted, as well as easily adsorbed by the soil; the chemical half-life is very short and as such the risk to both frogs and turtles is quite low (Info. Ventures 1999). It is also non-toxic to aquatic invertebrates, a food item for these species.

Research has shown this compound is practically non-toxic to birds (Info. Ventures). It is also practically non-toxic to bees, a common prey item for flycatchers, and other birds. Because the chemical does not bioaccumulate in tissue, there is little risk to Townsend's big-eared bats or pallid bat. Any chemical residues present on insects consumed immediately after the herbicide treatment would be eliminated from their bodies.

The surfactant, R-11®, will be used in conjunction with glyphosate (Rodeo™) to facilitate the adherence of the herbicide to the plant leaves. Research has shown R-11® can have effects on gilled, aquatic organisms (minnows and shrimp) in lab situations. However, at field spray concentrations, an accidental direct spray into a stream would be quickly diluted and have negligible effects (Bakke, 1999).

2,4-D

There are significant differences in toxicity to vertebrates among the forms of 2,4-D. In many instances, the toxic response seems to be species-specific (RA, 1992). The amine formula is generally non-toxic to fish, while the ester form is highly toxic. Oral LD_{50}'s in mammals ranges from 100 mg/kg/day for dogs, cattle, and swine to 848 mg/kg/day for guinea pigs. In birds, acute oral LD_{50} values range from 472 mg/kg/day in pheasants to more than 2000 mg/kg/day in mallards. For both amine and ester forms, an LD50 of over 5000 was recorded for Japanese quail, bobwhite, and ring-necked pheasant. No reproductive or teratogenic effects were observed in chickens, and pheasant eggs when sprayed with various forms of 2,4-D, even at dosage levels of up to 20 times the field application rate. Based on studies with honey bees, insects appear to be relatively tolerant to high levels of 2,4-D.

The bioaccumulation ratio is low for test animals exposed to 2,4-D and accumulated residues are rapidly excreted after exposure (RA, 1992). Studies have found low levels of residue ranging from 0.05 to 6 mg/kg in live and kidney tissue samples from wildlife, including deer, pheasant, grouse, and others.

The amine formula dissolves readily in water so concentrations are diluted quickly and since streamside buffers would be used, herbicide could only enter the water accidentally. Aquatic invertebrates (Daphnia) have a low LC50, but due to the very low concentrations and brief time the chemical may be in the water, there would be little effect on the abundance of prey base for frogs and turtles (Norris, et.al., 1991).

In the case of willow flycatcher, pallid and Townsend's big-eared bats, and black bear the risk of secondary effects from consumption of exposed prey is low due to the fact that 2,4-D doesn't bioaccumulate.

Effects to deer are expected to be minimal. Although deer will move through the treated sites, they do not represent preferred forage habitat for deer. A deer would have to concentrate on sprayed sites exclusively for some time in order to consume high enough doses of herbicide to cause harmful effects. This is not the normal foraging pattern for deer, as they are continually moving as the browse.

The surfactant, R-11®, would also be used with 2,4-D. This product should not have any effects on animals using upland sites where the spray would be used (Bakke, 1999).

2,4-D is variable in its effects on individual species dependent on the form of the chemical making it difficult to generalize about the effects to wildlife. The risk of potential carcinogenic effects from exposure has not been demonstrated by research studies (SERA, 1997)

Clopyralid (Transline™)

Toxicity studies of clopyralid (Transline™) have been conducted on laboratory mammals, specifically rats, mice, rabbits, and dogs. The acute toxicity is quite low, with an LD_{50} of 3000 mg/kg/day to greater than 5000 kg/mg/day depending on process used to produce it (SERA, 1999).

The chemical may be more toxic to birds than mammals, although studies are limited. The results of one study on mallards determined an LD_{50} of 1465. A problem with all the studies on birds was that none of the exposures resulted in mortality high enough to estimate the LD_{50} (SERA, 1999).

Tests of chronic toxicity show no carcinogenic effects. There was no evidence of cancerous tumors in a two-year feeding with rats at 2000 mg/kg/day of a two-year feeding of mice at 1500 mg/kg. Likewise, studies showed no effects on reproduction, fetus development, or mutation in a variety of animals. The metabolism of clopyralid has been studied in one mammalian species. It suggests that clopyralid does not bioaccumulate in rats in detectable amounts, and that 79-96% of the dose is excreted unchanged in the urine during the first 24 hours (SERA, 1999). Secondary effects would be negligible for this chemical.

