11. APPENDICES

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11.1 – Herbicide Mixture Analysis

The analysis of herbicide mixtures for site-specific projects would be performed according to the process described below. Under specified conditions, dose addition analysis is believed to provide a reasonable estimate of the cumulative toxicity of chemical mixtures. Standard #16 of the Proposed Action limits mixtures to three herbicides or fewer. When toxicity data is available for surfactants or other inert ingredients, that data should be included in the mixture analysis.

Dose addition is considered most appropriate for mixtures with components that affect the same endpoint by the same mode of action, and are believed to behave similarly with respect to uptake, metabolism, distribution, and elimination (Choudhury et al., 2000). The precise toxic mechanism(s) in fish are not clearly documented for the 10 herbicides contained in the proposed action, but effects to the kidney and liver are typical endpoints in terrestrial wildlife. In addition, it is known that the proposed herbicides have bioconcentration factors that fall within a range that does not indicate bioconcentration risk (all BCF <32), are relatively soluble, and their chemical structure indicates that they are likely to behave similarly in salmonids. Thus, it is believed that the assumption of similar uptake, metabolism, distribution, and elimination is adequately met in fish for dose-addition analysis at low concentrations.

Dose addition analysis is also a reasonable assumption when analyzing mixtures of chemicals with different or unknown toxicity mechanisms, when expected doses will be below known toxic levels (ATSDR, 2004). This is also supported by data from Feron et al. (1995), as cited in EPA (Choudhury et al., 2000), which showed interaction when mixture chemical components were present in concentrations at or near their respective LOAELs. No interaction was observed between chemical components when present at concentrations 1/10 or 1/3 or their respective LOAELs.

The dose addition analysis described in this document is believed to produce conservative estimates of mixture toxicity for several reasons. First, the assumption of dose addition in itself is conservative; the dose addition protocol assumes an additive response for all chemicals in the mixture, when in fact some chemicals may produce independent, non-additive responses. For example, the EPA description of dose addition analysis in Choudhury et al. (2000) states that separate dose addition analyses should be performed for each affected organ. The protocol described here utilizes one hazard index (HI) that includes all herbicides, regardless of toxicity site, potentially resulting in a higher HI value than if mixture components were analyzed in smaller groups by affected organ. In addition, by using a "level of concern" for the HI of 0.1, rather than the 1.0 specified by the EPA (Choudhury et al. 2000), an "uncertainty factor" of 10 is incorporated. This is in addition to the "uncertainty factors" (of 20 for endangered aquatics, and 10 for non-endangered) incorporated into calculation of the individual HQs.

The primary sources of uncertainty in utilizing dose addition analysis in the proposed manner are the lack of mixture analysis studies utilizing more than two chemicals, and the lack of information regarding toxicological mechanisms for the 10 proposed herbicides in fish. The uncertainty risk, with respect to the lack of information on mixtures involving more than two chemicals, increases with the number of mixture components. Likewise, since little information is available on toxicity mechanisms in fish, uncertainty regarding toxicity mechanism interactions will increase with an increasing number of mixture components. In an effort to minimize these risks, the proposed action states the mixtures will contain no more than three active herbicide ingredients.

The hazard index method of assessing dose addition described below is relatively simple and straightforward. The approach is used or recommended by a number of agencies, including EPA, National Academy of Sciences, National Research Council, and Occupational Health and Safety Administration (ATSDR, 2004). The process essentially consists of calculating a hazard quotient (HQ) for each mixture component, and subsequently summing the HQs to create a HI. If the HI is < 0.1, then an acceptable level of mixture toxicity risk is assumed to be present. A HI would be calculated to assess potential effects to fish, aquatic invertebrates, algae, and aquatic macrophytes. Calculation of the HQ proceeds as described in the USFS contracted herbicide Risk Assessments prepared by Syracuse Environmental Research Associates (and discussed in detail in the effects analysis portion of this document) - the HQ is the ratio of the anticipated level of exposure to a level of exposure associated with a toxicity metric. The lowest available NOAEC (either measured or estimated) is the metric to be used in this analysis. Once the HQ for each component of the mixture has been calculated, then the HQs are summed to produce the HI. The HQ values for the standard exposure scenarios used in the SERA risk assessments are available in the project file. If the HI of the herbicide mixture is ≥ 0.1 for listed aquatic species, then further analysis of the exposure scenarios (calculation of the environmentally expected concentration portion of each HQ) should be conducted to ensure their accuracy. The SERA risk assessments (and other relevant literature sources) should be consulted to determine the degree to which fate and transport factors and site-specific design features may ameliorate herbicide delivery. If the HI remains ≥ 0.1, then the mixture is unacceptable to use under Standard #16.

Literature Cited

ATSDR (Agency for toxic substances and disease registry). 2004. Public Health Assessment Guidance Manual.

Choudhury, H. Cogliano, J., Hertzberg, R., Mukerjee, D., Rice, G., and Teuschler, L. 2000. Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures. U.S. Environmental Protection Agency. Washington, DC 20460

Feron, VJ; Groten, JP; Jonker, D; Cassess, FR; van Bladeren, PJ. (1995) Toxicology of chemical mixtures: challenges for today and the future. Toxicology 105:415-427.

11.2 – Hazard Quotient Summary for Aquatic Species

WORKSHEETS FOR THREATENED OR ENDANGERED FISH
Invasive Plant EIS Biological Assessment

Hazard Quotients for Herbicides in the Proposed Action
Invasive Plant EIS, USDA Forest Service
Region 6, Portland OR 29-Mar-05

The worksheets used to produce the hazard quotient numbers in the table below use either 1/20th of the acute LC50, following protocol of EPA (2004), or a lower acute or chronic NOEC, for the acute toxicity index. These values were reviewed and agreed to by Shawna Bautista, USDA Forest Service and Rick Golden, NOAA Fisheries, for use in assessing risks to threatened and endangered fish, while attempting to account for uncertainty regarding sublethal effects.

For assessing chronic risk to listed fish, water concentrations were estimated for a 90-day interval using flowing streams (the types of habitats in which our listed aquatic species occur). Exposures of concern were not plausible, so chronic exposure risk was not evaluated further. The worksheets for calculating the hazard quotient values and the chronic toxicity screen are included in the analysis file.

Literature Cited

EPA. 2004. Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs – Endangered and Threatened Species Effects Determinations.

Table 11.2-1. Toxicity indices for listed fish used in the effects analysis for the BA.

Indices represent the most sensitive endpoint from the most sensitive species for which adequate data are available. Numbers in red indicate the toxicity index used in calculating the hazard quotient for exposures to listed fish. Generally, the lowest toxicity index available for the species most sensitive to effects was used. Measured chronic data (NOEC) was used when they were lower than 1/20th of an acute LC50 because they account for at least some sublethal effects, and doses that are protective in chronic exposures are more certain to be protective in acute exposures.

Herbicide	Duration	Endpoint	Dose	Species	Effect Noted at LOAEL
Chlorsulfuron	Acute	NOEC	2 mg/L (1/20th of LC50)	Brown trout	LC50 at 40 mg/L
	Chronic	NOEC[1]	3.2 mg/L	Brown trout	rainbow trout length affected at 66mg/L
Clopyralid	Acute	NOEC	5 mg/L (1/20th of LC50)	Rainbow trout	LC50 at 103 mg/L
	Chronic				none available
Dicamba	Acute	NOEC	1.4 mg/L (1/20th LC50)	Rainbow trout	LC50 at 28 mg/L
	Chronic				none available
Glyphosate (no surfactant)	Acute	NOEC	0.5 mg/L (1/20th/LC50)	Rainbow trout	LC50 at 10 mg/L
	Chronic	NOEC	2.57 mg/L[2]	Rainbow trout	Life-cycle study in minnows; LOAEL not given
Glyphosate with POEA surfactant	Acute	NOEC	0.065 mg/L (1/20th of LC50)	Rainbow trout	LC50 at 1.3 mg/L for fingerlings (surfactant formulation)
	Chronic	NOEC	0.36 mg/L	salmonids	estimated from full life-cycle study of minnows (surfactant formulation)
Imazapic	Acute	NOEC	100 mg/L	all fish	at 100 mg/L, no statistically sig. mortality
	Chronic	NOEC	100 mg/L	fathead minnow	No treatment related effects to hatch or growth
Imazapyr	Acute	NOEC	5 mg/L (1/20th LC50)	trout, catfish, bluegill	LC50 at 110-180 mg/L for North American species
	Chronic	NOEC	43.1 mg/L	Rainbow	"nearly significant" effects on early life stages at 92.4 mg/L
Metsulfuron methyl	Acute	NOEC	10 mg/L	Rainbow	lethargy, erratic swimming at 100 mg/L
	Chronic	NOEC	4.5 mg/L	Rainbow	standard length effects at 8 mg/L
Picloram	Acute	NOEC	0.04 mg/L (1/20th LC50)	Cutthroat trout	LC50 at 0.80 mg/L
	Chronic	NOEC	0.55 mg/L	Rainbow trout	body weigh and length of fry reduced at 0.88 mg/L

Table 11.2-1. Toxicity indices for listed fish used in the effects analysis for the BA.

