Appendix E – Aquatics

List of Roads with Proposed Chemical Treatments within 100 Feet of a Fish-Bearing Stream

Table 3 - List of roads proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams

5th Field Watershed	Stream	Road Name (Road #)	Miles of road proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams	TES Fish Species Present at Site	TES Fish Species Present in Watershed
Upper Tucannon River Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 0.39 miles	Tucannon River	Tucannon River Road (4700)	0.13	SRC, BT	SRS, SRC, BT
	Unnamed Trib to Tucannon River	Cummings Creek Rd (470020)	0.07	BT	
	Hixon Canyon	Hixon Canyon Rd (4700165)	0.13		
	Panjab Creek	Panjab CG Rd (4713020)	0.02		
		Meadow Creek Road (4713)	0.04	BT	
Pataha Creek Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 0.02 miles	Pataha Creek	Stevens Ridge Rd (4016)	0.02		NF
Asotin Creek Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 0.05 miles	Lick Creek	Sourdough Gulch Rd (4100350)	0.05		SRS, SRC, BT

5th Field Watershed	Stream	Road Name (Road #)	Miles of road proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams	TES Fish Species Present at Site	TES Fish Species Present in Watershed
Lookingglass Creek	Mottet Creek	Lookingglass Rd (6300)	0.21	SRS	SRS, SRC, BT
		Jubilee Rd (6400)	0.17		
Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 0.38 miles					
Grande Ronde River/Grossman Creek	Sheep Creek	Unnamed Rd (6234)	0.14		SRS, SRC, BT
Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 0.14 miles					
Grande Ronde River/Cabin Creek	Phillips Creek	Glenn Canyon Rd (3148)	0.04	SRS	SRS
		Phillips Creek Rd (3738)	1.0	SRS	
Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 6.33 miles	Little Phillips Creek	Middle Ridge Rd (3734)	0.08	SRS	
	Phillips Creek	Unnamed Rd (3738090)	0.03	SRS	
	Phillips Creek	Craig's Cabin Rd (3740)	0.02	SRS	
	Little Phillips Creek	Oregon SR - 204	5.16	SRS	
Upper Umatilla River	Thomas Creek	Corporation Rd (3200)	2.11	MCS, MCC, BT	MCS, MCC, BT
Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 2.74 miles	South Fork Umatilla River	Corporation Rd (3200)	0.38	MCS, MCC	
		Umatilla Forks CG Rd (3200035)	0.08		
		Buck Creek Rd (3200045)	0.06		
	Umatilla River	Corporation Rd (3200)	0.07		
	Unnamed Trib to Umatilla River	Corporation Rd (3200)	0.04		

5th Field Watershed	Stream	Road Name (Road #)	Miles of road proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams	TES Fish Species Present at Site	TES Fish Species Present in Watershed
Meacham Creek	Meacham Creek	Meacham Creek Rd (3000030)	0.04	MCC	MCS, MCC, BT
Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 4.64 miles	Camp Creek	Camp Creek Rd (3000035)	0.12		
	Meacham Creek	Butcher Creek Rd (3102020)	0.009	MCS	
	Meacham Creek	Meacham Creek Rd (3000030)	4.37	MCC, MCS	
	Unnamed Trib to Meacham Creek	Meacham Creek Rd (3000030)	0.06	BT	
	Unnamed Trib to Meacham Creek	Meacham Creek Rd (3000030)	0.04		
Birch Creek Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 1.81 miles	Pearson Creek	Pearson Creek Rd (5400)	1.81		MCS
Upper Camas Creek	Dry Camas Creek	Unnamed Rd (5226300)	0.02		MCS, MCC, BT
Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 2.41 miles		Unnamed Rd (5226320)	0.03		
	Hideaway Creek	Pearson Creek Rd (5400)	0.14		
		Unnamed Rd (5445)	0.01	MCS	
	Camas Creek	Pearson Creek Rd (5400)	0.07	MCS	
		Oregon – 244	1.95	MCS	
	Bear Wallow Creek	Pearson Creek Rd (5400)	0.04	MCS	
	Bowman Creek	Unnamed Rd (5916040)	0.10	MCS	
	Camas Creek	Tower Mtn Rd (5226)	0.05		
North Fork John Day River/Big Creek	Big Creek	Big Creek Meadows CG (5225020)	0.05		MCS, MCC
Total miles	North Fork John Day	Texas Bar Rd (5500)	0.05	MCS	