Research indicates this chemical is a low risk to wildlife when used at the recommended levels (SERA, 1999). There is little risk of acute and chronic effects, and indications are it does not bioaccumulate in the body so secondary effects are not an issue. The small size and number of the plots to be treated and their wide distribution would further reduce any adverse effects to wildlife.

Picloram (Tordon 22K™)

Picloram (Tordon 22K™) will be used in the upland sites away from riparian habitat. Effects to turtles, frogs, and willow flycatcher are not of concern with use of this chemical in these areas as there is no habitat for these species where this chemical is proposed for use. The total acreage to be treated is with picloram is approximately one acre. Sites will be treated using a combination of picloram and 2,4-D in this alternative.

Research indicates that this herbicide is relatively safe in the environment. Because of its persistence in the soil (half-life of 20-300 days) it is available in the environment longer than the other chemicals to be used in this alternative (Info. Venture and Extoxnet). Picloram (Tordon 22K™) is rapidly absorbed through the intestinal track of animals and excreted unchanged in the urine (SERA, 1999). **Therefore, secondary effects to wildlife are expected to be minimal.**

Studies conducted on birds indicate that picloram is practically non-toxic (U.S. EPA 1995). The LD_{50}s are from 2000 to 5000 mg/kg/day in ducks, pheasants and quail, with no mortality observed even at the highest levels (EXTOXNET 1999). Test results indicate that the chemical is slightly to non-toxic in mammals, with greater toxicity observed in large animals (i.e. cattle >720 mg/kg/day). Smaller mammals, such as rats, have an LD_{50} between 5000 and 8200, 2000 to 4000 for mice, and approximately 2000 for rabbits.

There is some evidence that at high concentrations, picloram (Tordon 22k™) in combination with 2,4-D esters may have an additive (not synergistic) effect, the manner in which picloram (Tordon 22k™) and 2,4-D are rapidly excreted in an unchanged form by mammals, reduces the risk of interaction with other molecules (U.S. EPA, 1995).

Picloram (Tordon 22k™) is relatively non-toxic to insects based on studies conducted on honey bees. The chemical has shown no effect on reproduction, no increase in birth defects. There is no evidence of cancer and mutations associated with picloram (Tordon 22k™) (Risk Assessment 1992, SERA 1999).

The limited use of picloram (Tordon 22k™) in this alternative presents a low risk to the potentially affected wildlife species in the project area.

Alternative 2

Botanical Effects

This alternative would utilize manual/mechanical methods for treatment of target plants, including hand pulling, mulching, mowing, and propane torching. **The sustained effort and number of workers required to eradicate knapweed on the total infested acreage in the Salmon River must be carried out multiple times every year for approximately 12 years, or until viability of seed in the seed bank is exhausted, in order to achieve objectives. Literature and experience indicate that the sustained effort required to achieve eradication using mechanical means is difficult to achieve.**

Effects from hand pulling on target plants will vary by site conditions (size, soil type, moisture level, etc.). Small, roadside populations can be eliminated by hand pulling, and returning seedlings, if small in number, can also be treated effectively by that method. Most of the larger river bar sites are covered with rocks varying in size from small and medium sized cobbles to large boulders. The knapweed roots can often be twined down between rocks. Moving the rocks necessary to remove enough of the roots to prevent re-sprouting creates bare ground, and this disturbance creates the perfect medium for seedling germination. Knapweed will re-sprout if the plants are not cut below the crown at least two inches (Sheley, 1999). Hand pulling also increases the amount of seed available for germination. The action of pulling up the plants and roots brings seeds that may otherwise be buried to the surface, where germination then occurs. Seed viability decreases with time; thus each successive year that seeds remain undisturbed and do not germinate, the viability and germination potential decreases (Orloff, personal communication, 2000). Encouraging seeds to germinate allows an increase of propagative plant material to enter the environment (i.e. broken tap-root fragments, root hairs, etc.). As the amount of propagative material present increases, the population density may also increase, resulting in a lower probability of eradication and lower efficacy of the method.

Technical bulletins out of the States of North Dakota and Montana (MSU Circular 311, May 1998; and NDSU, W-1146, March 1998) do not consider hand pulling an effective option for control or eradication on large, densely infested knapweed sites.