Indices represent the most sensitive endpoint from the most sensitive species for which adequate data are available. Numbers in red indicate the toxicity index used in calculating the hazard quotient for exposures to listed fish. Generally, the lowest toxicity index available for the species most sensitive to effects was used. Measured chronic data (NOEC) was used when they were lower than 1/20th of an acute LC50 because they account for at least some sublethal effects, and doses that are protective in chronic exposures are more certain to be protective in acute exposures.

Herbicide	Duration	Endpoint	Dose	Species	Effect Noted at LOAEL
Sethoxydim	Acute	NOEC	0.06 mg/L (1/20th LC50)	Rainbow trout	LC50 of Poast at 1.2 mg/L
	Chronic	NOEC			none available
Sulfometuron methyl	Acute	NOEC	7.3 mg/L	Fathead minnow	No signs of toxicity at highest doses tested
	Chronic	NOEC	1.17 mg/L	Fathead minnow	No effects on hatch, survival or growth at highest doses tested
Triclopyr acid	Acute	NOEC	0.26 mg/L (1/20th LC50)	Chum salmon	LC50 at 5.3 mg/L[3]
	Chronic	NOEC	104 mg/L	Fathead minnow	Reduced survival of embryo/larval stages at 140 mg/L
Triclopyr BEE	Acute		0.012 mg/L	Bluegill sunfish	LC50 at 0.25 mg/L
	Chronic[4]	NOEC	104 mg/L	Fathead minnow	Reduced survival of embryo/larval stages at 140 mg/L
2,4-D	Acute (ester)	NOEC	0.05 mg/L (1/20th LC50)	several species	LC50 at 1 mg/L
	Chronic (amine)	NOEC	10 mg/L	sunfish	LOEC not reported
NPE Surfactants	Acute[5]	NOEC	0.2 mg/L (1/20th LC50)	fathead minnow, rainbow trout	LC50 at 4.0 mg/L
	Chronic[6]	NOEC	1.0 mg/L	trout	no LOEL given

1 Chronic value for brown trout (sensitive sp.) was estimated using relative potency in acute and chronic values for rainbow trout, and the acute value for brown trout.

2 Estimated from minnow chronic NOEC using the relative potency factor method (SERA Glyphosate 2003).

3 Using Wan et al. (1989) value for lethal dose.

4 Chronic and subchronic data for triclopyr are limited to triclopyr TEA. No data is available for triclopyr BEE.

5 Exposure includes small percentage of NP and NP1-2E (Bakke, 2003).

6 Chronic exposure is from degredates NP1EC and NP2EC, because NPE breaks down rapidly and NPEC's are more persistent (Bakke, 2003).

These values were reviewed and agreed upon by Shawna Bautista, USDA Forest Service, and Rick Golden, NOAA Fisheries on March 18, 2005.

11.3 – GLEAMS Ecotype Analysis

Ecotype Influence on Risk Assessment Predictions of Herbicide Concentrations in Surface Water

Herbicide effects to stream aquatic resources from ground-based application methods was analyzed by SERA in a hypothetical scenario designed to represent a plausible "worst case" application that was expected to occur in National Forests nationwide. This application scenario was analyzed in risk assessments for each of the 10 herbicides included in the Proposed Action using the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) chemical fate model. The SERA risk assessments are accessible via the internet at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml. The hypothetical application scenario analyzed in each SERA document was even application of the herbicide (with no streamside buffers) to a 10 acre site, adjacent to a stream with a discharge of 1.8 cubic feet per second (cfs). Three input parameters were varied, soil type (clay, loam, sand), rainfall (5-250 inches), and herbicide application rate to display how stream herbicide concentrations could vary under different conditions. Typical herbicide application rates were based on reported Forest Service use, while high application rates were either the highest application rate allowed under the label or the highest application rate reported for Forest Service use.

National Forest System lands administered by USFS Region Six have local environmental conditions that may vary considerably from the default input parameters used for the GLEAMS model in the SERA risk assessments. While the GLEAMS modeling contained in the SERA risk assessments fulfills the objective of accomplishing a general assessment of the risks associated with use of the 10 herbicides considered in the Proposed Action in a nationwide context, it is also recognized that considerable variation exists in different National Forests across the nation. Some environmental parameters have the potential to significantly influence herbicide stream concentrations. Examples include site slope, timing of rainfall, more complex and varied soil structure, ground cover, temperature, and size and shape of application site. The GLEAMS model contains input variables for all of these parameters. In some cases fixed input values were used, and in other cases no values were entered for these parameters. In addition, stream flows vary widely, and may be less than or considerably greater than 1.8 cfs. Since the SERA risk assessments assumed no herbicide loss through breakdown, consideration of the influence of temperature on herbicide breakdown rate is not relevant.

The analysis contained in this document attempts to assess how local variation for some of these input parameters may influence model output (stream herbicide concentration). Since the GLEAMS model was developed for row crop agriculture analysis, certain input parameters may not be utilized in the manner most appropriate for analysis of herbicide delivery from applications in montane forests. The default parameters used in the SERA risk assessment modeling for fixed inputs include 10 percent for slope, rainfall timing of once every 10 days, a single soil layer (horizon), sparse grass for ground cover, 1.8 cfs for stream flow, and a 10 acre square for an application site. The input parameters selected for comparison are slope, soil types, rainfall, vegetation cover, and streamflow. These input parameters were selected because they can exert considerable influence over model output.

The five ecotypes selected to represent local environmental conditions within USFS Region Six are coastal mountain ranges, western Cascades, eastern Cascades, eastern Oregon and Washington grasslands, and the Blue Mountains. These five areas are believed to provide a general representation of the environmental diversity present within USFS Region Six, while recognizing that considerable variation can occur within each ecotype. For purposes of this analysis, a watershed within each ecotype with sufficient local environmental information was selected. Local environmental information was obtained from USFS watershed analysis documents and other sources.

The relevance of the influence of local variation in the input parameters on model output was determined by considering three questions: (1) would the model output be expected to change, (2) if output change is expected, is the change positive or negative, and (3) if there is an expected positive change (herbicide concentration expected to increase), would it be expected to make a difference to ESA listed aquatic species?

If the analysis using local input parameters indicates that an increase in predicted herbicide concentration may occur, then that herbicide would be subjected to a screen that would indicate whether there was a potential for an increased concern for listed aquatic species. The screen is summarized below in Table 11.3-1. Table 11.3-2 of the “indirect effects” analysis portion of the BA displays instances where the hazard quotient (HQ) exceeded the “level of concern” (LOC) for each species group as a result of predicted herbicide concentrations in the SERA risk assessments. The LOC was defined as when the hazard quotient exceeded a value of 1. The hazard quotient (HQ) is defined as the ratio of the predicted environmental concentration to an effects threshold concentration.

Table 11.3-1. Potential for increased concern for listed aquatic species when use of local environmental factors is likely to increase stream herbicide concentration predictions.

Hazard Quotient Value	**Potential for Concern for Increased Risk to Listed Aquatic Species**	**Site-specific Project Analysis Procedure Recommendation**
[1]HQ >1	Yes	Use local parameters
0.1 ≤ HQ ≤ 1	Likely	Use local parameters
0.01 ≤ HQ < 0.1	Not likely	Use local parameters if project size/intensity > SERA scenario
HQ < 0.01	No	Use of local parameters not necessary

[1] HQ values are located in the Excel worksheets used to create Table 2 in the BA, and are part of the BA analysis file.

If the existing SERA risk assessment concentration predictions resulted in HQ values exceeding 1 for any aquatic species group, then considering local conditions that would result in predictions of higher concentrations would clearly have the potential to increase concern for listed aquatic species. If the SERA risk assessment concentration predictions resulted in HQ values that were ≤ 1, but ≥ 0.1, then considering local conditions are likely to increase concern for listed aquatic species. If the SERA risk assessment concentration predictions resulted in HQ values that were < 0.1, but ≥ 0.01, then considering local conditions would not be likely to increase concern for ESA listed aquatic species. If the SERA risk assessment concentration predictions resulted in HQ values that were < 0.01, then considering local conditions would not result in an increased concern for ESA listed aquatic species.

11.3.1 Coastal Mountains

Site-specific information for analysis of the influence of coast range mountain environmental conditions on predicted herbicide concentrations in surface water was taken from the Yachats/Blodgett Watershed Analysis (Siuslaw National Forest, 1997). The Yachats/Blodgett watersheds are located on the central Oregon coast and are about 38,600 acres in size. It provides a cross section of soil, topography, and environmental conditions found throughout much of the coast range.

Terrestrial invasive plants known to occupy the Yachats/Blodgett area include Scot's broom; Giant, Japanese, and Himalayan knotweed; English ivy; Himalaya and Evergreen blackberry; Reed canary grass; and European beachgrass. Of these species, the knotweed and blackberry species, as well as Reed canary grass are commonly found in riparian areas. All are recommended for treatment, and the local Soil and Water Conservation District is particularly concerned about treating knotweed species. The herbicides triclopyr, glyphosate, picloram, sulfometuron methyl are likely to be used as part of an integrated treatment plan.