5th Field Watershed	Stream	Road Name (Road #)	Miles of road proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams	TES Fish Species Present at Site	TES Fish Species Present in Watershed
proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 1.49 miles	River	Unnamed Rd (5500053)	0.01		
		Unnamed Rd (5505)	0.009		
		North Fork River Rd (5506)	0.61	MCS, MCC	
	Texas Bar Creek	Texas Bar Rd (5500)	0.09	MCS	
	Oriental Creek	Unnamed Rd (5506100)	0.06		
	Big Creek	North Fork River Rd (5506)	0.61	MCS	
Granite Creek Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 1.17 miles	Granite Creek	Olive Lake Drive (1000)	0.04	MCC	WCT, MCS, MCC, BT
		Granite Creek Rd (1035)	0.10	MCC	
		Unnamed Rd (1035012)	0.27	MCC	
		W730000	0.41	MCS	
	Unnamed Trib to Granite Creek	Unnamed Rd (1300)	0.28	WCT	
	Squaw Creek	Unnamed Rd (1035032)	0.06	MCS	
	Ten Cent Creek	Unnamed Rd (7350)	0.01	MCS	
Lower Camas Creek Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 0.04 miles	Sugarbowl Creek	Western Rte (5300)	0.02	MCS	MCS, MCC
	FiveMile Creek	Western Rte (5300)	0.02	MCS	
	Tribble Creek	Unnamed Rd (5300140)	0.003	MCS	
Willow Creek Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 0.05 miles	Dry Creek	Dry Creek Spring Rd (3200120)	0.01		NF
		Unnamed Rd (3200130)	0.01		
		Moonshine Rd (3200160)	0.02		
		UNI-22	0.02		

5th Field Watershed	Stream	Road Name (Road #)	Miles of road proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams	TES Fish Species Present at Site	TES Fish Species Present in Watershed
North Fork John Day River/Potamus Creek Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 2.24 miles	Ditch Creek	Olde Western Rt (2100)	0.48	MCS	MCS, RT, MCC
		Penland Lake Rd (2103)	0.01	MCS	
		Ritter Rd (2104120)	0.01		
		Western Rte (5300)	0.04		
	Long Canyon	Ritter Rd (2104)	0.02		
	Unnamed Trib to Potamus Creek	Kelly Fire Trail (5300210)	0.06		
	Martin Creek	Unnamed Rd (2107)	0.02		
	West Fork Meadow Brook	Trailer Court (3900105)	0.34	MCS	
		Unnamed Rd (3900101)	0.06		
		Helport Rd (3900110)	0.05	MCS	
		Unnamed Rd (3969)	0.07		
	Hinton Creek	Bone Point Rd (3963)	0.35	MCS	
		Unnamed Rd (3963016)	0.10		
	North Fork John Day River	Bone Point Rd (3963)	0.17	MCC	
	East Fork Meadow Brook Creek	Unnamed Rd (3971)	0.03	MCS	
		Unnamed Rd (3972)	0.08	MCS	
	Pole Creek	Western Rte (5300)	0.12		
	Unnamed Trib to Stalder Creek	Unnamed Rd (2106060)	0.01		
	Martin Creek	Upper Rhea Creek Rd (2100050)	0.04		
	East Fork Meadow Brook Creek	Unnamed Rd (3969)	0.17	MCS	
	West Fork	US 395	0.01	MCS	