Hand pulling the large, densely infested sites would create substantial disturbance and generate bare ground, which then would be susceptible to being replaced with knapweed seedlings. This could occur within the same growing season if hand pulling is conducted early in the year when moisture is plentiful. The site conditions have a large effect on whether or not hand pulling can be successful or not. In areas of large rocks or heavy clay soils, it would be difficult to remove enough of the root to avoid re-sprouting, even under moist conditions. Smaller plants that have less extensive root systems would break off right at the root crown, making re-sprouting highly probable. On lighter soils where removal of the entire plant is possible, there would be a germination flush of seedlings due to disturbance. Non-target plants in close proximity to knapweed will most likely also be pulled up when knapweed is pulled up. This will eliminate competition on the sites of desirable species to compete with the knapweed. The increased frequency of visits to infested sites to hand pull plants will increase the risk of spread by humans picking up seed lodged in soil in boots and on tools, and when handling and transporting flowering and/or seeded material for disposal.

Hand pulling **diffuse knapweed** in anything but the rosette stage is very different than spotted knapweed. The plant is significantly prickly, much more branched and voluminous for removal, and if flowers have been pollinated, the plants will continue to develop ripe seeds after removal from the soil (Roche, and Roche, 1990, in Sheley, 1999). Thus all plant material must be disposed of.

Effects to microorganisms from hand pulling are likely to be low. Soil compaction from repeated passes over certain areas for treatment would occur within infested sites and this may affect the relative abundance of species to favor those species of microorganisms better adapted to compaction.

Mulching with plastic: The basic premises of using synthetic materials for mulching is the solarization of the soil to the point where the vegetation under the cover is killed, prevented from germinating, or otherwise suppressed from growing; and as barriers for weed control. There has been much research on the efficacy of available materials. The variables considered include the color of the plastic, the thickness of the material, and the chemical make-up of the plastic (FAO, 1991). The soil under clear plastic generally gets hotter than under black plastic if applied totally flat against the ground; however, the difference in temperature was found to be insignificant in the effects on target weeds in one study (FAO, 1991) and significant in temperature differences, but still ineffective on perennials in another study (Horowitz, 1983). Most of the research on this topic comes from the agricultural applications of solarization under very controlled conditions, i.e. formed planting beds, bare flat soil, application of water under the mulches, etc., and is focused on weed seeds, not established plants. There is limited information available on the application of these techniques in a wildland situation.

From the literature, however, it is clear that:

1. The materials used as mulch need to be laid as close to the ground as possible with no air gaps, in areas that have optimum solar radiation;
2. The soil should be wet for maximum heating;
3. Some weeds are more susceptible than others (mostly winter annuals; established perennials in some trials were not affected at all, (M. Horowitz, 1983); and
4. The effects on different weed species will vary in duration.

One of the drawbacks in using plastic mulches for control is the solid waste disposal of the material once it becomes unusable, and the cumbersome and expensive nature of its application.

Effects on Target Plants

Based on trials with black plastic mulch in 1998, approximately 14,000 square feet at Kelly Gulch were mulched in 1999. For a variety of reasons, the large-scale mulching varied in effectiveness on the target plants. When the plastic was removed in the fall of 1999, some established knapweed plants appeared wilted and chlorotic, but still alive in some areas. Those plants have the potential to recover. Other mulched areas were apparantly more successful at killing and/or suppressing establised knapweed plants. Mulching has limited application for sucessfully meeting eradication objectives. It would not be practical for large scale treatment on all sites.

Effects on Non-Target Plants

Since mulching is a non-selective technique, it has the ability to affect all non-target plants under the plastic covers. Effects would vary by species. Some may be killed, some may just be suppressed, and others may be enhanced. Mulching studies under conditions similar to Salmon River have not been conducted and information is limited in the scientific literature. In the mulching trials conducted in 1998, one native forb appeared suppressed only, and some of the annual non-native grasses were also suppressed.

The effects of mulching on fungi and microorganisms vary by species. Some fungi are eliminated if temperatures get hot enough; some fungi are enhanced (Abu-Gharbieh, in FAO, 1991). Microorganisms are reduced in the short-term, but are expected to recover in the long-term.

Mowing is not considered an eradication or control method, but can be used to reduce seed production. It has been proven effective in combination with other methods (i.e.herbicides) (Brown et al 1996). Trials with **diffuse knapweed** resulted in 22% of plants mowed to a height of two inches each month of the growing season (April-October) still growing four years later (Roche and Roche, 1990). Mowing in early flowering did not eliminate the production of viable seed for the year. Mowed **spotted knapweed** also continues to produce flowering stalks well into the late part of the growing season. It would have limited effectiveness alone or in combination with other mechanical methods.

Propane torching can be effective on small knapweed seedlings, early in the year, before tap-roots have developed and fire season has begun. Torching will also have similar lethal effects on **non-target** seedlings that come into contact with the flames. It is not likely that torching would have detrimental effects on **fungi and microorganisms**, as the duration of the flaming is usually short-term.