About 3 percent of the Yachats/Blodgett area has greater than 60% slope. Over half (55%) of the area has slopes less than 30%. Relative to many areas within the Oregon and Washington Coast Range Province, this area has very gentle relief. In the Yachats/Blodgett area, as with other areas within the province, gentle slopes are found on the valley bottoms of large perennial streams. Slopes above valley bottoms, and slopes draining to smaller perennial and intermittent streams are steeper. Thus, including values for local slopes into the model have the potential to slightly decrease modeled stream herbicide concentration predictions in valley bottoms. Local slopes above valley bottoms, and slopes draining to smaller perennial and intermittent streams have to potential to moderately increase modeled stream herbicide concentration rates.

Soils in the Yachats Blodgett area are moderately deep to very deep, very productive, and well-drained. Silt loams are derived from Yachats Basalt, Tuffaceous Siltstone, and Sandstone formations. These soils are best modeled by loam. Deep gravelly loams are derived from the Tyee formation and are best modeled by sand.

Mass movement of soil is an important ecological process in this area, replacing readily depleted gravels and large wood in streams. Most large landslides originate high in the basin in intermittent or small perennial channels and run out to valley bottoms. Surface layers of these soils tend to be thick and high in organic matter. On slopes greater than 30 percent, surface erosion is especially significant when vegetation is removed. Surface soil erosion is generally precluded by dense vegetation.

Local soil types do not appear to have a high degree of influence on stream delivery for most herbicides, with some exceptions. Invasive plant treatment with on unstable slopes could result in herbicide introduction to streams via mass movement, though most invasive plants are found in relatively flat riparian corridors. It appears that local soil conditions would not significantly change the stream delivery of picloram and sulfometuron methyl from modeled concentrations. The presence of organic matter in the local soils could result in significant overestimation of stream delivery of triclopyr and glyphosate in Yachats/Blodgett area soils.

Average annual precipitation in the Yachats/Blodgett area is 80 to 100 inches. Maximum precipitation occurs from November through May, while minimum precipitation occurs during July through September. Annual precipitation modeled for 100 inches per year would adequately predict water concentration rates. During relatively extreme events, five to seven inches of rain may fall in twenty-four hours. Water concentration rates would be modeled by 200 to 250 inches per year for extreme events.

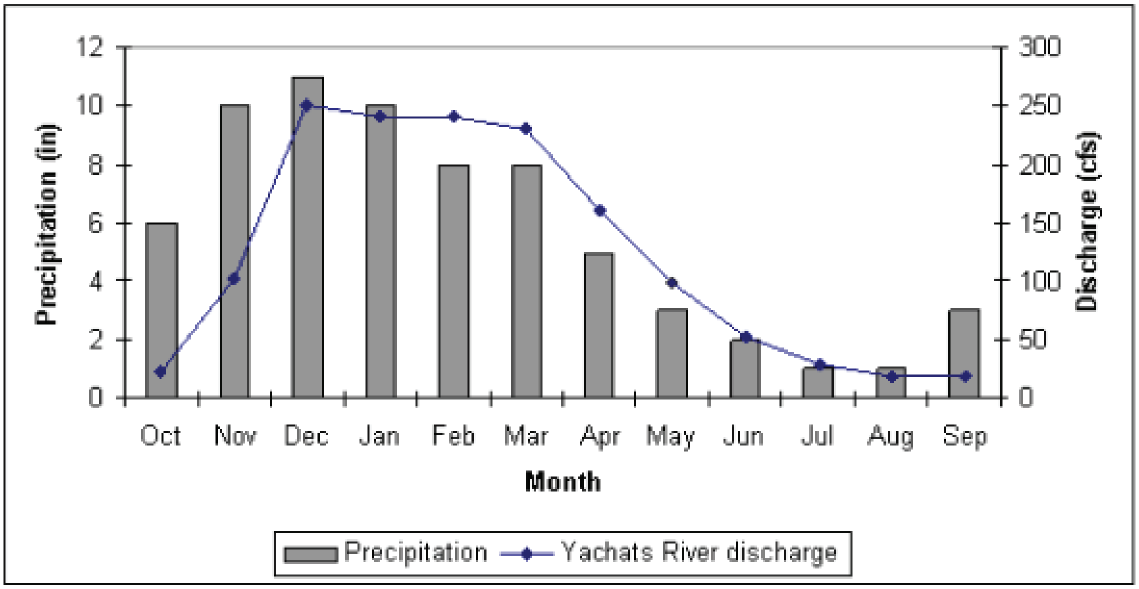

Figure 11.3-1. Comparison of estimated mean monthly flow of Yachats River at mouth, and precipitation at Newport (1910-1996).

Estimated stream low-flow discharge ranges from 4 cfs to 19 cfs at the mouth of the major streams in the Yachats/Blodgett area. Perennial stream density is very high in this area, with less than 100 acres needed to produce a perennial stream. These small perennial streams have very low discharges, particularly during the dry season. For major streams, the 1.8 cfs modeled in the risk assessments adequately models predicted herbicide concentrations. For smaller streams, other factors considered have a more pronounced effect than for larger streams. Discharge in smaller streams is particularly sensitive to the storms that would introduce herbicides. The exception is treatment of roadside invasive species. Local streamflows have the potential to greatly decrease or slightly increase modeled stream herbicide predictions. As displayed in

Figure 11.3-1, average monthly wet season flows, as estimated at the mouth of Yachats River, can vary from summer flows by a factor of about 12, to about 250 cfs.

Figure 11.3-1 shows that stream flow response to storms is strongly related to rainfall. Snow is not common in the area, and most soils are well-drained and convey water to streams promptly. Thus, storms that bring herbicides to streams concurrently increase stream flows soon after the onset of the storm and remain increased for a short time after the storm abates.

Natural disturbance, climate, soils, and human activities have shaped the landscape pattern of plant communities in the Yachats/Blodgett area. Forests grow quickly in the area, and most riparian areas are forested. Exceptions are artificially maintained meadows intended to support game animals, though even these sites are abundantly vegetated. Bare soil is rare in the area, and quickly vegetates once exposed, which prevents most surface erosion. Mixed pine-hardwood forests are modeled, although this is not a particularly sensitive parameter. In most areas, this vegetation type would tend to overestimate the water concentration rate. Some areas infested with invasive plants are monocultures of herbaceous invasive plants, or are immediately adjacent to surface water. The model would tend to underestimate water concentration rates in these circumstances.

Table 11.3-2. Modification of the SERA GLEAMS stream herbicide concentration predictions by local factors in Yachats/Blodgett area.

Herbicide	Slope	Soil Types	Vegetation cover	Rainfall	Streamflow	Potential range of variation	Potential for Increase in Aquatic Species Concern
Picloram	- to +	NC	- to +	NC	NC to +	- to +	Yes – [2]F, M Likely – A Not Likely – I
Glyphosate	- to +	- to [1]NC	- to +	NC	NC to +	- to +	Yes – [3,4]F, [4]I, [4]A Likely – [4]M Not Likely - [3]I
Triclopyr	- to +	- to NC	- to +	NC	NC to +	- to +	Yes – [5]F, [6]I, [5]A, [5]M Likely – [7]I
Sulfometuron methyl	- to +	NC	- to +	NC	NC to +	- to +	Yes – A, M No – F, I

[1] NC = no change.

[2] A = algae, F = fish, M = aquatic macrophytes

[3] without surfactant

[4] with surfactant

[5] BEE and TEA forms

[6] BEE form only

[7] TEA form only

Table 11.3-2 displays how the GLEAMS model predictions of delivery of these herbicides might change if select model input parameters were modified to reflect local conditions. The column "Potential for Increase in Aquatic Species Concern" in Table 11.3-2 displays whether any increase in concern for aquatic species resulted from inclusion of local input parameters. For the coastal mountains, it appears that an increase in potential concern for toxic effects to fish would occur for glyphosate and picloram, to algae for glyphosate, picloram, and chlorsulfuron, and to aquatic macrophytes for metsulfuron and chlorsulfuron. A possible increase in potential concern for toxic effects was identified to algae for metsulfuron, and for aquatic macrophytes for picloram. No changes increases in potential concern for any species group were identified for triclopyr or clopyralid. In general, situations that increased concern for potential effects to aquatic species from the level of risk stated in the risk assessments occurred for smaller stream channels with steeper side slopes, with risk increasing at higher altitudes. Conversely, risk lower than that stated in the risk assessments was identified for larger stream channels at lower altitude, and possibly in smaller stream channels with sideslopes less than 10 percent.

In summary, from Table 11.3-2 and the supporting discussion, it appears that if local input parameters for the Yachats/Blodgett area were used, predicted stream herbicide concentrations may depart from the results reported. In general, risk assessment may underestimate herbicide concentrations in small streams and overestimate herbicide concentrations in larger streams.

In the flatter areas such as valley bottoms, slope is likely to be less than the 10 percent modeled, decreasing stream herbicide concentrations. In almost all other terrain in the watershed, slopes exceed the 10 percent modeled, and herbicide delivery to streams could be expected to increase significantly. As noted above, local soil types do not appear to markedly change expected herbicide delivery for most herbicides likely to be applied in the watershed, with the possible exceptions of triclopyr and glyphosate in organic soils found in the area.