5th Field Watershed	Stream	Road Name (Road #)	Miles of road proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams	TES Fish Species Present at Site	TES Fish Species Present in Watershed
Wall Creek Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 4.63 miles	Meadow Brook Creek Wilson Creek	Unnamed Rd (2300)	0.02		MCS, RT
	Swale Creek	Unnamed Rd (2100090)	0.40		
	Swale Creek	Unnamed Rd (5350)	0.04		
	Unnamed Trib to Wilson Creek	Bull Pr CG Rd (2039030)	0.002		
	Little Wall Creek	Unnamed Rd (2122)	0.42		
		Unnamed Rd (2122025)	0.02		
		Unnamed Rd (2122047)	0.01		
		Unnamed Rd (2202065)	0.41	MCS	
	Moreland Canyon	Unnamed Rd (2120045)	0.35		
	Wilson Creek	Unnamed Rd (2128)	0.72	MCS	
	Lovlett Creek	Unnamed Rd (2200019)	0.02		
	Three Trough Creek	Morphine/Three Trough Rd (2202)	0.03		
	Bacon Creek	Unnamed Rd (2202090)	1.49		
	Big Wall Creek	Unnamed Rd (2300)	0.41		
		Unnamed Rd (2300080)	0.01	MCS	
		Unnamed Rd (2300100)	0.08		
	Unnamed Trib to Big Wall Creek	Unnamed Rd (2300101)	0.03		
	South Fork Big Wall Creek	Unnamed Rd (2402)	0.17		
Lower John Day River/Kahler Creek	Kahler Creek	Oregon State Hwy - 207	0.08		RT

5th Field Watershed	Stream	Road Name (Road #)	Miles of road proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams	TES Fish Species Present at Site	TES Fish Species Present in Watershed
Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 0.08 miles					
Desolation Creek	Desolation Creek	Toll Bridge Rd (1000023)	0.04	MCS	WCT, MCS, MCC, BT
Total miles proposed for herbicide treatment within 100 feet of Class 1 & 2 Streams = 0.04 miles					

Effects of Active Ingredients in Herbicide to Aquatic Organisms

The most sensitive effect from the most sensitive species tested was used to determine the toxicity indices for each herbicide. Quantitative estimates of dose from each exposure scenario were compared to the corresponding toxicity index to determine the potential for adverse effect. Doses below the toxicity indices resulted in discountable effects. Table 2 lists the toxicity indices for fish used for the R6 2005 FEIS BA. Values in bold are the values used to assess risk to fish from acute exposures. Indices represent the most sensitive endpoint from the most sensitive species for which adequate data are available. Numbers in bold 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.

Table 4 - Toxicity Indices for Fish Used for the R6 2005 FEIS

Herbicide	Duration	Endpoint	Dose	Species	Effect Noted at LOAEL (Lowest Observable Adverse Effect Level)
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
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

Herbicide	Duration	Endpoint	Dose	Species	Effect Noted at LOAEL (Lowest Observable Adverse Effect Level)
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
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
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).
Indices represent the most sensitive endpoint from the most sensitive species for which adequate data are available. Numbers in bold 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.
*NOEC = No Observed Effect Concentration

Results of the exposure scenarios as applied to listed fish on the Umatilla National Forest are displayed in Table 5. The R6 2005 FEIS Fish BA displayed the results by placing stars (*) and diamonds (♦) where there was an exceedence in the level of concern (LOC). For purposes of this BA, the table of stars and diamonds has been modified to show the hazard quotients (HQ) value in order to exemplify the magnitude of difference between typical and high application rates, and aquatic and non-aquatic formulations. The cells that contain a slash and no number mean that there was no exceedence in level of concern (LOC).

The LOC exceedences occur when the HQ value exceeds 1. Exceedences in LOC indicate occasions where the expected exposure concentration (EEC) is greater than the no observable effect concentration (NOEC) value used for that aquatic species group, which may lead to an indirect effect to listed aquatic species if conditions were similar to what was modeled in the SERA risk assessments. To calculate an HQ, simply take the ratio of EEC/NOEC values. Toxicity indices used in the R6 2005 FEIS for aquatic organisms are NOEC values, refer to table above. Two types of indirect effects are possible, those toxic to the listed aquatic species, and those mediated by toxic effects to an ecosystem component that is part of the Primary Constituent Elements (PCE) or associated essential habitat features.