Wildlife Effects

Direct effects discussed relative to herbicide toxicity will not occur in this alternative. Effects to wildlife in this alternative are expected to be minimal.
Implementation of this alternative will result in more potential human disturbance to wildlife because of the greater frequency of treatment necessary to achieve objectives. Human activity may affect wildlife use of an area while the manual treatment is taking place; however, the amount of disturbance will be localized and short-term. Wildlife will only be temporarily disturbed.

Alternative 3

Botanical Effects

This alternative will treat all areas using manual methods described in Alternative 2 as long as evaluation criteria are being met on all sites. If objectives are not met on any given site, herbicides could be used as described in Alternative 1. 2,4-D will not be used on any sites. **Direct effects of chemical treatment on target and non-target plants in this alternative have been discussed above in Alternative 1. Effects under this alternative will be slightly reduced from Alternative 1 due to the elimination of 2,4-D used in combination with glyphosate (Rodeo™) and clopyralid (Transline™) or picloram (Tordon 22k™). It is expected that the overall efficacy of treatment will be slightly reduced** (S.Thornhill, 1999). Some broadleaved non-target species will not be affected as much in this alternative due to the absence of 2.4-D.

As described above, effects from hand pulling on target plants will vary by site conditions (size, soil type, moisture level, etc.). **The discussion of effects of manual treatment in Alternative 2 above applies to this alternative.**

Observations on hand pulling efforts to date lead to the conclusion that: 1) re-sprouting necessitates the re-treatment of the same plants numerous times; 2) numbers of plants actually increase due to the disturbance that stimulates seed germination; and 3) preventing flowering by hand pulling bolted plants can work as a short-term control method, but is not adequate for eradication (W. Stephans, 2000; and personal communication M. Knight, 1998, 1999).

The hand pulling effects of this alternative on target plants will differ from those discussed in Alternative 2 primarily by the length of time anticipated to meet the objective of eradication**.** Hand pulling will take a longer period of time to achieve. In this alternative, if handpulling is successful at meeting the objective of eradication, it is anticipated that eradication will be achieved in 10 years. If objectives are not met, herbicides will be used and the objective will be met within 5 years from the time the objectives are not met and herbicide use commences. This will result in a one to 10 year increase in the amount of time it would take to meet the objective in Alternative 1, which proposes herbicide treatment immediately.

Wildlife Effects

In this alternative, chemical herbicides will potentially be used as described in Alternative 1. 2,4-D will not be used. Effects to wildlife will be reduced slightly less without the use of 2,4-D. The effects of this chemical are highly variable, ranging from non-toxic to highly toxic depending on the chemical form and which wildlife species is being considered.

The effects of the manual treatment proposed for this alternative are the same as those described above in Alternative 2.

Alternative 4

Botanical Effects

No action toward the eradication of knapweed will result in serious negative effects to biological diversity and critical ecosytem structure, organization and function in the Salmon River and adjacent areas at risk of infestation.

The consequences of not controlling aggressive plant pests, knapweeds specifically, is well-documented in the literature **(see Appendix F**), and known first hand in the intermountain region of the United States where spotted knapweed has infested more than 4.5 million acres (MSU, 1998). Spotted knapweed alters the structure, organization, and function of ecological systems (Sheley, 1999; Harmful NIS, 1993). Effects of the No Action Alternative on ecosystem structure will include:

1. Altering soil properties such as nutrient levels, organic matter content; decompostion rates, and rates of erosion;
2. Altering composition of plant communities, by displacing native plant species and leading to the threat of extinction of rare plant elements. In 22% of the Federally listed Threatened and Endangered plants, noxious weeds either are the major cause of listing, or contribute to the reasons for listing (Harmful NIS, 1993). Biological diversity is impaired by invasive species causing population declines, species extinction, or simplification of ecosystems; and
3. Altering the structure of animal communities and reducing habitat for insects, birds, or other organisms that are dependent on plant communities for forage, cover, and shelter. Effects on just one pivotal species of an ecosystem can cause major effects that cascade through the system like dominos.

Effects of Alternative 4 on ecosystem organization will include: the reduction of soil microflora, the reduction of relative abundance of native plant species, allelopathy (the effect of one plant on germination and seedling establishment of another) where spotted knapweed inhibits other plant species and hence establishes pure stands, and long-term weed success due to seed production and viability.

Effects of no action on the functions of ecosystems will include: altering soil moisture regimes, nutrient availability and cycling, reducing water infiltration rates and increasing runoff rates, and altering disturbance cycles.

