DRAFT ENVIRONMENTAL ASSESSMENT

Use of Integrated Pest Management (including herbicides) to Control Leafy Spurge Occurrences along the Klamath and Scott Rivers and in the Quartz Valley Watershed

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1) Purpose

The purpose of the proposed action, to control or eradicate Leafy spurge (*Euphorbia esula*) occurrences on private lands along the Klamath and Scott rivers and Quartz Valley tributaries, is to reduce the size of existing populations and prevent Leafy spurge from dispersing along these water courses. Due to the persistence of this species, there remains a small window of opportunity to control incipient occurrences before they become unmanageable. The use of an Integrated Pest Management (IPM) strategy is being considered in order to curtail the environmental degradation caused by Leafy spurge and to allow the passive restoration of riparian vegetation. Promoting healthy and functioning riparian habitats will improve water quality and habitat for anadromous fish and riparian associated terrestrial wildlife.

2) Need

The need for the proposed action resulted from a dramatic increase in Leafy spurge occurrences. Surveys conducted by the Siskiyou County Department of Agriculture (SCDA) over the last decade indicate Leafy spurge sporadically infests over sixty miles of the Klamath and Scott rivers and their tributaries and that the number of Leafy spurge sites have increased by over 100 percent along the Klamath River and over 200 percent along the Scott River since 2001. Taken together, these occurrences represent the only large Leafy spurge infestation in California. Unconstrained spread of this species is likely to further degrade riparian ecosystems in Siskiyou County and increase the likelihood for infestations in neighboring counties through which the Klamath River flows.

3) Decision to be Made

The U. S. Fish and Wildlife Service (Service) is responsible for ensuring this project is in compliance with the National Environmental Policy Act. The Service's Director will select one of the alternatives analyzed in detail and will determine, based on the facts and recommendations contained herein, whether this Environmental Assessment (EA) is adequate to support a Finding of No Significant Impact or whether an Environmental Impact Statement is required.

4) Background

Leafy spurge is native to Europe and Asia and was introduced to northeast North America in the early 1800s. It is an erect, branching, perennial plant with smooth stems and showy yellow flower bracts. The leaves of Leafy spurge are small (0.25 to 0.5 inches), oval to lance shaped, somewhat frosted, and slightly wavy along their margins. The flowers are inconspicuous and are borne on greenish yellow structures surrounded by yellow bracts. All parts of the plant contain a white milky juice called latex that is poisonous to humans and wildlife.

Leafy spurge is an aggressive invader that can adapt to a variety of soil types and environmental conditions. Its rhizomatous branching root system can spread up to 30 feet per year in width and depth from the parent plant. Since its introduction to North America, it has doubled in acreage every 10 years, and currently infests 5 million acres in 35 states in the United States alone.

Leafy spurge can reproduce both by seeds and by vegetative means. Seeds are borne in pods that contain three gray-brown, oblong smooth seeds. After the seeds mature, seed capsules open explosively, dispersing seeds up to 15 feet from the parent plant. Seeds that land in water can germinate while floating, giving Leafy spurge the ability to root as soon as it makes land fall. Thus, rivers and streams are effective vectors of seed dispersal. Vegetative buds along roots can also grow into new shoots. If the root is tilled or cut, each part of the root may grow into a new, independent plant.

Because Leafy spurge is extremely prolific and has such a complex root system it can readily displace native vegetation through shading, out competing, and usurping available water. Leafy spurge also contains plant toxins that slow or stop the growth of other nearby plants. For these reasons Leafy spurge infestations can significantly alter the composition of native vegetation and reduce floral biodiversity, affecting the abundance and distribution of rare plants. Research conducted by Butler and Cogan (2004) indicated that Leafy spurge infestations reduced species richness by an average of 51 percent across eleven plant associations in North Dakota. Similarly, Belcher and Wilson (1989) reported that cover values of all common native species were negatively correlated with cover of Leafy spurge in a Canadian mixed-grass prairie. These authors also found that four common native grasses were absent at sites where Leafy spurge was most abundant. Leafy spurge infestations can also displace native bank stabilizing vegetation, increasing the potential for erosion and sediment delivery to adjacent rivers and creeks.

Changes in plant species composition resulting from Leafy spurge infestations can affect community composition and habitat utilization patterns of wildlife. Scheiman et al. (2003) discovered that densities of two species of grassland sparrow were lower in areas with high Leafy spurge cover than areas with low to medium cover. Conversely, meadowlark nesting success increased with amount of Leafy spurge cover. Leafy spurge infestations reduced habitat utilization of three large ungulates including elk (*Cervus elaphus*) and deer (*Odocoileus spp.*) by up to 32 percent in the Theodore Roosevelt National Park (Trammel and Butler 1995). A more recent study conducted at the Theodore Roosevelt National Park found Leafy spurge seeds in deer feces (Wald et al. 2005). However, due to the limited amount of seeds found the authors concluded that deer seldom forage on Leafy spurge. Leafy spurge pollen and nectar is attractive to many insect pollinators including bees, flies, and butterflies (Larson 2008) and seeds are consumed by some birds (Blockstein et al. 1987; Wald et al. 2005).

Information regarding soil moisture uptake by Leafy spurge is limited. However, Geronimo et al. (2008) reported that Leafy spurge acquired water from deeper soils than native forbs and grasses in Southeastern Idaho. They also found depletion of soil moisture at depths between 19 and 60 inches was greater where Leafy spurge occurred compared to areas where only native forbs and grasses occurred. Consequently, large areas of Leafy spurge infestations adjacent to rivers and streams may reduce water yields to these systems.

The continued expansion of Leafy spurge can also result in direct economic losses by reducing grazing and forage production, recreational opportunities, and jobs and secondary economic impacts by reducing water conservation benefits and increasing commodity prices (Leitch et al. 1994). The economic impacts of Leafy spurge on grazing lands in Montana, North Dakota, South Dakota, and Wyoming were estimated in 1994 to be $37.1 million in direct losses and $82.6 million in secondary economic impacts. By 2002, this estimate of economic loss had risen to $186 million (Lym 2005).

Leafy spurge is persistent and very difficult to control. Control strategies must be conducted regularly and persistently over many years to be successful (Lym and Zollinger 1995; Beck 2008). Because Leafy spurge can re-infest rapidly, it is recommended that treatments be applied annually until control reaches 90 percent or more (Lym and Messersmith 2006). When implementing treatments it is also recommended that infestations be periodically monitored to evaluate treatment effectiveness. If control objectives are not being met, it may signal inadequate treatments, at which point changes in techniques and strategies should be considered (Goodwin et al. 2006).

Several control options are available and most successful attempts at controlling Leafy spurge have used an IPM strategy in which different treatment methods, suited to site specific conditions, were used. Most control options, when used singly, take several years to be effective. During this time seed production and dispersal continue, perpetuating the spread of the infestation. Therefore, leading authorities on Leafy spurge management have concluded that eradication or even effective control in some situations cannot be achieved by biological agents, grazing, or manual controls without coupling these treatments with an herbicide treatment (Goodwin et al. 2006).