At higher stream flows (larger stream channels or wet season flow conditions), risk assessment model predictions tend to overestimate the herbicide concentration in most local streams. For smaller streams, other factors considered have a more pronounced effect than for larger streams.

Vegetation cover is not a particularly sensitive parameter and does not appear to change water concentration rates, with the exception of herbicides applied to some areas of invasive plants adjacent to streams.

11.3.2 Western Cascades

The Western Cascades Province is bounded on the west by the Willamette Valley and Puget Sound Trough Province; on the east by the Eastern Cascades Province; and to the south by the Southern Cascades Province. The province is distinguished by volcanic activity and glacial history. The region is dominated by humid forests of Douglas-fir and western hemlock.

Site-specific information for analysis of the influence of western cascades environmental conditions on predicted herbicide concentrations in surface water was taken from the Fish Creek Watershed Analysis (Umpqua National Forest, 1999). The Fish Creek watershed is located in southwestern Oregon and is about 53,500 acres in size. It provides a cross section of soil, topography, and environmental conditions found throughout much of the western slopes of the Cascade Mountains.

Invasive plant species known to be present in the Fish Creek watershed and recommended for treatment in the watershed analysis include Scotch broom, tansy ragwort, St. Johnswort, spotted knapweed, bull thistle, and Canadian thistle. The herbicides triclopyr, glyphosate, picloram, metsulfuron, clopyralid, and chlorsulfuron might be applied as part of the integrated treatment plan.

Portions of the Fish Creek watershed can be characterized as relatively steep and dissected mountains. Slopes can exceed 100 percent in steep areas, and side slopes greater than 20 percent are common. However, some locally extensive areas of essentially flat ground (slopes < 5 percent) are also present, and are typically covered with a cap of highly permeable pumice ash flow material. Thus, including values for local slopes into the model have the potential to slightly decrease to moderately to somewhat highly increase modeled stream herbicide concentration predictions. Due to the high soil mobility of clopyralid (high solubility and low sorption to soil particles), it is expected to be the most affected by higher slope values.

Three general groups of soil types are present within the Fish Creek watershed: Western Cascades, High Cascades, and those derived from pumice ash flows. Western Cascades type soils are moderately deep, fine and fine loamy, and derived from residual basalt and clay formations. On slopes greater than 30 percent, surface erosion is especially significant when vegetation is removed. Western Cascade type soils are most closely represented by clay or loam. High Cascades type soils are generally coarse, loamy, and shallow to deep, derived from basaltic andesite, and glacial till and outwash. They usually have low organic matter content and low plant-available water-holding capacities. Soil erosion risk is considered a potential site-productivity hazard, particularly on slopes greater than 30 percent. High Cascade type soils are most closely represented by loam. Pumice ash flow soils are coarse textured and generally provide rapid infiltration, but store relatively high plant-available water. Organic matter content is generally concentrated within 15 to 25 cm of the surface. Pumice ash flow soils are most closely represented by sand. Western Cascades is the dominant soil type within the watershed.

Local soil types do not appear to have a high degree of influence on stream delivery for most herbicides, with some exceptions. It does not appear that local soil conditions would significantly change the stream delivery of metsulfuron, clopyralid, and chlorsulfuron from that modeled in the risk assessments. The presence of some organic matter in the pumice ash flow soils, combined with their strong adsorption properties, could result in significant overestimation of stream delivery of triclopyr and glyphosate in pumice ash flow soils, which would most resemble the "sand" soil classification in the risk assessment modeling.

Average annual precipitation in the Fish Creek watershed is approximately 70 inches. Maximum precipitation occurs during November and December, precipitation minimum occurs during July and August, with October being the transition month between the dry and wet seasons. Annual precipitation modeled for 100 inches per year would adequately predict water concentration rates. During relatively extreme events, up to five inches of rain or equivalent precipitation may fall in twenty-four hours. Water concentration rates would be modeled by 200 inches per year.

Stream low-flow discharges can range from less than 1 cfs to 40 cfs at the creek mouth. The 1.8 cfs modeled in the risk assessments is on the lower end of the range of stream discharges present within the Fish Creek watershed. Local streamflows have the potential to greatly decrease or slightly increase modeled stream herbicide predictions. As displayed in Figure C-2, average monthly wet season flows, as measured in the Fish Creek mainstem, can vary from summer flows by a factor of about 12, to about 500 cfs.

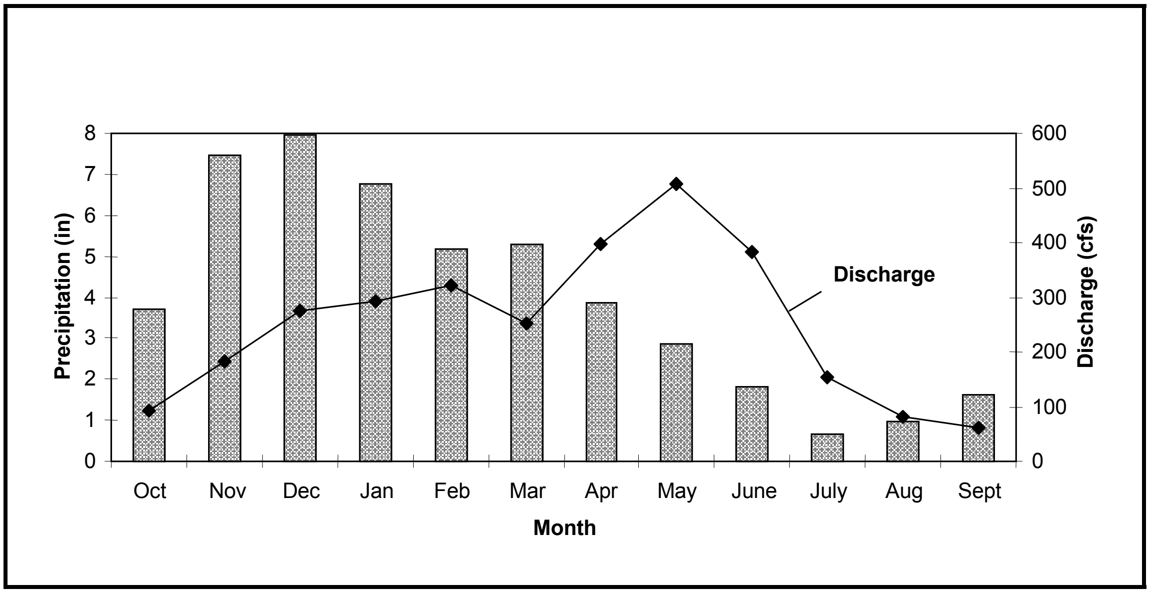

Figure 11.3-2. Comparison of mean monthly flow of Fish Creek (1948-1960) 4.7 miles upstream from outlet, and precipitation at Toketee Falls (1953-1996), elevation of 2,060'.

Figure 11.3-2 shows that stream flow response to storms varies seasonally, and these flows are most relevant to herbicide delivery modeling. Due to the snowmelt in the spring, stream flow can be expected to be at their highest and the risk of storm induced high herbicide concentrations at their lowest. Due to relatively low stream flow following summer and early fall storm events, storms during these periods appear to have the ability to result in the highest stream herbicide concentrations. Locally intense summer thunderstorms would have the potential to result in highest herbicide concentrations in streams, due to low base flow conditions. The more widespread fall rains would have the potential to deliver herbicide to streams flowing slightly above annual low flow conditions, but across a more widespread area than for summer thunderstorms.

Natural disturbance, climate, soils, and human activities have shaped the landscape pattern of plant communities in the Fish Creek Watershed. Forested vegetation is heavily fragmented in some areas within the watershed, with early, mid, and late seral stage forests. Mixed pine-hardwood forests are modeled, although this is not a particularly sensitive parameter. In early seral stage areas, this vegetation type would tend to underestimate the water concentration rate. Some areas infested with invasive plants are not forested, are monocultures of herbaceous invasive plants, or are immediately adjacent to surface water. The model would tend to underestimate water concentration rates in these circumstances.

Table 11.3-3. Modification of the SERA GLEAMS stream herbicide concentration predictions by local factors in Fish Creek watershed.