Most of the damaging effects to ecosystems are exemplified in the intermountain region where spotted knapweed dominates vast areas of wildland. The Salmon River watershed is a forested ecosystem with a history of high interval disturbance regimes such as fires and floods. A similar trend of infestation could occur in that these conditions greatly increase the potential for knapweed to spread throughout the watershed and into other areas in Siskiyou County and adjacent areas.

Wildlife Effects

Effects of not treating knapweed and allowing it to continue to spread will have a long-term indirect negative effect on wildlife and their habitat. The subsequent reduction in biological diversity of plants could affect quantity and quality of forage for a variety of species. Encroachment of knapweed into early successional habitat areas will reduce the quality and quantity of forage, and potentially hamper the growth process of oaks for those species dependent on that habitat. Knapweed does not provide forage or habitat value for wildlife.

The effects of knapweed infestations on wildlife habitat can be demonstrated by what has occurred in western Montana. Elk use was reduced by 98% on range dominated by knapweed when compare to range dominated by bunchgrasses. It was predicted a loss of 220 elk annually in Montana because of infestations on winter range.

Issue 4 - Effects to Federally Listed and Proposed and Forest Service Sensitive Species (TESP)

Three separate Biological Assessments and Evaluations, for wildlife, fish, and plants, were prepared for this project. They are available for review and upon request at the Salmon River Ranger District Office.

Many of the wildlife and plant TESP species will not be present at the project sites, for a number of reasons: the project is outside the species range, the species does not use the limited habitats involved in the project, the timing of the project is different than the time the species could potentially use the sites, the species has very large home ranges and will infrequently and briefly use the sites, or the behavior of the species is such that they will not use the sites involved. The following species meet one or more of the criteria listed above: bald eagle, Northern spotted owl, marbled murrelet, peregrine falcon, Northern goshawk, California wolverine, Pacific fisher, American marten, great gray owl, Cascade frog, Southern torrent salamander, and all 25 species of Endangered or Sensitive species of plants found on the Klamath National Forest.

The Biological Assessment /Biological Evaluation for federally listed terrestrial wildlife and Forest Service Sensitive species determined there will be **no effect** on the listed species, bald eagles and Northern spotted owl; **no effect** on Sensitive species peregrine falcon, Northern goshawk, California wolverine, Pacific fisher, American marten, great gray owl, Cascade frog and Southern torrent salamander from implementing this project. Furthermore, the project **may affect individuals, but is not likely to result in a trend toward federal listing or loss of viability** for the pallid bat, Townsend's big-eared bat, willow flycatcher, western pond turtle, and foothill yellow-legged frog. The determination of no effect for bald eagle and Northern spotted owl was discussed with the U.S.

Fish and Wildlife Service (USFWS). The USFWS, Yreka Field Office concurs with this determination.

The Biological Assessment prepared by the District fisheries biologist for Federally listed fish species made a tentative determination that implementation of the project **may affect but is not likely adversely affect (MANLAA)** the continued existence of the SONCC coho salmon or their Critical Habitat; **MANLAA** the continued existence of KMP steelhead. The project may affect individuals but is not likely to result in a trend toward listing of spring-run chinook salmon. A final Biological Assessment (BA) has not been agreed upon with the National Marine Fisheries Service (NMFS), but will be completed prior to a decision.

The Biological Evaluation (BE) for Forest Service Sensitive plant species determined there will be **no effect** to Sensitive plants.

Alternative 1

Effects to TESP species from implementation of this alternative have been documented in the BAs and BEs. Effects to these species are within those analyzed under the Wildlife, Botanical, and Aquatic species consequences sections above and will not be repeated in this section. **Effects are expected to be minimal for these species as most of them, with the exception of the aquatic species are not located within the project area**.

Alternative 2

Direct effects of manual treatment of knapweed on TESP wildlife, botanical, and aquatic species will be none to slight under this alternative.

Alternative 3

Effects to TESP will be within those analyzed above under the Wildlife, Botanical, and Aquatic species consequences for Alternatives 1 and 3. **Effects are expected to be minimal for these species as most of them, with the exception of the aquatic species are not located within the project area.**

Alternative 4

The effects of no action to TESP species are largely covered in the discussions under Wildlife, Botanical and Aquatic consequences of Alternative 4 discussed above. With the exception of aquatic species habitat adjacent to proposed treatment areas along the river bar and floodplain, the majority of species do not occur within the project area. Old growth dependent species such as the Northern spotted owl are not likely to be directly affected if no action is taken to eradicate knapweed in the short-term. In the long term, if no action is taken to eliminate knapweed, biological diversity could be affected in all the ecosystem communities within the watershed. In the event of catastrophic flood or fire, habitat could be converted from native vegetation to a knapweed dominated system. **Loss of a healthy functioning ecosystem that contains a diversity of habitat components will ultimately affect the abundance and distribution of TESP species.**

Issue 5 - Effects To Local Community Well-Being and Quality Of Life

Many local citizens expressed concern that their unique rural community environment and quality of life will be adversely affected by the use of chemical herbicides.