The first report of Leafy spurge in Siskiyou County was from Quartz Valley in the 1940s. The SCDA has been treating Leafy spurge in Siskiyou County for many years using an IPM approach. Specific treatments employed included manual methods such as tarping, hand pulling and digging; biological controls (insects); and limited herbicide application. Despite these efforts, surveys conducted by the SCDA over the last decade indicate Leafy spurge sites have increased by over 100 percent along the Klamath River in the past five years and over 200 percent along the Scott River since 2001. The failure to control the spread of Leafy spurge was primarily attributed to the ineffectiveness of certain treatments and the inability to treat a large percentage of existing occurrences. For the most part, biological controls were ineffective due to unfavorable environmental conditions that prevented the control organisms from surviving over winter. Inaccessible, rocky, or densely vegetated terrain also inhibited or prevented proper implementation of manual treatments in many areas. Additionally, manual treatments are labor intensive, and typically require repeated and timely follow-up visits to be effective. For these reasons, the SCDA was only able to treat a small percentage of known occurrences annually, and abundant sources of seed production were unmanaged, allowing the continued spread of Leafy spurge.

Based on SCDA surveys, there are currently 569 discrete occurrences of Leafy spurge along the Klamath and Scott rivers and Quartz Valley tributaries (J. Aceves pers. comm.) (Map 1). These occurrences are distributed over 60 river miles and range in size from one plant up to 0.16 acres. Taken together, all of the discrete occurrences on private lands in these watersheds total approximately 72 net acres. Most occurrences are located on rocky river bars and floodplains or in dense riparian vegetation where treatment options are limited. Because these occurrences are currently confined to small, well defined areas, they can still be readily controlled or even eradicated with persistent, adaptive management that uses knowledge gained from previous and ongoing control attempts to derive new management approaches and strategies. If not treated promptly, however, these small patches will likely expand into large infestations and eradication will become physically or economically unattainable (Lym and Messersmith 2006; Goodwin et al. 2006). Therefore, the Service is partnering with the SCDA to actively control existing Leafy spurge occurrences on private lands where landowners have granted permission to the SCDA to enter and treat Leafy spurge on their property. For this project the SCDA will determine and implement the appropriate site specific treatments while the Service will provide funding to support implementation of selected treatments.

5) Public Involvement

This EA will be made available in order to provide background information to interested parties who wish to review and provide comments. A public announcement will be made in the local newspaper and the EA will be posted on the Yreka Fish and Wildlife Office's website (http://www.fws.gov/yreka).

6) Alternatives, Including the Proposed Action

Over the past decade the SCDA has been treating Leafy spurge using a variety of control methods. All of the following alternatives represent a continuation of these ongoing control efforts and are consistent with the SCDA IPM strategy, which includes evaluating progress and modifying actions as necessary to meet control objectives.

This assessment considers three alternatives for treating Leafy spurge occurrences on private lands within the riparian areas of the Klamath and Scott rivers and Quartz Valley tributaries. Alternative 1 (no action) proposes no additional management actions other than previously released biological control agents. Because there are often public concerns regarding the use of herbicides, Alternative 2 proposes the use of a control strategy using manual and biological treatments only. Alternative 3 proposes the use of a control strategy including the use of biological, manual, and herbicide treatments.

Alternative 1: No Action

The No Action Alternative refers to no additional actions being taken to control Leafy spurge along the Klamath and Scott rivers and Quartz Valley tributaries other than previously released biological control agents.

Biological control uses natural enemies of weed species, including insects. While many insect species (beetles, moths, gall midge) have been released in the United States to manage Leafy spurge, the flea beetle (*Apthona sp.*) has proven to be the most successful control agent. The larvae of these beetles feed on the roots and root hairs of Leafy spurge while the adults feed on the leaves and flower bracts. However, numerous early attempts by the SCDA to establish two species of flea beetle (*Apthona lacertosa* and *A. nigriscutis*) from North Dakota in Siskiyou County have failed (Villegas et al. 2007). It is believed that the shallow, sandy soils at the beetle release sites did not provide adequate over-wintering habitat (J. Aceves pers. comm.). In 2007, the SCDA initiated a new biological control program using *A. lacertosa* and longhorn beetles (*Obera erythrocephala*) collected from Oregon. Unlike the previous release sites, these beetles were released at two sites that contained Leafy spurge growing in loamy soil. Beetles at these two sites have overwintered for four years and Leafy spurge occurrences at these two release sites are expected to decline as beetle numbers increase.

Alternative 2: Biological and Manual Control

Alternative 2 would use a variety of manual methods and biological control agents to reduce or eradicate Leafy spurge occurrences. The proper control method(s) for a given occurrence will be selected after considering site specific conditions. Specific manual methods considered in this alternative include tarping and hand pulling and digging. This alternative is expected to result in the treatment of 20 to 24 acres (of the 72 total) of Leafy spurge annually.

Tarping consists of removing all vegetative material, including the Leafy spurge plants, and placing a protective cover (usually plastic or a geotextile) over the bare ground. Over time this reduces the population by preventing light from reaching the soil, effectively preventing seed germination and growth under the tarp. Where possible, tarping will extend 15 feet or more beyond the perimeter of the occurrence to prevent recently dispersed seeds from sprouting and to keep the roots from growing to the edge of the tarp and then producing plants. Flat, sandy areas without large rocks, dense vegetation, or other debris are most conducive to tarping. These areas allow for the tarp to lay flat on the ground and do not have debris that may poke through the tarp. In areas subject to annual high water, tarps are removed annually. Because all vegetation under the tarp may be killed, surveys will be conducted to ensure that rare or sensitive species do not occur in areas proposed for tarping.

Hand pulling and digging are most effective where there are only a few plants and they are in their first year of growth (Drlik et al. 1998; Goodwin et al. 2006). Hand pulling usually results in breaking the root system a few inches below the ground and both methods are only effective if the entire root system is removed. Because vegetative buds along roots can grow into new shoots and Leafy spurge seeds can germinate anytime during the growing season, repeated annual visits are necessary to ensure seedlings are removed in their first year of growth. Over time, repeated pulling and digging of seedlings will exhaust the root system.

In addition, beetles will continue to be used to manage Leafy spurge at the two sites where they have previously been introduced and have become established. Although currently there are no additional known occurrences of Leafy spurge growing in loamy soils in Siskiyou County on private lands, beetles could be released at newly discovered occurrences if loamy soils are present to provide overwintering habitat.

Alternative 3: Biological, Manual, and Herbicide Control

This alternative would use the same biological and manual control methods described in Alternative 2 as well as the use of herbicides. The proper control method(s) for a given occurrence will be selected after considering site specific conditions. Research has shown that herbicides and biological control used together can be effective at controlling Leafy spurge. Timing is the most important factor when combining these two treatment methods. Fall herbicide applications are compatible with flea beetle survival and can enhance flea beetle population establishment (Merritt et al. 2003). For this alternative glyphosate would be the herbicide used due to its efficacy at controlling the target species, low toxicity to non-target organisms, and chemical properties that limits its movement in, and potential adverse impacts to, the environment.

Glyphosate is a non-selective systematic herbicide. It is applied directly to plant foliage where it is absorbed across leaves and stems. In plants it disrupts the shikimic acid pathway by inhibiting enzymes and reducing production of aromatic amino acids that are vital for protein synthesis and plant growth (Miller et al. 2010). Glyphosate adsorbs strongly to most soils and is readily degraded by soil microbes to aminomethyl phosphonic acid (AMPA) which is degraded to carbon dioxide (EPA 1993).   The median half-life of glyphosate in soils ranges from 2 to 197 days with 47 days being typical (Giesy et al. 2000). However, the adsorptive qualities of glyphosate can slow microbial degradation and increase its persistence in soils (Tu et al. 2001). The half-life of glyphosate on foliage ranges from 2.5 to 26 days (Newton et al. 1984; Willis and McDowell 1987). Glyphosate is highly water soluable but solubility varies depending on the type of glyphosate salt in the active ingredient (Messersmith 2007).   Half-life in fresh water ranges from a few days to several weeks depending on system properties (SERA 2011). If glyphosate reached surface water, it would not be broken down readily by water or sunlight (EPA 1993). However, glyphosate will likely dissipate rapidly from natural water bodies through adsorption to suspended particles and bottom sediments where they are subsequently broken down by microbes (Feng et al. 1990; Goldsborough and Brown 1993).