Herbicide	Slope	Soil Types	Vegetation cover	Rainfall	Streamflow	Potential range of variation	Potential for Increase in Aquatic Species Concern
Picloram	- to +	[1]NC to +	- to +	+	- to +	- to +	Yes – [2]F, M Likely – A Not Likely – I
Glyphosate	- to +	- to NC	- to +	+	- to +	- to +	Yes – [3,4]F, [4]I, [4]A Likely – [4]M Not Likely - [3]I
Metsulfuron	- to +	NC	- to +	+	- to +	- to +	Yes – M Likely – A No – F, I
Clopyralid	- to +	NC	- to +	+	- to +	- to +	Not Likely – A, M; No – F, I
Chlorsulfuron	- to +	NC	- to +	+	- to +	- to +	Yes – A, M Not Likely – F No – I
Triclopyr	- to +	- to [1]NC	- to +	+	- to +	- to +	Yes – [5]F, [6]I, [5]A, [5]M Likely – [7]I

[1] NC = no change.
[2] A = algae, F = fish, M = aquatic macrophytes
[3] without surfactant
[4] with surfactant
[5] BEE and TEA forms
[6] BEE form only
[7] TEA form only

Table 11.3-3 displays how the GLEAMS model predictions of delivery of these herbicides might change if select model input parameters were modified to reflect local conditions. The column "Potential for Increase in Aquatic Species Concern" in Table 11.3-3 displays whether any increase in concern for aquatic species resulted from inclusion of local input parameters. For the western cascades, it appears that an increase in potential concern for toxic effects to fish would occur for glyphosate and picloram, to algae for glyphosate, picloram, and chlorsulfuron, and to aquatic macrophytes for metsulfuron and chlorsulfuron. A possible increase in potential concern for toxic effects was identified to algae for metsulfuron, and for aquatic macrophytes for picloram. No changes increases in potential concern for any species group were identified for triclopyr or clopyralid. In general, situations that increased concern for potential effects to aquatic species from the level of risk stated in the risk assessments occurred for smaller stream channels with steeper side slopes, with risk increasing at higher altitudes. Conversely, risk lower than that stated in the risk assessments was identified for larger stream channels at lower altitude, and possibly in smaller stream channels with sideslopes less than 10 percent.

In summary, from Table 11.3-3 and the supporting discussion, it appears that if local input parameters for the Fish Creek watershed were used, predicted stream herbicide concentrations resulting from the application scenario modeled in the risk assessments may depart somewhat from the results reported. In some cases, predicted stream herbicide concentrations would likely be much less if inputs for local parameters were used. In other situations, predicted stream herbicide concentrations using local input parameters may exceed those modeled in the risk assessments.

In the flatter areas of pumice ash flows soil, slope is likely to be less than the 10 percent modeled, decreasing stream herbicide concentrations. In almost all other terrain in the watershed, slopes exceed or greatly exceed the 10 percent modeled, and herbicide delivery to streams could be expected to increase significantly. As noted above, local soil types do not appear to markedly change expected herbicide delivery for most herbicides likely to be applied in the watershed, with the possible exceptions of triclopyr and glyphosate in pumice ash soils.

In streams with flows higher than 1.8 cfs, the model will overestimate herbicide concentrations. This is most likely in the spring, which is dominated by snowmelt runoff and flows 10 to 15 times annual low flows. Summer and fall storms can have flows 4 times annual low flows. Only in the smallest perennial streams would spring base flow not exceed 1.8 cfs, and storm flows would further increase flow. Risk assessment modeling would almost certainly overestimate herbicide concentrations in stream in all but the smallest perennial tributaries during the spring. During the summer and fall, a larger portion of the perennial streams would be expected to flow near or slightly below the 1.8 cfs modeled.

Vegetation cover is not a particularly sensitive parameter and does not appear to change water concentration rates, with the exception of herbicides applied to some areas of invasive plants adjacent to streams.

11.3.3 Eastern Cascades

Site-specific information for analysis of the influence of eastern Cascades environmental conditions on predicted herbicide concentrations in surface water was taken from the Entiat Water Resource Inventory Area (WRIA) 46 Management Plan (Chelan County Conservation District, 2004). The Entiat WRIA is located in central Washington and is about 305,600 acres in size. It consists of the Entiat River watershed, including the Mad River, and a few minor tributaries to the upper Columbia River. The Entiat WRIA provides a cross section of soil, topography, and environmental conditions found throughout much of the eastern Oregon and Washington Cascade mountains.

Terrestrial invasive plants known to occupy the Entiat WRIA include spotted, Russian, and diffuse knapweed; yellowstar, Canada, perennial sow, musk, and Scotch thistle; Scotch broom; jointed goatgrass; rush skeleton weed; common crupina; puncture vine; purple loosestrife; Dalmation toadflax; spotted catsear; perennial pepperweed; St. Johnswort; longspine sandbur; tansy ragwort; oxeye daisy; and wild four o'clock. The most common invasive plants include Dalmation toadflax, Canada thistle, and knapweed. Knapweeds are especially prevalent along roads. The herbicides chlorsulfuron, clopyralid, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, and triclopyr are likely to be used as part of an integrated treatment plan. Chlorsulfuron, clopyralid, glyphosate, imazapic, and picloram are most likely to be used broadly as they are effective in treating the species occupying the largest areas within the Entiat WRIA.

The Entiat WRIA is characterized by rolling hills in the Columbia River tributaries area. Steeper terrain, created by uplifting and the formation of the Cascade Mountains is more common throughout the area. Narrow, incised canyons are found in the mid to lower valleys. Much of the topography is the result of alpine glaciation, significantly affecting the upper half of the basin and creating steep slopes and relatively flat valley bottoms. Using 10 percent slopes to model water contamination rates accurately reflects conditions on parts of the rolling hills and valley bottoms. Valley sides, canyon sides, and parts of the rolling hills are inaccurately reflected. Thus, including values for local slopes into the model have the potential to slightly decrease to significantly increase modeled stream herbicide concentration predictions.

Soils in the Entiat are generally highly erodible due to widespread deposits of volcanic ash and pumice or loess at the surface. Sediment delivery rates are typically high, primarily a result of steep slopes and high stream densities. Flooding and debris flows are significant transport processes for both sediment and organic material. Management disturbances such as grazing, tractor yarding, and roading generally accelerate natural erosion and sediment delivery hazards in sensitive soils. Concurrently, disturbed sites, particularly roads, have an increased risk of invasive plant infestation. Modeled water contamination rates would be better represented by loam, which balanced favors losses in sediment with losses in runoff.

Local soil types do not appear to have a high degree of influence on stream delivery predictions for most herbicides, provided the soil is relatively undisturbed by human activities. Disturbed areas, which are also the most likely to be infested by invasive plants, are more likely to deliver sediment with herbicides. Thus, the model may underestimate water contamination rates, particularly for highly soluble herbicides that do not bind well with soil particles, such as picloram and chlorsulfuron.

Average annual precipitation in the Entiat WRIA ranges is 90 inches in alpine areas to 10 inches in the lowlands. Fluctuations outside of average are common and extremes may best describe the local climate. During common extreme events, four inches of rain may fall in twenty-four hours. Water contamination rates would be best modeled by 200 inches per year for this area.

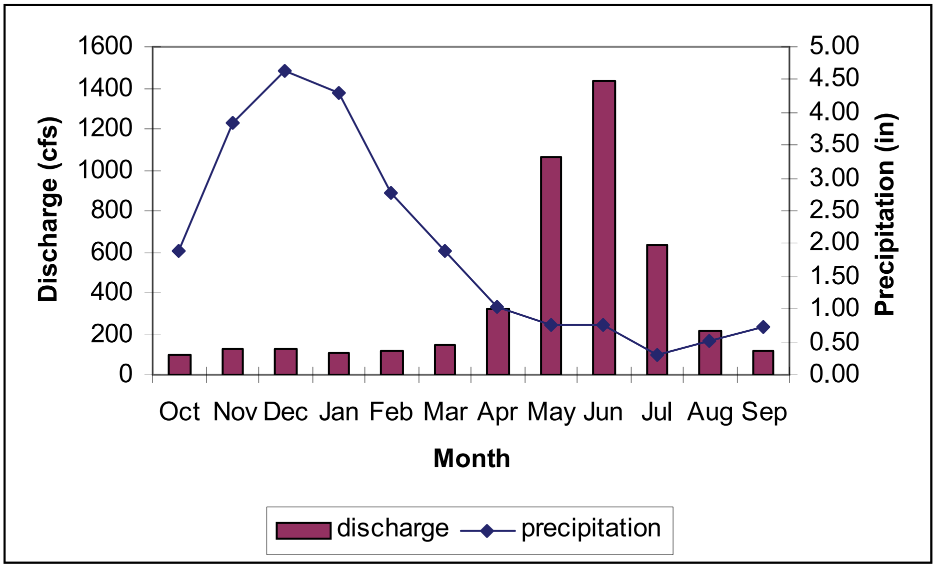

Figure 11.3-3. Comparison of mean monthly flow of Entiat River near Ardenvoir (1957-2003; and precipitation at Leavenworth (1919-1996).

Measured low flows in the Entiat River greatly exceed the 1.8 cfs modeled in the risk assessments, though smaller perennial streams would be expected to have lower flows. A large portion of the annual precipitation falls as snow and accumulates to form the winter snowpack. Warm spring temperatures and rain release water accumulated in snowpack as runoff. Occasional large frontal and convective storms in the spring, summer and fall may increase flow or cause flooding. The vast majority of runoff occurs between early May and mid-July when snowmelt reaches its peak. Spring herbicide applications would coincide with the highest flows, decreasing the concentration of herbicides in all but ephemeral streams. Summer or fall herbicide application would coincide with lower flows, though ephemeral streams would not be flowing then and the source of base flow of perennial streams is groundwater rather than runoff. Locally intense storms would be accompanied by sediment production and increased stream flows. No change to a slight increase to water concentrations would be expected at this time.