This issue will be measured by whether the alternative proposes to use chemical herbicides.

Alternative 1

Chemical herbicides will be used in this alternative, potentially on all infested sites if necessary. Many letters from the public indicated that the use of synthetic herbicide products of any kind in the environment will be objectionable to them. They believe that the Salmon River watershed is pristine and relatively free of any toxic substances and that use of chemical herbicides will negatively impact their rural community environment and quality of life.

Yes, this alternative proposes the use of chemical herbicides; this alternative will negatively impact the local citizens' expectations of a pristine, rural community environment and relatively "chemical-free" quality of life.

Alternative 2

This alternative is a community-based alternative that proposes to use alternatives to chemical herbicides to eradicate knapweed. This alternative will avoid use of any synthetic products (except for plastic mulch) and utilize manual methods of weed removal. This alternative is widely supported by the local community. This alternative will require a persistent and committed expenditure of human resources to diligently maintain a level of treatment in order to eradicate knapweed and prevent its return and further spread.

Chemical substances will not be introduced into the Salmon River community for the purpose of noxious weed treatment. The Salmon River citizens' expectations of a rural community environment that is relatively "chemical-free" will remain intact.

No, this alternative will not negatively impact the local citizens' expectations of a rural community environment and quality of life

Alternative 3

This alternative proposes continued manual, non-chemical treatment of knapweed through cooperative participation. This alternative will pursue non-chemical treatment as long as evaluation criteria are met on all sites within the area. Herbicides would be used as a "last resort" to treat knapweed only after mechanical treatment methods have been depleted. This alternative responds to some members of the public who indicated they will support the use of chemical treatment "as a last resort," only after it is proven that alternate methods cannot achieve the objective of eradication.

This alternative may be acceptable to those members of the public who believe all other practicable means have been attempted and agree with the monitoring results if they determine herbicides must be employed. This alternative still will be objectionable to those who are opposed to the use of any chemical treatment in the watershed under any circumstances. They believe that the use of chemical herbicides will negatively impact their rural community environment and quality of life.

This alternative will negatively impact the local citizens' expectations of a rural community environment and quality of life if chemical herbicides are used as a last resort; it will not if manual methods are effective at achieving eradication.

Alternative 4

No action will be taken to treat the knapweed infestation in the Salmon River area. Chemical herbicides will not be used. The Salmon River watershed will remain relatively "chemical-free" within the value system of local citizens.

Large-scale knapweed infestation may impact local property values. It may affect the ability of landowners to raise animals and crops if knapweed invades pasture and garden areas. Recreational experiences may be negatively impacted by large-scale infestations of knapweed due to the reduced aesthetic value to some people who believe that non-native weed infestations are unappealing.

This alternative may impact community values and quality of life, but herbicides will not be used.

Issue 6: Adverse Effects from the Use of 2,4-D:

Particular concern was expressed over the use of 2,4-D. There is strong local opposition to the use of this chemical in the Salmon River watershed. Environmental effects of 2,4-D are discussed in Chapter 3, environmental consequences of Issues 1-4. This issue will be measured by whether the alternative uses 2,4-D.

Alternative 1

This alternative proposes the use of both the amine and ester formulations of 2,4-D in combination with other herbicide formulations to be used on most sites. **This alternative will negatively affect those opposed to the use of 2,4-D.**

Alternative 2

This alternative does not propose the use of 2,4-D alone or in combination with other herbicides. **This alternative will not negatively affect those opposed to the use of 2,4-D.**

Alternative 3

This alternative does not propose the use of 2,4-D or any other herbicides. **This alternative will not negatively affect those opposed to the use of 2,4-D.**

Alternative 4

This alternative does not propose the use of 2,4-D or any action at all. **This alternative will not negatively affect those opposed to the use of 2,4-D.**

Issue 7: Chemical Herbicides Should Be Used as a Last Resort:

Alternative 1

This alternative proposes the use of chemicals. This alternative does not utilize chemicals as a last resort. This alternative does propose monitoring to determine the effectiveness of treatment as follow up.

No, this alternative does not consider alternative approaches to herbicide use. Monitoring will be conducted to evaluate the effectiveness of treatment after implementation.