Surfactants are often added to glyphosate formulations to increase the effectiveness of the herbicide. For this project the nonionic surfactant R11 will be used. Nonionic surfactants reduce surface tension so that more rapid penetration of the herbicide into the plant is possible. The principal functioning chemical agent in R11 is nonylphenol ethoxylate (NPE). Upon entering the environment, NPEs readily degrades into nonylphenol (NP) (EC 2002). NP is moderately water soluble and adsorbs strongly to soils and sediments (EC 2002; EPA 2005). Under aerobic conditions, nonylphenol compounds in soil initially biodegrade readily with half-lives as short as 7 days. This initial phase is then followed by a secondary phase of prolonged degradation with half-lives as long as 110 days (EC 2002). In water, NPE and NP are moderately resistant to degradation and are therefore considered persistent in aquatic environments (EPA 2005; EPA 2010).

Herbicide treatment will consist of spot spraying individual plants by hand using backpack-mounted sprayers. Herbicide application will occur only at low nozzle pressure and within 2.5 feet of the ground. Application would be halted when wind speeds exceed five miles per hour (mph) and when there is a greater than 30 percent forecast for rain within six hours. Using these standards and guidelines the potential for overspray and drift will be minimized and approximately 80 percent or more of the applied herbicide mix will come in contact with the target species and be absorbed by the plant (J. Aceves pers comm.). Maximum application rate for glyphosate under its EPA approved label is 4.0 lbs a.i./ac (active ingredient per acre). However, the SCDA has found that an herbicide mix containing significantly less active ingredient can effectively control Leafy spurge. For this project the SCDA will use an herbicide mix containing a 2 percent herbicide concentration (which consists of 54 percent glyphosate and 46 percent surfactant and water) and 98 percent water. This equates to 1.38 ounces of glyphosate per gallon. The SCDA estimates that it takes 25 gallons of herbicide mix, which contains 2.15 lbs of glyphosate, to treat a solid acre of Leafy spurge using a broadcast treatment. Given that the current occurrences of Leafy spurge are small and will be spot treated by hand, the actual amount of herbicide mix applied per acre of treatment is expected to be considerably less than 25 gallons per acre. Therefore, it is expected that a maximum of 2.15 lbs of glyphosate may be applied per acre of treatment.

Prior to implementing an herbicide treatment, all SCDA treatment personnel are trained by a Qualified Applicator Certificate holder, which is issued by the California Department of Pesticide Regulation. Specifically, treatment personnel are trained on appropriate application techniques including; how to use, calibrate, and maintain all application equipment; how to properly store tanks and backpack sprayers in field vehicles; and appropriate safety precautions. Additionally, all treatment personnel are required to review and follow all herbicide label requirements. In the field, herbicides are applied by a two person crew consisting of a crew leader and a technician. All crew leaders for this project are returning SCDA employees that have experience in herbicide application.

As part of the initial treatment, herbicides may be applied to an estimated 72 acres infested with Leafy spurge. The majority of herbicide treatments will occur during the months of July through September. Individual occurrences may be treated twice in a given year depending on the efficacy of the initial treatment. If a second treatment is necessary, it would occur in October. Discrete occurrences to be treated range in size from one plant up to .16 acre patches and are spread out over 60 river miles. Due to the size of the occurrences and their spatial distribution only one to two acres will be treated per day. Thus, it will take two to three months to complete the herbicide treatment. Because many years of treatment will be necessary before Leafy spurge is completely controlled or eradicated, follow-up herbicide treatments may be applied for up to five years. During follow-up treatments up to 72 acres could be chemically treated annually. However, because each treatment is expected to reduce the number of plants in an occurrence, the number of treated acres is expected to decline annually.

All acres proposed for treatment occur on private lands where the land owner authorizes permission for SCDA to enter and agrees to the treatment of Leafy spurge either verbally or in writing using a Noxious Weed Consent Agreement (see Appendix C). All of the private landowners have been advised of the environmental hazards of a growing Leafy spurge infestation and the potential positive and negative aspects of proposed treatment efforts, including the use of herbicides. Upon request, landowners have also been provided with a copy of the herbicide label.

Alternatives not considered for detailed analysis: **Grazing, Burning, and Cultivating**

<u>Grazing:</u> Sheep and goats can control Leafy spurge by grazing on the topgrowth of the plant. Grazing is best suited to control Leafy spurge on large infestations, primarily in pasture and rangelands. Where Leafy spurge occurrences are small and discontinuous, fencing may be required to concentrate foraging. Because the majority of occurrences are small and widely dispersed and often occur in inaccessible areas, grazing was not considered a practical method to meet the purpose of controlling Leafy spurge along the Klamath and Scott rivers and Quartz Valley tributaries.

<u>Burning</u>: When used in conjunction with other methods, burning has resulted in some success in reducing Leafy spurge seed viability. Due to the size, distribution, and location of existing occurrences, burning was not considered practical to meet the purpose and need of this project.

<u>Cultivating</u>: Cultivating or tilling the soil at a depth of three to four inches every two weeks during the growing season and every three weeks when plant is dormant has proven to be an effective method for controlling Leafy spurge. However, this technique has primarily been tested in pasture and rangelands and is not suitable for rocky terrain, areas containing dense vegetation, or areas where access for large machinery is difficult, which are conditions along the Klamath and Scott rivers and Quartz Valley tributaries.

7) Affected Environment

The specific areas to be treated include the Mill and Shackleford Creek drainages which originate in Quartz valley; the Scott River from Shackleford Creek downstream to its confluence with the Klamath River; and the Klamath River from the Scott River downstream to the Siskiyou County border.

8) Environmental Consequences

Alternative 1: No Action

Under Alternative 1, Leafy spurge would continue to be controlled using beetles at two sites along the Scott River totaling less than one acre. The remaining occurrences along the Klamath and Scott rivers and Quartz Valley watershed would remain unmanaged and would likely continue to spread at rates equal to or greater than those observed over the last decade. Not treating these occurrences would also increase the risk of the establishment of new sites downstream of the existing occurrences, threatening native plants and habitats.

Ecological Impacts

Soil Quality: Continued expansion of Leafy spurge can increase the potential for soil erosion by reducing plant diversity. Additionally, preliminary data from a study investigating soil properties suggests Leafy spurge can affect the function of soil microbes which could impact recruitment or reestablishment of native species (Larson 2011).

Botanical: Potential consequences of not controlling Leafy spurge to plant communities are well documented. Leafy spurge has the ability to overtake plant communities, dramatically changing their composition. Potential effects of not controlling Leafy spurge in the majority of the infested areas that are not conducive to bio control include a reduction in native grasses, forbs, and woody plants including rare and sensitive species. There are 19 plants that meet the California Native Plant Societies rare or endangered criteria within 0.5 miles of the main stem Klamath River between Iron Gate Dam and the Siskiyou County border.

Invasive plants can also attract pollinators away from native flowers. Larson et al. (2006) reported that native species received fewer visits in areas infested with Leafy spurge. A burgeoning Leafy spurge population may therefore depress pollination of native species. This would be of particular concern in areas where rare or sensitive species are located.