The Entiat WRIA has six identified vegetation types: shrub-steppe, open forest, closed forest, sub-alpine forest, open sub-alpine forest, and rock or open water. Human activities such as grazing sheep and logging have altered the landscape pattern of plant communities in the Entiat WRIA. Mixed pine-hardwood forests are modeled, although this is not a particularly sensitive parameter. For Entiat WRIA, this is the most adequate of the vegetation types available to model for open forest, closed forest, and sub-alpine forests. The model would tend to estimate water contamination rates adequately for these vegetation types. Modeling an agricultural field would more adequately model the other vegetation types. The model would tend to underestimate water contamination rates in these circumstances.

Table 11.3-4. Modification of the SERA GLEAMS stream herbicide concentration predictions by local factors in the eastern Cascades.

Herbicide	Slope	Soil Types	Vegetation cover	Rainfall	Streamflow	Potential range of variation	Potential for Increase in Aquatic Species Concern
Chlorsulfuron	- to +	+	[1]NC to +	+	- to +	NC to +	Yes – [2]A, M Not Likely – F No – I
Clopyralid	- to +	NC to +	NC to +	+	- to +	- to +	Not Likely – A, M; No – F, I
Glyphosate	- to +	NC to +	NC to +	+	- to +	- to +	Yes – [3,4]F, [4]I, [4]A Likely – [4]M Not Likely - [3]I
Imazapic	- to +	NC to +	NC to +	+	- to +	- to +	Yes – M Not Likely – A No – F, I
Picloram	- to +	+	NC to +	+	- to +	NC to +	Yes – F, M Likely – A Not Likely – I
Imazapyr	- to +	NC to +	NC to +	+	- to +	- to +	Yes – A, M Not Likely – F No – I
Metsulfuron methyl	- to +	NC to +	NC to +	+	- to +	- to +	Yes – M Likely – A No – F, I
Triclopyr	- to +	NC to +	NC to +	+	- to +	- to +	Yes – [5]F, [6]I, [5]A, [5]M Likely – [7]I

[1] NC = no change.
[2] A = algae, F = fish, M = aquatic macrophytes, I = aquatic invertebrates
[3] without surfactant
[4] with surfactant
[5] BEE and TEA forms
[6] BEE form only
[7] TEA form only

The column "Potential for Increase in Aquatic Species Concern" in Table 11.3-4 displays whether any increase in concern for aquatic species resulted from inclusion of local input parameters. In summary, from Table 11.3-4 and the supporting discussion, this analysis indicates that if local input parameters for the Entiat WRIA were used, predicted stream herbicide concentrations may depart from the results reported. Under some circumstances, predicted stream herbicide concentrations would likely be similar to or less than those in the SERA risk assessments when local input parameters are considered. Under other circumstances, predicted stream herbicide concentrations using local input parameters may exceed those modeled in the risk assessments.

In the flatter areas such as alluvial stream terraces and flat rolling terrain, slope is likely to be less than the 10 percent modeled, decreasing stream herbicide concentrations. On rolling hills and steep rimrock escarpments, slopes exceed the 10 percent modeled, and herbicide delivery to streams could be expected to increase significantly. As noted above, local soil types do not appear to markedly change expected herbicide delivery for most herbicides likely to be applied in the watershed, except in disturbed areas using highly soluble herbicides that do not bind well with soil particles, such as picloram and chlorsulfuron.

At higher stream flows (larger stream channels or wet season flow conditions), risk assessment model predictions will overestimate the herbicide concentration in most local streams. For smaller streams, other factors considered have a more pronounced effect than for larger streams.

Vegetation cover is not a particularly sensitive parameter and but may change water concentration rates in riparian areas due to loss of vegetation.

11.3.4 Eastern Grasslands

Site-specific information for analysis of the influence of eastern Oregon and Washington grasslands environmental conditions on predicted herbicide concentrations in surface water was taken from the Crooked River National Grassland Watershed Analysis (Deschutes and Ochoco National Forests, 2003). The Crooked River National Grassland watersheds are located in central Oregon and are about 658,000 acres in size. It provides a cross section of soil, topography, and environmental conditions found throughout much of the eastern Oregon and Washington grasslands.

Terrestrial invasive plants known to occupy the Crooked River National Grassland area include whitetop; musk, yellowstar, Canada, Scotch, and bull thistle; spotted, diffuse, and Russian knapweed; morning glory; hound's-tongue; teasel; leafy spurge; St. John's wort; perennial pepperweed; Dalmatian toadflax; sulphur cinquefoil; Mediterranean sage; and medusahead. Medusahead and the knapweed species occupy large areas within the Crooked River National Grassland. Compared with other areas in Central Oregon, densities of invasive plants are moderate to high. The herbicides chlorsulfuron, clopyralid, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, and sethoxydim are likely to be used as part of an integrated treatment plan. Clopyralid, glyphosate, imazapic, and picloram are most likely to be used broadly as they are effective in treating the species occupying the largest areas within the Crooked River National Grasslands.

Crooked River National Grassland is characterized by flat rolling terrain broken by buttes, rolling hills, and steep rimrock escarpments along the major drainways. The mainstems of Lower Crooked River, Willow Creek, and Mud Springs Creeks contain larger, flatter alluvial stream terraces. Using 10 percent slopes to model water contamination rates accurately reflects conditions on the flat rolling terrain and alluvial stream terraces. Rolling hills are less accurately reflected, and steep escarpments are inaccurately reflected. Thus, including values for local slopes into the model have the potential to slightly decrease to significantly increase modeled stream herbicide concentration predictions.

Soils in the Crooked River National Grassland, in their native condition, are generally highly fertile and well drained. Water contamination rates would be consistent with results of modeling using loam as the particle size in the model. However, nearly all soil in the area has been heavily impacted by past human activities such as agriculture and grazing, resulting in compaction and loss of ground cover. Modeled water contamination rates would be better represented by clay, which favors herbicide losses in sediment.

Channel, sheet, and rill erosion are the dominant erosion process across the Crooked River National Grassland under current climactic conditions. All three erosion processes are affected by the health of plant communities in the area, which in turn affects delivery of sediment and herbicides, if present, to streams. Again, past and present human activities strongly influence the importance of these processes to delivery of herbicides to streams.

Local soil types do not appear to have a high degree of influence on stream delivery predictions for most herbicides, provided the soil is relatively undisturbed by human activities. Disturbed areas, which are also the most likely to be infested by invasive plants, are more likely to deliver sediment with herbicides. Thus, the model may underestimate water contamination rates, particularly for highly soluble herbicides that do not bind well with soil particles, such as picloram and chlorsulfuron.

Average annual precipitation in the Crooked River National Grassland is 9 inches. Maximum precipitation occurs from November through May, while minimum precipitation occurs during July through September. Annual precipitation modeled for 10 inches per year would adequately predict water contamination rates. During relatively extreme events, two inches of rain may fall in twenty-four hours. Water contamination rates would be modeled by 100 inches per year for extreme events.

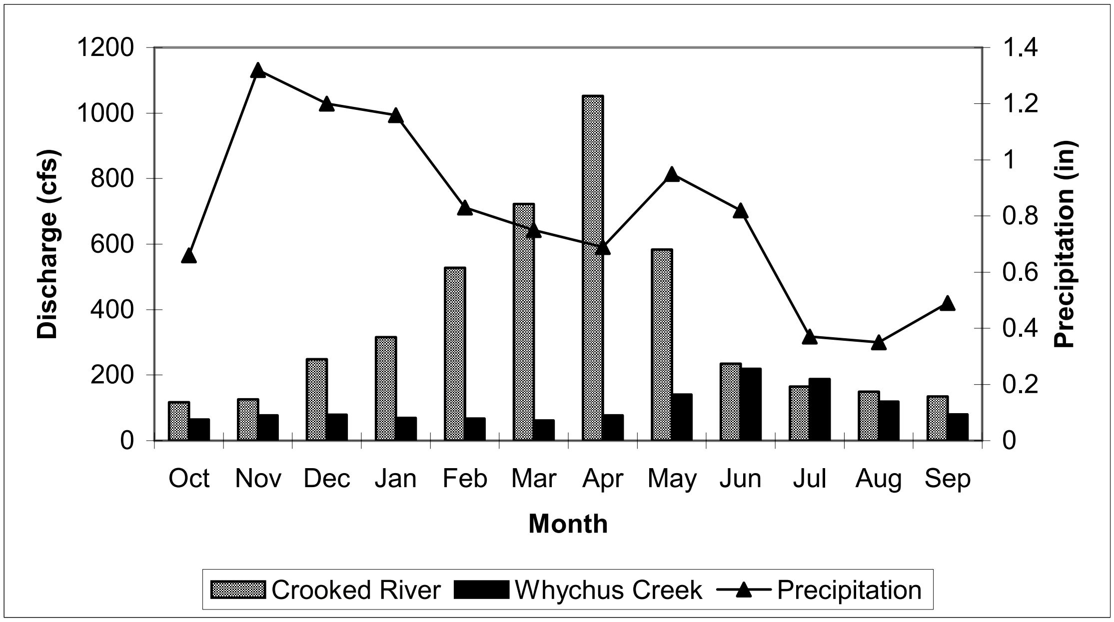

Figure 11.3-4. ***Comparison of mean monthly flow of Crooked River near Madras (1941-1997); mean monthly flow of Whychus (formerly Squaw) Creek near Sisters (1907-1993;) and precipitation at Madras (1913-1997)***.