Alternative 2

This alternative does not propose the use of chemicals at any time. Chemicals would not be used as a last resort. On-going monitoring would be conducted to determine the effectiveness of treatment.

No, this alternative does not use chemicals as a last resort but does consider an alternative approach to herbicide treatment. Monitoring will be conducted to evaluate the effectiveness of treatment during and after implementation.

Alternative 3

This alternative proposes the use of chemical herbicides as a last resort after alternative methods have been determined to not be the most effective method of treatment. This alternative proposes an evaluation strategy to determine effectiveness of treatment in meeting objectives. Evaluation criteria will be used to determine if chemical herbicide use is needed.

Yes, this alternative considers alternative approaches to knapweed treatment and utilizes chemical herbicides as a last resort. Monitoring will be conducted to determine the effectiveness of the treatment.

Alternative 4

No action would be taken to treat knapweed in this alternative.

No, this alternative will not consider alternative approaches to treatment or monitoring effectiveness.

Achievement of Purpose and Need for Action

This section will evaluate the alternatives in terms of achievement of the purpose and need stated in Chapter One. An efficacy rating will be applied to each alternative that rates the effectiveness of treatment measures in meeting the objective of eradication proposed in each alternative. Efficacy will be expressed in terms of the percentage of plants eliminated, 100% elimination is the goal of eradication. The amount of time (duration) estimated to achieve eradication is also taken into consideration in determining the effectiveness of treatment. The longer the duration to reach the objective, the greater the chances are that knapweed infestations will spread beyond the ability to control them and the lower the probability of success.

The different alternatives for treating spotted and diffuse knapweed have varying levels of effectiveness for meeting the purpose and need for action (eradication of the species). Scientific literature on spotted and diffuse knapweed was reviewed to assess the most effective treatment methods (see Appendix F)). Weed Specialists from Siskiyou County and throughout Northern California were consulted (S.Orloff, J.DiTomaso, S.Thornhill personal communication), chemical treatment and manual control methods were researched in the literature, and professional judgment and field experience was used to validate the assumptions. Diffuse knapweed for purposes of this exercise was considered to be similar to spotted knapweed and the two species were rated together in this analysis.

Alternative 1

The proposed action has the highest potential to achieve the purpose and need due to the use of herbicides on all sites to treat knapweed. Herbicides are generally considered to be the most effective tools in treating spotted knapweed for a number of reasons:

- Spraying the plants does not create the disturbance that manual treatments create. The disturbance of the soil and plant material stimulates seedling germination. Direct treatment of live plant material will kill the plant without creating disturbance that promotes growth.
- Use of contact herbicides (glyphosate, 2,4-D) assures the plant is completely killed, as opposed to hand-pulling that has the potential to leave plant material (roots) that can resprout**.**
- Chemicals that have an effect on soil seed banks (picloram and Transline™) have an added effectiveness in that treatment may only have to be conducted every other year or longer.
- Spotted knapweed is a relatively long-lived perennial. Plants can live up to 9 years. Killing plants by spraying eliminates having to re-treat the same plants repeatedly. Retreatment is necessary when mechanical methods result in: re-sprouting following hand pulling; or remulching from unsuccessful mulching of large, established plants that are resistant and difficult to eliminate; or mowing the same plants every year.
- Numbers of treatments per year are generally less than with other methods as regrowth does not occur after plants are killed.
- Costs of treatment are generally less than other methods due to the labor costs, and retreatment costs can be expected to decrease at a faster rate than with other labor intensive methods.

Treatment Cost

Based on SCDA data, the estimated cost for herbicide treatment is approximately $300.00 per acre. In the Montana study (Brown et al 1999), the cost of chemical treatment per acre was approximately $30.00 per acre for 2 years.

Based on the literature (Brown, et al. 1999) and professional opinion, this alternative is expected to achieve 100% effectiveness in eliminating knapweed populations within 5 years.

Alternative 2

This alternative has a low efficacy rating due to the use of only manual methods on all population sizes. Even though manual pulling is effective on small population sizes, the total acreage of small sized populations is small relative to the overall infestation.

- Manual treatment requires complete removal of all plant material (esp. seeds and roots) from the site or re-growth will occur.
- Manual pulling and digging encourages seed germination by creating bare ground through disturbance, bringing up seed that might otherwise stay buried (and lose viability) by churning the soil.
- The increased number of visits to each site and the length of time involved in manual treatment increases the potential for spread by increase in human traffic through infested areas.
- An adequate workforce for achieving eradication must be sustained at a higher level and over a longer period of time than that for chemical control.
- Manual treatment is much more labor intensive and requires more person hours of labor, which contributes to a much higher cost of treatment for this alternative.