Water quality: There are no anticipated direct effects to water quality from Alternative 1. Indirect effects may occur as Leafy spurge displaces native vegetation. Over time this could affect water quality by reducing shade and increasing erosion and sediment delivery to adjacent creeks and rivers. Additionally, by depleting late summer deep soil moisture, Leafy spurge could impact water yields to adjacent streams and rivers.

Fish and Wildlife: Uncontrolled Leafy spurge may have an adverse effect to fish in the project areas over time by reducing shade vegegtation, increasing the potential for erosion, and decreasing water yield. The Klamath and Scott rivers support a variety of anadromous fish including the federally listed coho salmon (*Oncorhyncus kisutch*) as well as Chinook salmon (*Oncorhyncus tshawytscha)*, steelhead trout (*Oncorhyncus mykiss*), and Pacific lamprey (*Lampetra tridentata*). These species have similar life histories including the need for cold water and coarse gravel for spawning. In their 2009 report to Congress, the National Oceanic and Atmospheric Administration identified altered sediment supply and impaired water quality as threats to anadramous salmonid populations in the Klamath River (National Oceanic and Atmospheric Administration 2009).

Similar to aquatic species, impacts to terrestrial wildlife would be expected over time as Leafy spurge displaces native vegetation. Forage for ungulates and suitable nesting habitat for some ground nesting birds would likely decline. However, Leafy spurge produces seeds that are eaten by a variety of birds and provide a pollen source for some bees.

Human Health and Safety:

Under Alternative 1, biological controls would continue to function at sites along the Scott River. Additional control methods would not be employed. Therefore, this alternative does not pose a risk to human health or safety.

Cumulative Impacts:

If no additional actions are undertaken to control Leafy spurge, it is anticipated that this species will continue to expand, eventually becoming the dominant plant in many riparian areas. Expanding Leafy spurge occurrences would continue to degrade watershed health and function by impacting water quality, altering native plant distribution and abundance, and reducing wildlife forage. Taking no action now could lead to needing to undertake a larger control effort in the future or render future control unattainable.

Alternative 2: Biological and Manual Control

Under Alternative 2, the appropriate control method(s) for a given occurrence will be selected after considering site-specific conditions. All of the control methods proposed for this alternative require a time frame of several years to decades for success. While these methods may control individual occurrences over time, they may be ineffective at preventing the spread of Leafy spurge due to the length of time required to obtain control. Additionally, the proposed manual treatments are labor intensive, which limits the number of acres that can be treated per year, while rocky terrain and dense vegetation may prohibit implementation of these treatments in some areas. Therefore, on an annual basis, the majority of known occurrences will be untreated.

Ecological Impacts

Soil Quality: Direct effects to soil quality under Alternative 2 are expected to be minimal or short term. Tarping can initially reduce beneficial microorganisms in the soil but their populations quickly recolonize soils once tarps are removed (Pokharel 2011). Additionally, tarping can control some pathogens and increase availability of plant nutrients. Hand pulling and digging will disturb soils but this will only occur in small discrete patches. Biological controls will not affect soil quality. Indirect effects to soil quality at untreated occurrences would be the same as described in Alternative 1.

Botanical: Hand pulling, digging, and biological controls, would likely have an immediate benefit to botanical species by reducing competition with Leafy spurge while minimizing impacts to non-target species. While tarping will kill all vegetation within the treated area, surveys of proposed tarping sites will be conducted to ensure that rare or sensitive plants are not affected. Therefore, impacts to rare or sensitive plants should be negligible. However, because methods such as hand pulling and digging may not be effective at controlling the spread of Leafy spurge, impacts to rare or sensitive plant populations from Leafy spurge infestations will likely continue over time. Indirect effects to botanical species at untreated occurrences would be the same as described in Alternative 1.

Water quality: There are no anticipated direct effects to water quality from Alternative 2. Indirect effects from ground disturbing activities such as digging and hand pulling may be short-term increases in erosion and sediment delivery to the streams. Alternative 2 may be ineffective at controlling the spread of Leafy spurge and some occurrences may remain untreated. Water quality issues associated with the displacement of native vegetation by Leafy spurge as discussed under Alternative 1 may occur over time.

Fish and Wildlife: Alternative 2 is not expected to have direct impacts on fish or other aquatic species. However, ground disturbing activities such as digging could increase short-term erosion and sediment delivery to the streams. An increase in sediment delivery can adversely affect coho salmon and steelhead by interfering with the development of eggs and larvae.

Control methods that only remove or kill Leafy spurge such as hand pulling, digging, and biological control, would benefit species that utilize native vegetation for foraging or nesting. Tarping would result in a short term reduction of foraging and nesting habitat as they would kill all vegetation within the treated area.

While there is the potential for increased erosion, sedimentation, and destruction of non-target vegetation at the treatment sites, these impacts are not expected to be significant due to the size and distribution of the occurrences.

Human Health and Safety:

Under Alternative 2, there is some risk of injury due to the extensive use of manual treatments. However, all treatments would be implemented by experienced field staff. Additionally all field staff receive extensive training by the SCDA before implementing any control actions. Therefore, the risk to human health or safety from this alternative is expected to be minimal.

Cumulative Impacts:

Because the impacts of tarping, digging and hand pulling, and biological controls are expected to be short term or negligible, they are not expected to have a significant cumulative impact to plants, fish, or wildlife. While this alternative will likely have localized benefits, the number of acres that can be treated annually is limited. Therefore, this alternative may not effectively control the spread of Leafy spurge in watersheds such as the Klamath and Scott rivers where the occurrences are widely distributed.

Alternative 3: Biological, Manual, and Herbicide Control

Under Alternative 3, Leafy spurge will be controlled by utilizing the most effective IPM option available at each specific site. Biological control agents will be utilized at two sites where they have become established. These sites may serve in the future as nursery sites providing agents for releases at other sites which have suitable overwintering habitat. All other occurrences will be treated with herbicides unless other IPM methods are determined to be more suitable and cost effective. Leading authorities on Leafy spurge control have concluded that eradication and in some situations effective control cannot be achieved without herbicide treatment (Goodwin et al. 2006). Because most of the Leafy spurge along the Klamath and Scott rivers and Quartz Valley tributaries occur in inaccessible or rocky terrain or dense vegetation, which limits the applicability of other treatment methods, herbicides provide the best opportunity to control Leafy spurge in these areas. Additionally, herbicide treatments are less labor intensive which allows for more acres to be treated annually. This alternative allows for the management of up to 72 acres of Leafy spurge annually. These acres are distributed over 60 river miles in the Klamath, Scott River, and Quartz Valley watersheds and include all the known occurrences on private lands within these watersheds. Therefore, this alternative maximizes the capability to control the spread of Leafy spurge.

Ecological Impacts

Soil quality: As a result of dripping from treated plants and over-spray during applications up to 20 percent of the applied herbicide (a 2 percent glyphosate mix) may make contact with the ground. Glyphosate applied to soil can affect microbial communities which are responsible for increasing the availability of soil nutrients. Results of research on this topic are somewhat confounding (Tu et al. 2001) but glyphosate applied at recommended field application rates in natural environments appears to have little effect on microbial activity and communities (Tu 1994; Haney et al. 2000; Ratcliff et al. 2006). Tu (1994) also found that affected populations of microorganisms recovered rapidly after treatment suggesting that glyphosate did not pose a threat to long-term microbial activity.

Due to the small amount of herbicide anticipated to make contact with soil, the size and distribution of treated areas, and the limited and short-term impacts to soil microbes, impacts to soil quality are expected to be minimal.