Measured stream low-flow discharge are less than 3 cfs for Crooked River and less than 25 cfs for Whychus Creek. In the Crooked River, the measured low flows are extreme and typically low-flows are much higher. For major streams, the 1.8 cfs modeled in the risk assessments adequately models predicted herbicide concentrations. For smaller streams, other factors considered have a more pronounced effect than for larger streams.

As displayed in Figure 11.3-4, average monthly wet season flows, as measured in Crooked River near Madras, can vary from summer flows by a factor of about 9, to about 1000 cfs; while in Wychus Creek measured wet season flows can vary by a factor of 4, to about 220 cfs.

Figure 11.3-4 shows that stream flow response to storms varies seasonally in Crooked River, and these flows are most relevant to herbicide delivery modeling. Due to the snowmelt in the spring, stream flow can be expected to be at their highest and the risk of storm induced high herbicide concentrations at their lowest. Due to relatively low stream flow following summer and early fall storm events, storms during these periods appear to have the ability to result in the highest stream herbicide concentrations. Locally intense summer thunderstorms would have the potential to result in highest herbicide concentrations in streams, due to low base flow conditions. The more widespread fall rains would have the potential to deliver herbicide to streams flowing slightly above annual low flow conditions, but across a more widespread area than for summer thunderstorms.

Figure 11.3-4 shows that stream flow response to storms varies seasonally in Whychus Creek as well, and these flows are most relevant to herbicide delivery modeling. In the fall, precipitation may fall as snow and does not increase stream flow, while in the spring snow takes longer to melt an increase stream flow. In early summer, flows increase with snowmelt. Herbicide treatment is precluded when snow covers vegetation, and herbicide treatment in the summer would occur when flows exceeded baseflow conditions.

Human activities and climate have shaped the landscape pattern of plant communities in the Crooked River National Grassland. Overgrazing has caused loss of ground cover, and homesteading included clearing brush and trees. Mixed pine-hardwood forests are modeled, although this is not a particularly sensitive parameter. For Crooked River National Grasslands, modeling and agricultural field would be more appropriate. The model would tend to underestimate water contamination rates in these circumstances.

Table 11.3-5. Modification of the SERA GLEAMS stream herbicide concentration predictions by local factors in Crooked River National Grasslands.

Herbicide	Slope	Soil Types	Vegetation cover	Rainfall	Streamflow	Potential range of variation	Potential for Increase in Aquatic Species Concern
Clopyralid	- to +	[1]NC to +	+	NC	- to +	- to +	Not Likely – [2]A, M; No – F, I
Glyphosate	- to +	NC to +	+	NC	- to +	- to +	Yes – [3,4]F, [4]I, [4]A Likely – [4]M Not Likely - [3]I
Imazapic	- to +	NC to +	+	NC	- to +	- to +	Yes – M Not Likely – A No – F, I
Picloram	- to +	+	+	NC	- to +	NC to +	Yes – F, M Likely – A Not Likely – I
Clorsulfuron	- to +	+	+	NC	- to +	NC to +	Yes – A, M Not Likely – F No – I
Imazapyr	- to +	NC to +	+	NC	- to +	- to +	Yes – A, M Not Likely – F No – I
Metsulfuron methyl	- to +	NC to +	+	NC	- to +	- to +	Yes – M Likely – A No – F, I
Sethoxydim	- to +	NC to +	+	NC	- to +	- to +	Yes – F Likely – I, A, M

[1] NC = no change
[2] A = algae, F = fish, M = aquatic macrophytes, I = aquatic invertebrates
[3] without surfactant
[4] with surfactant

The column "Potential for Increase in Aquatic Species Concern" in Table 11.3-5 displays whether any increase in concern for aquatic species resulted from inclusion of local input parameters. In summary, from Table 11.3-5 and the supporting discussion, this analysis indicates that if local input parameters for the Crooked River National Grasslands area were used, predicted stream herbicide concentrations may depart from the results reported. Under some circumstances, predicted stream herbicide concentrations would likely be similar to less than those in the SERA risk assessments when local input parameters are considered. For most of the area, predicted stream herbicide concentrations using local input parameters may exceed those modeled in the risk assessments.

In the flatter areas such as alluvial stream terraces and flat rolling terrain, slope is likely to be less than the 10 percent modeled, decreasing stream herbicide concentrations. On rolling hills and steep rimrock escarpments, slopes exceed the 10 percent modeled, and herbicide delivery to streams could be expected to increase significantly. As noted above, local soil types do not appear to markedly change expected herbicide delivery for most herbicides likely to be applied in the watershed, except in disturbed areas using highly soluble herbicides that do not bind well with soil particles, such as picloram and chlorsulfuron.

At higher stream flows (larger stream channels or wet season flow conditions), risk assessment model predictions will overestimate the herbicide concentration in most local streams. For smaller streams, other factors considered have a more pronounced effect than for larger streams.

Vegetation cover is not a particularly sensitive parameter and but may change water concentration rates in riparian areas due to loss of vegetation.

11.3.5 Blue Mountains

Site-specific information for analysis of the influence of the Blue Mountains environmental conditions on predicted herbicide concentrations in surface water was taken from the Canyon Creek Watershed Analysis (Umatilla National Forest, 2003). The Canyon Creek watershed lies within the John Day River sub-basin in the southern Blue Mountains of east-central Oregon, and is about 74,000 acres in size. It is part of the greater Columbia River basin. The Canyon Creek WA provides a cross section of soil, topography, environmental, and management conditions found throughout much of the eastern Oregon and Washington Blue mountains.

No list of terrestrial invasive plants was found in the Canyon Creek Watershed Analysis. A list was included in the Galena Watershed Analysis, another Blue Mountain area watershed. This list was used as a basis for predicting the invasive plants to be treated in the Canyon Creek watershed. Terrestrial invasive plants include spotted and diffuse knapweed; yellowstar, Canada, and musk thistle; Dalmation and yellow toadflax; St. Johnswort; leafy spurge; and tansy ragwort. The herbicides chlorsulfuron, clopyralid, glyphosate, imazapic, metsulfuron methyl, picloram, and triclopyr are likely to be used as part of an integrated treatment plan. Clopyralid, glyphosate, and picloram are most likely to be used broadly as they are effective in treating most of the species likely found within the Canyon Creek watershed.

Canyon Creek watershed elevations range from 3,050 feet at the confluence with the John Day River to 8,000 feet along the eastern edge of the watershed. Much of the watershed lies on slopes ranging from 35 to 60 percent (~60 percent of the watershed); some slopes as steep as 150 percent or greater (~8 percent of the watershed) are found along the eastern boundary in the Strawberry Mountains. Using 10 percent slopes to model water contamination rates does not accurately reflect conditions in most of the watershed. Thus, including values for local slopes into the model have the potential to slightly to significantly increase modeled stream herbicide concentration predictions.

Rainfall and overland flow are the primary mechanisms driving erosion in the Canyon Creek watershed. Soils overlying sedimentary rock in the Canyon Creek watershed are the most vulnerable to surface erosion. Exposed soil can be found throughout the watershed in areas of natural or human caused vegetation removal. Examples of natural vegetation removal include fire, inner gorge sliding, and flooding. Human caused vegetation removal includes road construction, timber harvest, and livestock grazing. Concurrently, disturbed sites, particularly roads, have an increased risk of invasive plant infestation. Soil compaction, which reduces permeability and increases runoff and surface erosion, also results in lower water table elevations. Human activities that remove vegetation also compact soil over much of the Canyon Creek watershed. Modeled water contamination rates would be better represented by clay, which favors losses in sediment over losses in runoff.

Local soil types do not appear to have a high degree of influence on stream delivery predictions for most herbicides, provided the soil is relatively undisturbed by human activities. However, an undetermined but significant amount of the watershed has been disturbed by human activities. Disturbed areas, which are also the most likely to be infested by invasive plants, are more likely to deliver sediment with herbicides. Thus, the model may underestimate water contamination rates, particularly for highly soluble herbicides that do not bind well with soil particles, such as picloram and chlorsulfuron.

Average annual precipitation in the Canyon Creek watershed ranges from 13 inches near John Day to 39 inches in the higher elevations of the Strawberry Mountains. In the Canyon Creek watershed, the primary peak flow generating processes are spring rain, spring rain-on-snow, and snow melt. During reasonably extreme events, up to 2.6 inches of rain may fall in twenty-four hours. Water contamination rates that encompass these events would be modeled by 100 inches per year for this area.