Table 5 - Hazard Quotient Values for Acute Exposure Estimates for Sensitive Aquatic Organisms from the R6 2005 FEIS Broadcast Spray Scenarios

Aquatic Species Group	Application Rate	Chlorsulfuron	Clopyralid	Glyphosate w/o surfactant8*	Glyphosate w/ surfactant	Imazapic	Imazapyr**	Metasulferon Methyl	Picloram	Sethoxydin	Sulfometeron Methyl	Triclopyr TEA*	Triclopyr BEE	NPE Surfactant
Fish	High	--	--	6	43	--	--	--	5	3	--	15	125	--
	Typical	--	--	2	12	--	--	--	2	2.5	--	1.5	13	--
Aquatic Invertebrate	High	--	--	--	2.5	--	--	--	--	--	--	--	1.8	--
	Typical	--	--	--	--	--	--	--	--	--	--	--	--	--
Algae	High	5	--	--	3.1	--	5	--	--	--	3	9.5	214	--
	Typical	--	--	--	--	--	2	--	--	--	--	--	21	--
Aquatic Macrophytes	High	1064	--	--	--	1.4	8	9	2	--	36	9.5	214	--
	Typical	234	--	--	--	--	3	2	--		4		21	

'--' Predicted concentrations less than or equal to the estimated or measured 'no observable effect concentration' at both typical and high application rates.
'*' Aquatic formulations analyzed in the R6 2005 FEIS.

The exposure scenarios do not account for factors such as timing of application, animal behavior and feeding strategies, animal presence within a treatment area, or other relevant factors such as site-specific conditions. However, the SERA risk assessments do represent a worst-case scenario that is a good benchmark for assessing true concerns with actual application. Results of triclopyr exposures take into account the strict limitations on use identified in the forest plan standards, which makes the exposure scenarios implausible or impossible. Table 5 displays the results of exposure if all "worst-case" conditions reflected in the scenario occur, which is highly unlikely for Umatilla National Forest.

Chronic and Acute Exposures

The toxicity metric values (estimated or measured NOEC values) used in the R6 2005 FEIS analyses were selected as the most likely to protect against sub-lethal effects. For assessing potential risk to listed fish, while accounting for uncertainty regarding sub-lethal effects, the 1/20th of the acute LC50 (U.S. EPA 2004) or a lower chronic NOEC value was used for the acute toxicity index. Therefore, a LOC exceedence listed in Table 5 represents at least a greater than discountable risk of sub-lethal effects at the R6 2005 FEIS scale. For the action alternatives, effects analysis tiers to the results of the R6 2005 FEIS for chronic and acute exposures, and analyzes the potential for more than a discountable risk of sub-lethal effects as well as indirect effects from impacts to the food web.

Results of the R6 2005 FEIS analysis indicates that chronic exposures to fish are not plausible, in other words not mathematically possible. Therefore, chronic exposures to fish for the action alternatives are unlikely to occur. It is safe to assume that it is highly unlikely to reach a LOC for chronic exposures herbicide treatments on UNF.

The R6 FEIS identified three herbicides that mathematically exceeded the LOC for aquatic plants: Imazapyr, Metsulfuron, and Chlorsulfuron. The R6 2005 FEIS concluded that exposure of aquatic plants to chronic toxicity concentrations of imazapyr may be mathematically possible, but not plausible. Therefore, it is not plausible for the action alternatives to result in chronic toxicity of imazapyr for aquatic plants. For metsulfuron, the peak modeled stream concentration reported in the SERA risk assessment is 0.006 mg/l, which is approximately equal to the 0.005 mg/l that was calculated as the mathematically highest possible average stream concentration (with direct input). This indicates that the true 21 day concentration for non-fish species is likely much lower. Based on this, it is unlikely that exposure to chronic toxicity of metsulfuron to plants will occur for the action alternatives, even if there were no buffers.

The risk assessment for chlorsulfuron lists the highest average modeled stream concentration as 0.0022 mg/l, approximately 46 times higher than the estimated acute NOEC of 0.000047 mg/l. However, chronic toxicity to plants is unlikely to occur for the action alternatives because of Project Design Features that limit broadcasting chlorsulfuron.