Botanical: Glyphosate is a non-selective herbicide. Most plants that come into direct contact with glyphosate are killed or damaged but uptake and plant response varies depending on application method, rate, and frequency (Dill et al. 2010). For this project herbicides will be applied by hand using backpack sprayers at low nozzle pressure. Applications will be made in late summer when many of the grasses and other plants have become dormant. Project standards and guidelines for wind speed will minimize drift, effectively minimizing exposure to non-target plants. Therefore, direct effects to non-target plant species are expected to be minimal.

Upon making contact with soil, glyphosate adsorbs quickly and tightly, and is highly immobile (EPA 1993; Feng and Thompson 1990). For this reason glyphosate is not readily taken-up by plant roots and has little or no herbicidal activity once it touches soil (Sprankle et al. 1975; Giesy et al. 2000; Dill et al. 2010). Consequently, indirect effects to non-target plants are expected to be negligible.

Water Quality: Direct effects to water quality would include application of herbicides directly into water or accidental spillage. Herbicides will not be applied directly to vegetation emerging from water or directly over water. There is the possibility that glyphosate could travel through the air to adjacent water. However, herbicides will be applied by hand using backpack sprayers at low nozzle pressure. Additionally, application of herbicides will be halted when wind speeds exceed 5 mph, ensuring that drift will be negligible.

During herbicide treatments there is always the potential for the applicator to trip or fall. However, the spray tanks are constructed of durable plastic that is resistant to these types of impacts. As an emergency precaution all crews will carry spill equipment and will follow prescribed spill emergency procedures. Backpack sprayers will also be filled off-site to minimize spills and the potential to contaminate any water source.

Indirect effects to water quality would result from the movement of glyphosate from a treated area into a water source through erosion, runoff, or percolation. As a result of dripping from plants and over-spray a small amount of herbicide will reach the soil. Due to its adsorptive qualities, glyphosate is unlikely to move vertically into groundwater (EPA 1993). In arid areas with rocky, sandy soils, such as those found along the Klamath and Scott rivers, glyphosate typically will only penetrate the top 4 to 8 inches of soil (SERA 2011). Comes et al. (1976) found that glyphosate sprayed directly into a dry irrigation canal was not detectable in the first irrigation water flowing through the canal even though glyphosate residues were still persistent in the soil, suggesting that flowing water does not readily extract glyphosate from soils.

Although glyphosate is unlikely to leach into ground water or be extracted by flowing water, it can enter water sources when adsorbed to soil particles suspended in runoff (EPA 1993; Tu et al.

2001). Soil properties, topography, and rainfall are the primary factors controlling runoff events (Huddleston 1996; Brady and Weil 2008). Most of the proposed treatment will occur on river bars and floodplains characterized by low slopes ($\leq$ 20 percent) and well drained sandy or rocky soils. Average rainfalls for the months of July through September are 0.3, 0.3, 0.7, and 1.0 inches for the Klamath River (Happy Camp) and 0.3, 1.3, 1.3 inches for Scott River (Fort Jones). As such, it is unlikely that typical summer rainfall would generate runoff events that would transport glyphosate into adjacent water sources. However, intense thunderstorms can occur in the Klamath and Scott River areas during the summer months. These storms can have significant rainfall and represent the greatest likelihood of transporting glyphosate from the treatment area to a water source, especially if they occur immediately following an herbicide application. Due to the size and spatial distribution of the Leafy spurge occurrences to be treated, only one to two acres will be treated per day, effectively minimizing the number of recently treated acres exposed to random thunderstorm events. As stated above, treated areas are characterized by well drained soils with high infiltration rates and occur on shallow slopes that are resistant to erosion. Therefore, even in the worst case scenario it is unlikely that summer thunderstorms would generate enough erosion and runoff to measurably affect water quality.

To quantify this assumption a worst case scenario was modeled using the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS). Originally designed by U. S. Department of Agriculture to simulate water quality events on agricultural fields, recent versions of GLEAMS have incorporated parameters to address complex hydrology-erosion-herbicide interactions in other ecological systems (Knisel and Davis 2000). For this exercise, the worst case scenario consisted of a two inch rainfall occurring on the same day that two acres of Leafy spurge were treated with glyphosate. The two acres were distributed in a 25 foot wide strip to simulate a riparian corridor treatment. Results of this modeling exercise suggest that no detectable levels of applied herbicide would be transported by runoff or sediment yield outside of the treated area under the above scenario (See Appendix A for model results and model assumptions). These model results are very similar to the Syracuse Environmental Research Associates 2011 USDA Forest Service Glyphosate Risk Assessment GLEAMS model outputs for potential runoff and sediment loss from arid, sandy soils (SERA 2011).

The onset of consistent, heavy fall rains also increases the potential for runoff and erosion. In the Klamath and Scott River areas, consistent fall rains typically begin in late October or early November which is one to three months after treatment. Due to its short foliar and soil half-lives and adsorptive properties there is a low probability that glyphosate will enter water after the fall rains commence. A study conducted by the California Environmental Protection Agency (Wofford et al. 2003) in the Lower Klamath Basin failed to detect measurable concentrations in a forest stream below an experimental 13 acre glyphosate treatment following the first fall rain which occurred 37 days after the treatment. Even if glyphosate does enter a natural water body it typically dissipates rapidly through adsorption to suspended particles and bottom sediments and dilution (Feng et al. 1990; Goldsborough and Brown 1993; Newton et al. 1994).

The surfactants used in herbicide formulations can be toxic, and in some cases more toxic than the herbicide. Herbicides and surfactants can also have joint action where one or more of the components in a mixture impact the toxicity of other components in the mixture (SERA 2011). Research on R11 and the specific joint action of glyphosate and R11 is limited but suggests R11 is more toxic than glyphosate and increases the toxicity of glyphosate when combined in formulations (Trumbo 2005; SERA 2011). However, surfactants typically constitute a small percentage of the herbicide formulation. For the proposed treatments, a maximum of 0.38 percent of the formulation will be R11. Herbicide formulations will not be applied directly to emergent vegetation or directly over water, and project standards and guidelines will minimize drift. The adsorptive qualities and short soil half-life of NP (a degradation byproduct of R11), the stability of soils and shallow slopes in the treated areas, and lack of summer rains, also make it unlikely R11 or its degradation products will enter water sources through runoff or erosion. In the event that NPE or NE did enter a natural water body, their concentrations would be expected to decline rapidly after the initial contact (Trumbo 2005). Therefore, the use of the surfactant R11 is not expected to measurably affect water quality.

Fish and Wildlife: The toxicity of glyphosate to fish and the effect of pH on toxicity have been well documented (Appendix B. Table 1). Research indicates that increasing pH decreases the toxicity of glyphosate to fish (Wan et al. 1989). Data from the United States Geological Service's National Water Information System suggest that the pH of the Klamath (Seiad Valley) and Scott Rivers (west of Fort Jones) during the months when treatments are proposed are neutral to slightly basic (7-8.6). Based on EPA toxicity classifications, glyphosate would therefore be considered slightly toxic to practically nontoxic to salmonids and other fishes (Appendix B. Table 2). While some studies reported that sublethal concentrations of glyphosate had little effect on salmonids (Folmar et al. 1979; Morgan and Kiceniuk 1992), other studies indicate sublethal concentrations can result in erratic swimming, rapid respiration, temporary loss of olfaction, and avoidance behavior (Morgan et al. 1991; Tierney et al. 2006; Tierney et al. 2007). Glyphosate would also be considered slightly to practically nontoxic to other aquatic species including tadpoles, frogs, midges, and crustaceans (Appendix B. Table 3). Mussel larvae and juveniles appear to be the most sensitive and glyphosate would be considered moderately toxic to these species and life forms.