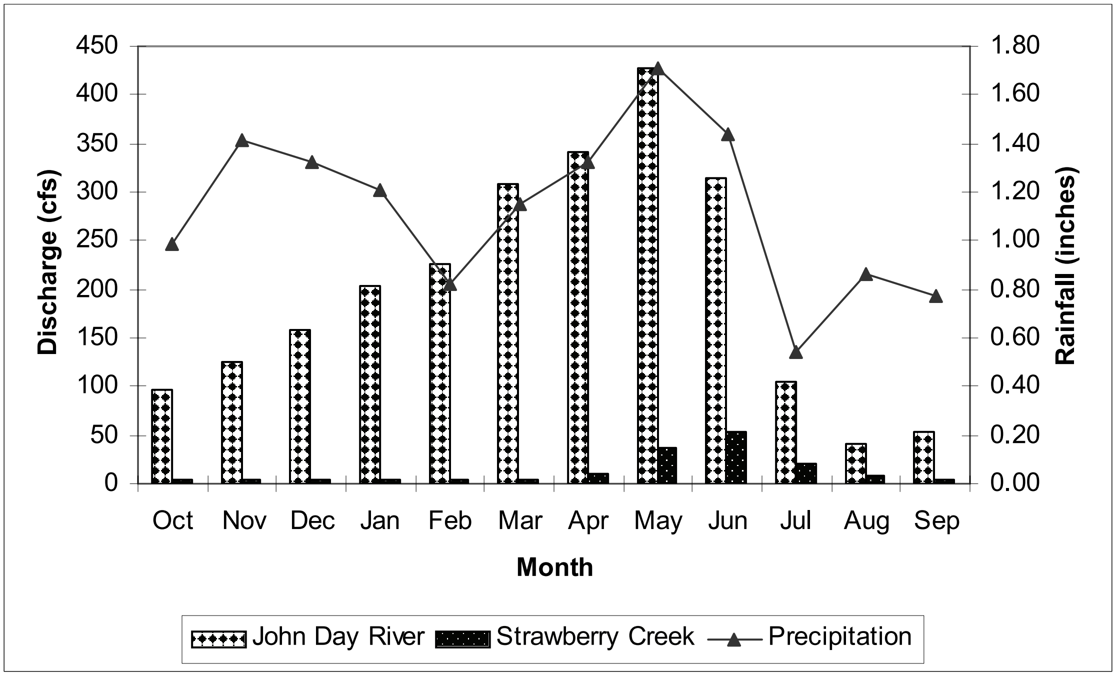

Figure 11.3-5. ***Comparison of mean monthly flow of John Day River near John Day (1968-2003); Strawberry Creek above Slide Creek near Prairie City (1930-1991); and precipitation at John Day (1953-1997)***.

No measured flows for Canyon Creek are available. Figure 11.3-5 shows two distinct hydrologic regimes in the general area. Strawberry Creek is representative of the upper part of the watershed, where stream flow is dominated by snowmelt. John Day River is representative of the lower portion of the watershed, where rain-on-snow and spring rains predominate. Both regimes have significant flows in the spring, with lower flows in the summer into early fall. Increased stream flow in late summer is due to locally intense thunderstorms.

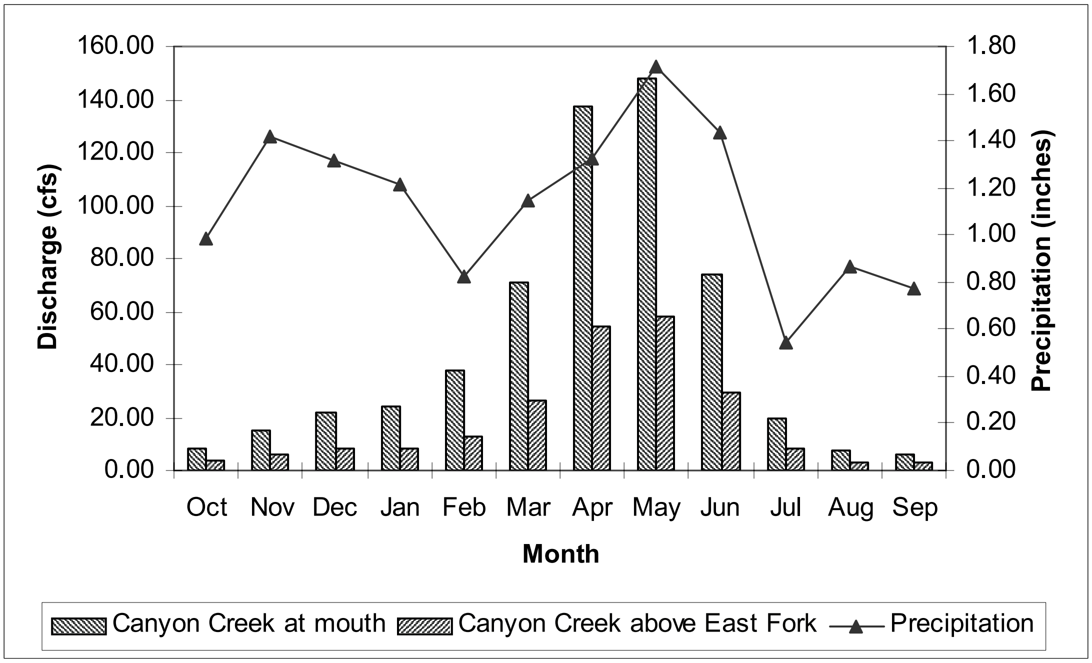

Figure 11.3-6. Comparison of estimated mean monthly natural flow of Canyon Creek near the mouth and Canyon Creek above East Fork Canyon Creek; and precipitation at John Day (1953-1997).

Oregon Water Resources Department estimates mean monthly natural flows in Canyon Creek for assigning water rights. The hydrograph created from this data suggests storage of water in the form of snow in the winter months, with increased flows in the spring due to snow melt and spring rains. Although natural stream flow exceed the 1.8 cfs modeled in these streams, assigned water rights reduce stream flow and may cause stream flows to fall below this discharge level.

Spring herbicide applications would coincide with the highest flows, decreasing the concentration of herbicides in all but ephemeral streams. Summer or fall herbicide application would coincide with lower flows, though ephemeral streams would not be flowing then and the source of base flow of perennial streams is groundwater rather than runoff. No change to a slight increase to water concentrations would be expected at this time.

Five broad potential vegetative categories were identified for the Canyon Creek watershed: forested uplands (88 percent of national forest lands in the watershed), non-forested uplands (8 percent), forested riparian zones (3 percent), non-forested riparian zones (<1 percent), and non-vegetated of administrative lands (1 percent). Disturbance processes include fire and fire exclusion, insects and disease, and human activities including logging and grazing. Mixed pine-hardwood forests are modeled, although this is not a particularly sensitive parameter. For Canyon Creek watershed, this is the most adequate of the vegetation types available, except for the non-forested vegetation types and heavily disturbed areas. The model would tend to estimate water contamination rates adequately for undisturbed forested vegetation types. Modeling an agricultural field would more adequately model the other vegetation types and would tend to underestimate water contamination rates in these circumstances.

Table 11.3-6. Modification of the SERA GLEAMS stream herbicide concentration predictions by local factors in the Blue Mountains.

Herbicide	Slope	Soil Types	Vegetation cover	Rainfall	Streamflow	Potential range of variation	Potential for Increase in Aquatic Species Concern
Chlorsulfuron	+	+	[1]NC to +	NC	NC to +	+	Yes – [2]A, M Not Likely – F No – I
Clopyralid	+	NC to +	NC to +	NC	NC to +	+	Not Likely – A, M; No – F, I
Glyphosate	+	NC to +	NC to +	NC	NC to +	+	Yes – [3,4]F, [4]I, [4]A Likely – [4]M Not Likely - [3]I
Imazapic	+	NC to +	NC to +	NC	NC to +	+	Yes – M Not Likely – A No – F, I
Metsulfuron methyl	+	NC to +	NC to +	NC	NC to +	+	Yes – M Likely – A No – F, I
Picloram	+	+	NC to +	NC	NC to +	+	Yes – F, M Likely – A Not Likely – I
Triclopyr	+	NC to +	NC to +	NC	NC to +	+	Yes – [5]F, [6]I, [5]A, [5]M Likely – [7]I

[1] NC = no change.
[2] A = algae, F = fish, M = aquatic macrophytes, I = aquatic invertebrates
[3] with and without surfactant
[4] with surfactant only
[5] BEE and TEA forms
[6] BEE form only
[7] TEA form only

The column “Potential for Increase in Aquatic Species Concern” in Table 11.3-6 displays whether any increase in concern for aquatic species resulted from inclusion of local input parameters. In summary, from Table 11.3-6 and the supporting discussion, this analysis indicates that if local input parameters for the Canyon Creek watershed were used, predicted stream herbicide concentrations may depart from the results reported. Under some circumstances, predicted stream herbicide concentrations would likely be similar to or less than those in the SERA risk assessments when local input parameters are considered. Under other circumstances, predicted stream herbicide concentrations using local input parameters may exceed those modeled in the risk assessments.

Slopes in the Canyon Creek watershed are generally exceed the 10 percent modeled, and herbicide delivery to streams could be expected to increase significantly. As noted above, local soil types do not appear to markedly change expected herbicide delivery for most herbicides likely to be applied in the watershed, except in disturbed areas using highly soluble herbicides that do not bind well with soil particles, such as picloram and chlorsulfuron.

At higher stream flows (larger stream channels or wet season flow conditions), risk assessment model predictions will overestimate the herbicide concentration in most local streams. For smaller streams, other factors considered have a more pronounced effect than for larger streams.

Vegetation cover is not a particularly sensitive parameter and but may increase water concentration rates in human disturbance, fire, or other loss of vegetation.

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