The effects analysis for this EIS focus on the probability and magnitude of acute exposures from herbicide treatments based on results from the SERA risk assessments. It must be made clear that the risk categories for herbicides identified in the R6 2005 FEIS Fish BA is risk to aquatic organisms (fish, invertebrates, algae, aquatic macrophytes) among the herbicides analyzed for the R6 2005 ROD. The herbicides analyzed in the R6 2005 FEIS were compared to each other and placed in a risk level category according to results from worst-case acute exposure scenario used in the SERA risk assessments. Herbicides analyzed in the R6 2005 FEIS were displayed in the following category of risk:

- Lowest risk: results from SERA risk assessments indicated no risk or a plausible risk to aquatic macrophytes only (includes chlopyralid, imazapic and metsulfuron methyl),
- Moderate risk: results from SERA risk assessments indicated a plausible risk to algae or invertebrates, in addition to plants (includes chlorsulfuron, imazapyr and sulfometeron methyl),
- Highest risk: results from SERA risk assessments indicated a plausible risk to fish which may or may not be a risk to algae, invertebrates, or macrophytes (includes sethoxydim, picloram, non-aqueous glyphosate and triclopyr).

The lowest risk group contains those herbicides for which LOCs were either not exceeded, or only exceeded the LOC for aquatic macrophytes. The moderate risk group contains those herbicides for which LOCs were exceeded for two aquatic species groups other than fish. The higher risk group contains those herbicides for which LOCs for fish were exceeded.

The ability of herbicides to come in contact with water once in the soil depends on complex toxicological properties and environmental parameters. A discussion of herbicide characteristics in soil is discussed in the Watershed Analysis for this project. Understanding how the herbicide reacts in soil helps in understanding the probability of adverse effects to aquatic organisms should the herbicide come in contact with water. These characteristics were considered for the analysis of effects from the action alternatives on federally listed and sensitive fish and their habitat.

Clopyralid (Lowest Risk Category)

Studies of clopyralid effects on soil invertebrates have been conducted, including field studies on the effects to microorganisms.

- Soil concentrations from USDA Forest Service applications are expected to be 1,000 less than concentrations that would cause toxic effects. Therefore, no effects to soil invertebrates or microorganisms are expected from use of clopyralid.
- Clopyralid is degraded by soil microbes, with an estimated half-life of 14 to 29 days, meaning that one-half of the amount applied remains in the soils after 90 days, one-fourth of the applied amount remains after 28 to 58 days, one –eight after 42 to 87 days, and so on.
- Increased soil moisture decreases degradation time.
- Clopyralid is weakly adsorbed and has a moderate leaching potential overall but high leaching potential in sandy soils.

Modeling results indicate clopyralid runoff is highest in clay soils with peaks after rainfall events. Clopyralid percolation is highest in sandy loam soils.

There is no probability of exceeding levels of concern for aquatic organisms under the proposed action because expected exposure concentrations in the SERA risk assessments did not exceed any NOEC value for any aquatic organisms analyzed. In addition, there would be no impact to the food web.

Imazapic (Lowest Risk Category)

Imazapic is a relatively new herbicide, and there are no studies on the effects of imazapic on either soil invertebrates or soil microorganisms.

- If imazapic was extremely toxic to soil microorganisms, it is reasonable to assume that secondary signs of injury to microbial populations would have been reported.
- Imazapic degrades in soil, with a half-life of about 113 days.
- Half-life is decreased by the presence of microflora.
- Imazapic is primarily degraded by microbes and it does not degrade appreciably under anaerobic conditions.
- Imazapic is weakly adsorbed in high soil pH, but adsorption increases with lower pH (acidic soils) and increasing clay and organic matter content.
- Field studies indicate that imazapic remains in the top 12 to 18 inches of soil and do not indicate any potential for imazapic to move with surface water.
- Modeling results indicate imazapic runoff is highest in clay and loam soils with peaks after the first rainfall.
- Imazapic percolation is highest in sandy soils.

There is no probability of exceeding levels of concern for fish, invertebrates, or algae under the proposed action because expected exposure concentrations in the SERA risk assessments did not exceed NOEC values. However, at the high application rate (keeping in mind worst-case scenario assumptions) the peak modeled stream concentration of 0.0018 Mg/L did exceed the NOEC value of 0.00127 Mg/L for aquatic macrophytes. The magnitude of difference between these two concentrations is extremely small, a difference of 0.00053. This indicates that the true concentration for aquatic macrophytes is likely to be much lower under the action alternatives, even if there were no buffers. Therefore, it is nearly impossible to indirectly adversely affect fish via the food web under the action alternatives.