As stated above the surfactant R11 can be more toxic than glyphosate. Although data on the toxicity of R11 is limited, it suggests that R11 is more toxic to fish and other aquatic species than glyphosate (Appendix B. Table 4). However, it is unlikely that measurable amounts of glyphosate, R11, or its degradation products will enter the Klamath and Scott rivers or their tributaries. Additionally, glyphosate and NPE dissipate rapidly in natural systems. Therefore, any potential introduction of glyphosate or R11 into these water bodies is expected to be minimal and not result in concentrations that approach even sublethal concentrations.

Glyphosate is highly water soluble and it does not readily bioaccumulate in the tissues of fish (Wang et al. 1984; Giesy 2000). Therefore, repeated applications of glyphosate are not expected to impact fish over time. Bioaccumualtion of glyphosate in other aquatic species and R11 in general are not well understood.

Direct effects to terrestrial wildlife and birds include exposure to glyphosate from direct spray. As workers will have to access each treatment area by foot, it is expected that most wildlife will vacate the immediate area of an application. Exceptions to this assumption would likely include species of low mobility including terrestrial-phase amphibians and avian nestlings. Amphibian skins are highly permeable to glyphosate (Quaranta et al. 2009), making direct contact a concern. Because the majority of the areas to be treated are small and project standards and guidelines will minimize drift, it is unlikely that amphibians will be sprayed directly. Additionally, herbicide treatments will occur after the breeding season for most avian species. Thus, direct effects to wildlife are not expected to be significant.

Indirect effects would include the ingestion of contaminated vegetation or prey, contact with contaminated vegetation, or herbicide-induced changes in vegetation. Due to their life histories and habitat requirements, small mammals would likely have the greatest exposure to these effects. A large body of information exists regarding the toxicity of glyphosate to small mammals. McComb et al. (2008) reported high intraperitoneal LD_{50} values (dose of a material that results in mortality of 50 percent of test organisms) ranging from 800 to 1370 mg/kg of body weight across the small mammal community in the Oregon Coast, indicating that glyphosate has a relatively low toxicity to small mammals. Several studies report little to no adverse effect on small mammal populations over time under various application methods and exposure rates (Ritchie et al. 1987; Sullivan 1990; Sullivan et al. 1997; Cole et al. 1998) other than those attributed to herbicide-induced changes in vegetation (D'Anieri et al. 1987; Santillo et al. 1989), suggesting the potential effects of ingestion and contact with contaminated vegetation or prey are insignificant or short term.

Little information exists on the effect of glyphosate to large mammals including ungulates. However, Leafy spurge is not regularly consumed by ungulates and project standards and guidelines will ensure exposure to non-target flora that may be consumed by ungulates is limited.

The EPA classifies glyphosate as slightly toxic to birds (EPA 2008) (Appendix B. Table 5). While studies indicate that high concentrations of glyphosate (>4500 ppm) in ingested foods can cause weight loss in birds, concentrations up to 833 ppm of technical grade glyphosate in ingested foods had no effect on growth and reproduction of bobwhite quail and mallard ducks (EPA 2008). As with other terrestrial species, the major impact to birds appears to be herbicide-induced changes in habitat (Santillo et al. 1984; Easton and Martin 1998).

Available data on honey bees and other arthropods indicates that there is a low potential for glyphosate to cause direct toxic effects. However, glyphosate has been shown to impact food consumption, behavior and reproductive capacity (Benamu et al. 2010; Schneider et al. 2009).

The toxicity of R11 to terrestrial wildlife and birds is not known. However, based on the studies of aquatic species it is reasonable to assume that R11 is also more toxic to terrestrial wildlife and birds than glyphosate.

Proposed treatment areas are small and distributed over 60 river miles. Therefore, any adverse effects to terrestrial wildlife and birds would not be concentrated and the potential for direct contact is reduced. Additionally, project standards and guidelines will limit the exposure to non-target flora, which will minimize impacts to habitat and forage. Consequently, any adverse effects of the proposed treatments are expected to be insignificant.

Human Health and Safety: Glyphosate is of relatively low oral and dermal acute toxicity and has been placed in Toxicity Category III for these effects (Toxicity Category I indicates the highest degree of acute toxicity and Toxicity Category IV the lowest) (EPA 1993). Exposure to concentrated product and inhalation of spray mist can cause eye and skin irritation and oral or nasal discomfort. However, any permanent ocular or dermal damage is very rare (Williams et al. 2000; Bradberry et al. 2004). EPA has also categorized glyphosate as a Group E oncogen – one that shows evidence of non-carcinogenicity for humans (EPA 1993).

Individuals potentially exposed to glyphosate would include workers and the general public. All SCDA treatment personnel are trained by a Qualified Applicator Certificate holder on appropriate application techniques, safety precautions, and herbicide label requirements. To protect workers and minimize exposure, all treatment personnel will be required to wear personal protective clothing and eyewear and complete a "Pesticide Safety Training Program" prior to working with equipment, mixing and loading, and treatment activities. Therefore, potential exposure to workers applying glyphosate will be effectively minimized.

All proposed treatments will occur on private lands and only with landowner consent. All landowners have been briefed on the herbicides to be used, application methods, and necessary or prudent precautionary measures during and following treatment. Upon request, landowners are provided with a copy of the herbicide label. Because all treatments will occur on private lands, which are not accessible by the general public, there is no expected exposure to the general public.