Treatment Costs

The cost of mechanical treatment is the highest of all the alternatives, estimated at approximately $15,000 per initial treatment per acre. In studies of methods used to control spotted knapweed in Montana, hand pulling bolted plants twice a year for two years produced 60% effectiveness at a cost of $13,900.00 per acre (the wage rate was $9/hour) (Brown et al., 1998). Using local data from the Kelly Gulch site, the Salmon River Restoration Council spent approximately 4 hours at $10/hr. to hand pull a 110 sq.ft. plot (.0026 acre) of densely infested knapweed (costs were $40 x 385 = $15,400/acre). Another plot of one tenth the density of the previous example took one hour to weed. Follow-up treatments would cost less, depending on return rate of the plants and subsequent germination from the soil seed bank, however multiple treatments are required per year.

Based on the literature (Brown, et al. 1999), professional opinion, and experience to date, this alternative is expected to achieve 60% effectiveness and will eliminate knapweed populations within 10 to 12 years

Alternative 3

This alternative has a moderate efficacy rating because of the delayed use of the most effective treatment. The discussion of efficacy of treatment above in Alternatives 1 and 2 above applies to this Alternative. The efficacy rating is expressed as a range depending on the results of evaluation of the treatment. The overall efficacy rating is expected to decrease for the following reasons:

- delayed use of the most effective method of treatment (herbicide use) if used at all.
- this alternative does not include the use of 2,4-D in combination with Rodeo™, so is slightly less effective as described above in Botanical effects section.

Treatment Costs

Treatment costs for this alternative will vary depending on whether mechanical or herbicide treatment is used and for what. The cost per acre would vary from $300.00 to $15,000.

Based on the literature (Brown, et al. 1999), professional opinion, and experience to date, this alternative is expected to achieve 60-100% effectiveness and will eliminate knapweed populations within 5 to 10 years

Alternative 4

This alternative takes no action towards eradication of spotted knapweed and has no efficacy rating.

Chapter 4
List of Preparers
Agencies and Persons Consulted

The following Forest Service specialists either participated on the Interdisciplinary Team or provided input to the analysis:

Anne Yost	Range Conservationist, ID Team Leader
Marla Knight	Botanist
Brenda Olson	Fisheries Biologist
Jay Power	Geologist
Marc Williams	Wildlife Biologist
Candy Cook-Slette	Archeologist
David Bakke	Regional Pesticide Use Coordinator
Lynda Karns	Forest NEPA Coordinator
Connie Hendryx	Document Preparation

Others consulted during the analysis process:

William Stephans	Agriculture Commissioner, Siskiyou County Dept. of Agriculture (SCDA)
Patrick Griffen	Deputy Agriculture Commissioner, (SCDA)
Smokey Thornhill	Deputy Agriculture Commissioner, (SCDA)
Butch Krebs	Biologist, California Department of Food and Agriculture
Patrick Akkers	California Department of Food and Agriculture
Bob Farnum	Weed Specialist, Amador County Department of Agriculture
Suzanne Ebright	Weed Specialist Plumas/Sierra Counties Dept. of Agriculture
Laura Finley	Biologist, U.S. Fish and Wildlife Service
Garwin Yip	Biologist, National Marine Fisheries Service

Fred Blatt	Environmental Specialist, North Coast Regional Water Quality Control Board
William Winchester	Biologist, North Coast Regional Water Quality Control Board
Frank Reichmuth,	North Coast Regional Water Quality Control Board
Stephen Wratten	Chemist, Monsanto Corp.
Kathy Brunetti	California Department of Pesticide Regulation
Jerry Cambell	California Department of Pesticide Regulation
Lily Tomlin	North Coast Laboratories
Celestine Duncan	Weed Management Services Consultant
Steve Orloff	Farm Advisor, U.C. Davis Agricultural Extension
Joe DiTomaso	Research Scientist, U.C. Davis
Vivian Parker	Resource Protection Associate, Indian Basket Weavers Association
Patty Clary	Executive Director, Californians for Alternatives Against Toxics
Alvis Johnson	Karuk Tribe
Harold Tripp	Karuk Tribe
Paula McCarthy	Karuk Tribe
Laverne Glaze	Indian Basket Weavers Association
Verna Reese	Indian Basket Weavers Association
Rene Stauffer	Indian Basket Weavers Association
Roy Lincoln	Chairman, Quartz Valley Reservation
Jesse Rose Allen	Salmon River Native Americans
Jim Bennett	Salmon River Native Americans