Metsulfuron methyl (Lowest Risk Category)

Studies on the effects of metsulfuron methyl on soil biota are limited to Pseudomonas species, though there are a few studies of insects that live in soil. The lowest observed effect concentration is 5 mg/kg, based on the Psuedomonas study. At recommended use rates, no effects are expected for insects.

- Effects to soil microorganisms appear to be transient
- Metsulfuron methyl degrades in soil, with a variable half-life up to 120 days.
- Half-life is decreased by the presence of organic matter though microbial degradation of metsulfuron methyl is slow.
- Non-microbial hydrolysis is slow at high pH but rapid at lower pH.
- Adsorption to soil particles, which affects the runoff potential of metsulfuron methyl, increased with increased pH and organic matter.
- Metsulfuron methyl has low adsorption to clay.
- Modeling results indicate that off-site movement due to runoff could be significant in clay soils.
- Metsulfuron methyl percolates in sandy soils.

There is no probability of exceeding levels of concern for fish, invertebrates, or algae under the proposed action because expected exposure concentrations in the SERA risk assessments did not exceed NOEC values. However, at the high and typical application rates (keeping in mind worst-case scenario assumptions) the peak modeled stream concentration of 0.0015 Mg/L for high application rate and 0.0003 Mg/L for typical did exceed the NOEC value of 0.00016 Mg/L for aquatic macrophytes. The magnitude of difference between these two concentrations is very small, a difference of 0.00053 for high application rates and 0.00284 for typical. Therefore, there is a very low probability of indirectly adversely affecting fish via the food web under the proposed action.

Chlorsulfuron (Moderate Risk Category)

Studies on the effects of chlorsulfuron on soil biota include lab and field studies on nematodes; fungi; populations of actinomycetes, bacteria, and fungi; and soil microorganisms.

- No effects of chlorsulfuron were found for soil biota at recommended application rates, with the exception of transient decreases in soil nitrification.
- The ‘no observable effects concentration’ for soil is 10 mg/kg, based on cellulose and protein degradation.
- Chlorsulfuron degrades in aerobic soil.
- Non-microbial hydrolysis plays an important role in chlorsulfuron breakdown, and hydrolysis rates increase as pH increases.
- Adsorption to soil particles, which affects the runoff potential of chlorsulfuron, is strongly related to the amount of organic material in the soil.
- Chlorsulfuron adsorption to clay is low.
- Chlorsulfuron is moderately mobile at high pH.
- Leaching is reduced when pH is less than six.
- Modeling results indicate that runoff would be negligible in sandy or loamy soils.
- In clay soils, off-site loss could be substantial (up to about 55 percent of the applied amount) in regions with annual rainfall rates of 15 to 250 inches.

There is no probability of exceeding levels of concern for fish or invertebrates under the proposed action because expected exposure concentrations in the SERA risk assessments did not exceed NOEC values. However, at the high application rate the peak modeled stream concentration of 0.05 Mg/L did exceed the NOEC value of 0.01 Mg/L for algae. For aquatic macrophytes, the NOEC value of .000047 Mg/L was exceeded at both typical and high application rates (keeping in mind worst-case scenario assumptions). The NOEC value used in the SERA risk assessment for aquatic macrophytes is 1/10th of the EC50, indicative of a conservative approach in the SERA risk assessments. The magnitude of difference between the expected exposure concentrations and the NOEC value for algae is small and unlikely to be reached under the action alternatives because of PDFs and buffers, as well as label directions.

There is a large magnitude of difference for aquatic macrophytes because of the NOEC value used and the sensitive nature of aquatic macrophytes. Under the proposed action, there is a low risk of impacting aquatic macrophytes, however, impacts would be localized and directed at the individual macrophyte where chlorsulfuron comes in contact with water. However, it is very unlikely that chlorsulfuron would come in contact with water at peak modeled concentrations under the SERA risk assessment because of PDFs, buffers and label direction. If it were to come in contact with water under the proposed action, impacts would not be of any magnitude that would lead to an adverse affect on fish. Therefore, there is a very low probability of indirectly adversely affecting fish via the food web under the action alternatives.