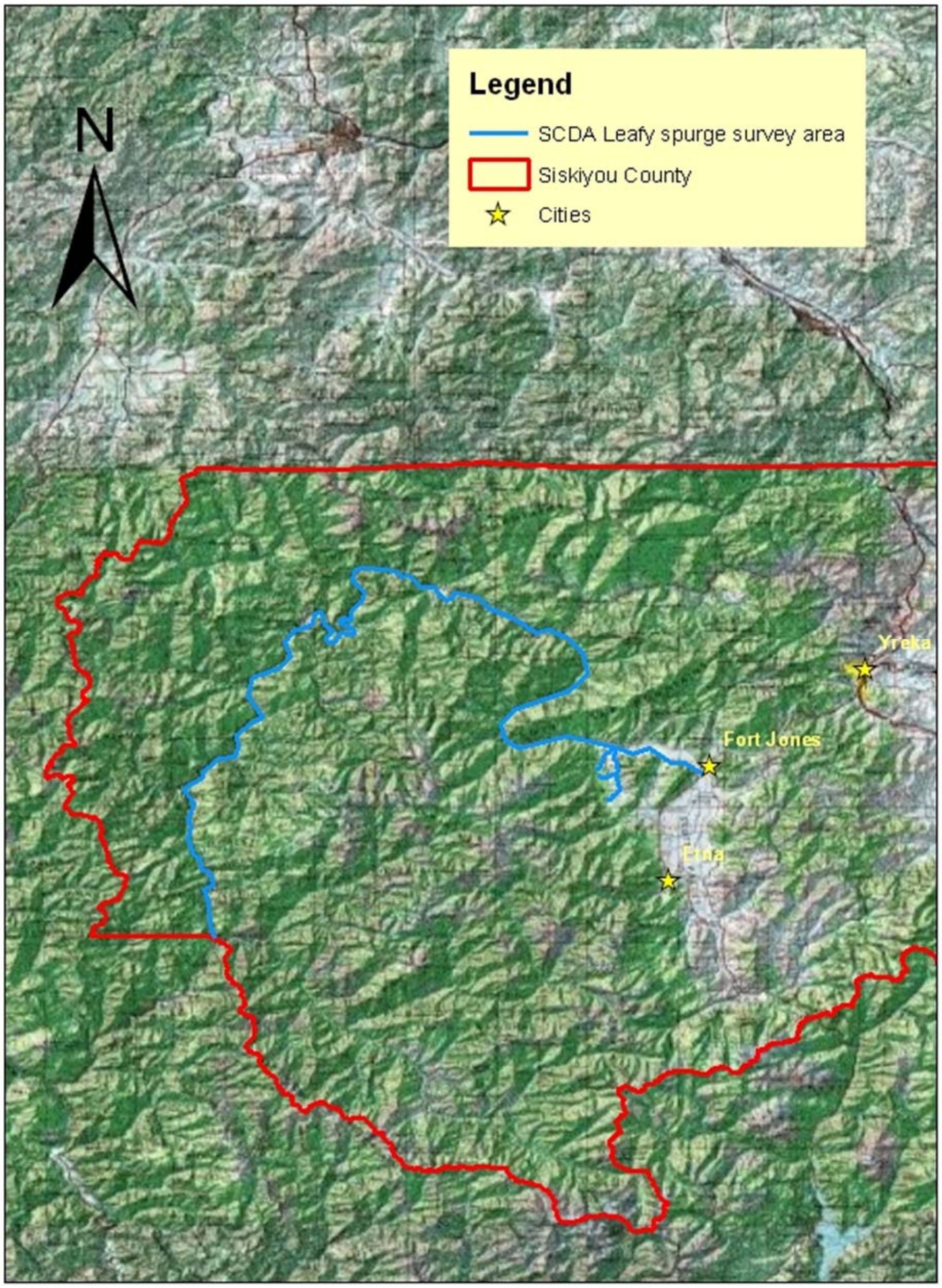
Cumulative Impacts

The majority of public lands along the Klamath and Scott rivers and in Quartz Valley are managed by the Klamath National Forest. The Klamath National Forest does not use herbicides to treat weeds on their property. Private landowners may use over-the-counter weed control that contains glyphosate to control weeds on their property. However, private lands within the Klamath and Scott river basins and Quartz Valley areas are rural and not densely populated. Therefore, the cumulative effects of herbicides containing glyphosate are expected to be negligible.

9). Summary Table of Alternatives

General	**Alternative 1**: No Action	**Alternative 2**: Biological and Manual Control	**Alternative 3**: Biological, Manual, and Herbicide Control
Acres treated annually	2	20-24	Up to 72
Overall potential to meet purpose and need	Low	Low to Moderate	Moderate to High
Environmental consequences			
Impacts to soil quality	No direct impacts. Likely indirect impacts at sites where Leafy spurge is not treated.	Likely but limited or short-term direct impacts. Indirect impacts same as Alt 1.	Direct impacts same as Alt 2.
Impacts to botanical species	No direct impacts. Likely indirect impacts at sites where Leafy spurge is not treated.	Localized but no direct impacts to sensitive species from tarping. Indirect impacts same as Alt 1.	Unlikely or negligible direct impacts.
Impacts to water quality	No direct impacts. Potential indirect impacts at sites where Leafy spurge is not treated.	Potential short-term direct impacts from digging. Indirect impacts same as Alt 1.	Unlikely or negligible direct or indirect impacts.
Fish and wildlife	No direct impacts. Likely indirect impacts at sites where Leafy spurge is not treated.	No direct impacts. Likely but limited or short-term direct impacts. Indirect impacts at sites where Leafy spurge is not treated same as Alt 1.	No direct impacts to fish or other aquatic species. Unlikely or negligible indirect impacts to fish or other aquatic species. Unlikely or negligible direct or indirect impacts to terrestrial wildlife.
Human health and safety	No impact.	Low potential for worker injury.	Low potential for worker injury. Very low potential for public exposure.

Map 1. General area surveyed by the Siskiyou County Department of Agriculture for Leafy spurge in 2010 and 2011. Proposed treatment areas include only the private lands within the surveyed area.



Appendix A. Results and assumptions for the GLEAMS modeling exercise simulating a worst case scenario following an herbicide treatment.

Table 1. Result of GLEAMS model for pesticide losses due to runoff, sediment, and percolation.

Pesticide Losses						
Pesticide	Runoff		Sediment		Percolation	
Glyphosate	G/HA	% App.	G/HA	% App	G/HA	%App
	0.0000	0.00	0.0000	0.00	0.0000	0.00

Model assumptions

This modeling exercise simulated a summer thunderstorm that deposited two inches of rain on the same day two acres of leafy spurge we treated with an herbicide containing glyphosate. The GLEAMS model requires the input of four categories of parameters; climate, pesticide, hydrology, and erosion, to estimate the amount of herbicide lost from runoff and sediment following a rainfall event. Listed below are the key assumptions made for each of these categories.

Climate Parameters: The precipitation data file consisted of a single, two inch rainfall occurring on 8/1/2011.

Pesticide (Glyphosate) Parameters:

Water solubility: 500,000 mg/L (based on Messersmith 2007)

Foliar half-life: 10 days (median values from Mortensen et al. 2008; Newton et al. 1984; and Willis and McDowell 1987)

Herbicide residue: 0 (Due to short foliar and soil half-lives it was assumed that there was no herbicide residue present from any previous applications when simulation begins).

Fraction of pesticide applied to foliage: 0.8 (fraction of herbicide estimated to come in contact with Leafy spurge during application; from J. Aceves pers.comm)

Fraction of pesticide applied to soil: 0.2 (fraction of herbicide that does come in contact with Leafy spurge during application)

Application rate: 4lbs active ingredient per acre (maximum application rate under EPA approved label)

Hydrology Parameters:

Drainage area: 2 acres (For this simulation the area treated with herbicides consisted of a 25 foot wide strip totaling 2 acres and represents the maximum number of acres that could be treated in a day. The drainage area for this simulation was synonymous with and included only the two acres treated with herbicides).

Fraction of plant available water when simulation begins: .5 (model range 0 = dry wilting point and 1 = wet to field capacity; assumed that riparian areas in mid-summer would have median value between fully wetted and wilting point)

Slope of drainage area: 20 percent

Longest flow path in drainage area: 25 feet

Organic matter content of soil: 2 percent of soil mass

Soil porosity (ratio of pore space per unit volume of soil): .4 in^3/in^3 (model range for hydrologic soil group A 0.30 to 0.50)

Field capacity of soil horizon (water retention value): 0.11 in/in (model range 0.11 for coarse sandy soils to 0.40 for silty clay soils).

Erosion Parameters:

Specific surface area for clay particles: $400m^2g$ (model range 20 to 800)

Soil loss ratio for overland flow profile segment: 0.4 (model range 0.01 for bare soil to 1 for dense vegetation cover; assumed moderate vegetation cover for this simulation)

Hydraulic roughness: 0.05 (model range 0.01 to 0.4; assumed moderate vegetation cover for this simulation)

Appendix B. Tables

Table 1. Observed 96-hour LC_{50} values for technical grade Glyphosate at different dilutions[1]

Fish species	Water pH 6.3	pH 7.2	pH 8.2
Coho salmon (*Oncorhyncus kisutch*)	27 mg a.e./L	36 mg a.e./L	210 mg a.e./L
Chinook Salmon (*Oncorhyncus tshawytscha)*	19 mg a.e./L	30 mg a.e./L	211 mg a.e./L
Rainbow trout (*Oncorhyncus mykiss*)	10 mg a.e./L	22 mg a.e./L	220 mg a.e./L
Bluegill sunfish (*Lapomis macrochirus*)	Average 99.6; Range 92-107 mg/L (pH unknown)[2]		

[1]Data from Wan et al. 1989.

[2] SERA 2011.

Table 2. EPA toxicity classifications for aquatic and avian species (from Giesy et al. 2000).

U.S. EPA toxicity classification	Acute aquatic LC_{50} or EC_{50} (mg/L)	Avian dietary LC_{50} (mg/kg)
Practically nontoxic	>100	>5000
Slightly toxic	>10, ≤ 100	>1000,≤5000
Moderately toxic	>1, ≤10	>500,≤1000
Highly toxic	≥0.1, ≤1	.50,≤500
Very highly toxic	≤0.1	<50

Table 3. Observed 48- and 96-hour LC_{50} values for other aquatic species exposed to glyphosate.

Species	Exposure	Acid/salt	Response
Mussel (*Lampsilis siliquoidea*)[1]	48 hours 96 hours	Glyphosate IPA	Larvae 5.0 mg a.e/L Juvenile 7.2 mg a.e/L
Mussel (*Lampsilis siliquoidea*)[1]	48 hours 96 hours	Technical grade glyphosate acid	Larvae >200 mg a.e/L Juvenile >200 mg a.e/L
Crustacean (*Daphnia magna*)[2]	48 hours	Glyphosate acid 95.6 %	Average 128; Range 95-172 mg/L
Crustacean (*Daphnia magna*)[2]	48 hours	Glyphosate acid 83 %	Average 647; Range 577-725 mg/L
Midge (*Chironomous plumosus*)[3]	48 hours	Glyphosate acid 96.7 %	Average 55; Range 31-97 mg/L
Tadpoles (*Litoria moorei*)[4]	48 hours	Glyphosate acid	Average 81; Range 76-86 ma a.e./L in deionized water Average 121; Range 111-133 mg a.e./L in lake water
Tadpoles (*Litoria*	48 hours	Glyphosate IPA	>343 mg a.e./L

moorei and *Lymnodynastes dorsalis*)[4]			
Sign-bearing froglet (*Crinia insignifera*)[4]	48 hours	Glyphosate acid	Average 83; Range 67-103 mg a.e./L in deionized water
Green frog (*Rana clamitans*)[5]	96 hours	Glyphosate IPA salt	>17.9 mg a.e./L

[1]Data from Bringolf et al. 2007.

[2]Data from SERA 2011.

[3]Data from Folmar et al. 1979.

[4]Data from Mann and Bidwell 1999.

[5]Data from Howe et al. 2004.

Table 4. Observed 48- and 96-hour LC_{50} values for aquatic species exposed to R11.

Species	Exposure	Response
Rainbow trout[1] (*Oncorhyncus mykiss*)	96 hours	3.8 mg/L
Bluegill sunfish[1] (*Lapomis macrochirus*)	96 hours	4.2 mg/L
Daphnia magna[1]	48 hours	19 mg/L
Fathead minnow[2] (*Pimephalus promelas*)	96 hours	5.7mg/L
Sacramento splittail[2] (*Pogonichthys macrolepidotus*)	96 hours	3.9 mg/L
Ceriodaphnia dubia[2]	96 hours	5.7 mg/L

[1] Data from Harman 1995.

[2] Data from Trumbo 2005.

Table 5. Avian acute toxicity for technical grade glyphosate[1].

Species	% active ingredient	LD_{50}/LC_{50} (mg a.e/kg or ppm a.e.)
Bobwhite quail (*Colinus virginianus*)	83	LD_{50} >3196 mg a.e./kg body weight
Bobwhite quail (*Colinus virginianus*)	98.5	LC_{50} >4570 ppm
Mallard duck (*Anas platyrhychos*)	98.5	LC_{50} >4570 ppm
Mallard duck (*Anas platyrhychos*)	95.6	LC_{50} >4971

[1] Data from EPA 2008.

Appendix C. Siskiyou County Department of Agriculture Noxious Weed Consent Agreement

SISKIYOU COUNTY DEPARTMENT OF AGRICULTURE
Noxious Weed Consent Agreement

This Consent/Agreement is made and entered into between the Siskiyou County Agricultural Commissioner (hereinafter designated collectively as "Commissioner") and ______________________________,
(please check one) ☐ Owner/Operator or ☐ Lease/Renter (hereinafter designated as "Cooperator").

Consent is hereby given by the Cooperator to the Commissioner, agents, employees and contract crew to enter upon the following described premises owned or controlled by the Cooperator for the purpose of surveying and treating described lands for the control of targeted noxious weeds. Such premises being more particularly described as follows (please print all information except signature):

______________ ______________ ______________
Property Name Property Address City

____
Property Description (if property address does not give adequate property location or property does not have an address)

______________ ______________ ______________
Name: ☐ Owner/Operator or ☐ Lease/Renter Address (if different than property address) City

______________ Is the property access locked? ☐ Yes, ☐ No. ______________
Phone # (Daytime) (if yes, please provide a key or appropriate property access information)

Request contact prior to entering property: ☐ Yes, ☐ No. ______________
(if yes, please provide name and daytime phone number of person to contact, if other than above name and phone number)

In accordance with the provisions of Chapter 6 of Division 4, commencing with Section 5401, of the Food and Agricultural Code of the State of California, it remains the landowner's responsibility to eradicate the noxious weeds on said property. This agreement shall in no way affect or eliminate cooperator's obligations pursuant to law including, but not limited to, the obligation to maintain and to remove such weeds. All noxious weed pest control operations conducted by the Commissioner pursuant to this agreement shall be under the sole direction of Commissioner. Commissioner will furnish the necessary materials and/or control methods and provide supervision for said operations at no cost to the undersigned Cooperator.

In consideration whereof Cooperator agrees:
1. That the Siskiyou County Agricultural Commissioner shall be allowed at all reasonable times to carry out all necessary and reasonable measures for the purpose of eradication of noxious weeds and to perform such acts as may seem necessary and proper to assist in this effort.
2. To release, indemnify, defend and save harmless the county of Siskiyou, its officers, agents and employees from any and all claims, expenses, causes of relating to or arising out of the activities performed pursuant to this agreement.
3. To notify all other parties on said property that the Commissioner will be entering said property for the purpose of weed survey and eradication and that future property entrance shall continue in effect for as long as targeted noxious weeds are on or are potentially on said premises.

This request and consent may be canceled by the undersigned property owner at any time hereafter upon giving two (2) days notice in writing, delivered to the Siskiyou County Agricultural Commissioner, 525 South Foothill Drive, Yreka, California 96097. Furthermore, Commissioner may terminate this agreement immediately upon oral notice should funding cease or be materially decreased.

______________________________ ______________
Cooperator Signature (if different from above printed names, please add printed name to signature, plus phone number) Date
☐ Verbal consent of cooperator (check this box if received verbal consent in lue of a signature, date above is date consent was given).

By: ______________ ______________ ______________
Agricultural Commissioner or agent signature Print Name Date

Target species: ______________ Area: ______________

Information supplied to Cooperator (check all that apply): ☐ Flyer (species information), ☐ Herbicide product label(s),
☐ Species and product information verbally discussed with Cooperator. Additional comments: ______________

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