Imazapyr (Moderate Risk Category)

There are no studies on the effects of imazapyr on soil invertebrates, and incomplete information on the effects on soil microorganisms.

One study indicates cellulose decomposition, a function of soil microorganisms, can be decreased by soil concentrations higher than concentrations expected from USDA Forest Service applications.

- There is no basis for asserting adverse effects to soil microorganisms.
- Imazapyr degrades in soil, with a half-life of 25 to 180 days.
- Degradation rates are highly dependent on microbial action.
- Anaerobic conditions slow degradation.
- Adsorption increases with time as soil dries and is reversible.
- Field studies indicate that imazapyr remains in the top 20 inches of soil and do not indicate any potential for imazapyr to move with surface water.
- In forest field studies, imazapyr did not run off and there was no evidence of lateral movement.
- Modeling results indicate imazapyr runoff is highest in clay and loam soils with peaks after the first rainfall.
- Imazapyr percolation is highest in sandy soils

There is no probability of exceeding levels of concern for fish or invertebrates under the proposed action because expected exposure concentrations (EEC) in the SERA risk assessments did not exceed NOEC values. However, at high application rates the peak modeled stream concentration of 1.0 Mg/L did exceed the NOEC value of 0.02 Mg/L for algae and 0.013 Mg/L for aquatic macrophytes. At typical application rates the peak modeled stream concentration of 0.036 Mg/L also exceeded the NOEC values for algae and aquatic macrophytes. The NOEC value used in the SERA risk assessment for aquatic macrophytes is 1/10th of the EC50, indicative of a conservative approach in the SERA risk assessments. The magnitude of difference between the expected exposure concentrations and the NOEC values for algae and aquatic macrophytes is relatively small and unlikely to be reached under the proposed action because of PDFs and buffers, as well as label directions.

Under the proposed action, there is little risk of impacting algae and aquatic macrophytes since emergent vegetation would not be treated. In the event that imazapyr did come into contact with water, impacts would be localized and of short duration, directed at the individual organism that were contacted. It is unlikely that impacts would be of a magnitude that would lead to an adverse affect on fish or invertebrates. Therefore, there is a very low probability of indirectly adversely affecting fish via the food web under the proposed action.

Sulfometuron methyl (Moderate Risk Category)

There are no studies on the effects of sulfometuron methyl on soil invertebrates. However, it is toxic to soil microorganisms. Microbial inhibition is likely to occur at typical application rates and could be substantial. Soil residues may alter composition of soil microorganisms. Sulfometuron methyl applied to vegetation at rates to control undesirable vegetation would probably be accompanied by secondary changes in the local environment that affect the soil microbial community more certainly than direct toxic action of sulfometuron methyl on microorganisms.

- The typical half-life for sulfometuron methyl varies from 10 to 100 days, depending on soil texture. Half-life decreases as soil particle size decreases. Presence of soil microorganisms also decreases half-life, though microbial breakdown occurs slowly. Sulfometuron methyl degradation occurs most rapidly at lower pH soils where rates are dominated by hydrolysis.
- Sulfometuron methyl mobility is generally greater at higher soil pH and lower organic matter content.
- Modeling results indicate sulfometuron methyl runoff is highest in clay and loam soils with peaks after the first rainfall. Sulfometuron methyl percolation is highest in sandy soils. Monitoring results generally support modeling results.
- Sulfometuron methyl applied to vegetation at typical application rates would probably be accompanied by secondary changes to vegetation that affect the soil microbial community more certainly than direct toxic action of sulfometuron methyl on soil microorganisms.

There is no probability of exceeding levels of concern for fish or invertebrates under the proposed action because expected exposure concentrations (EEC) in the SERA risk assessments did not exceed NOEC values. However, at high application rates the peak modeled stream concentration of 0.0076 Mg/L did exceed the NOEC value of 0.0025 Mg/L for algae and 0.00021 Mg/L for aquatic macrophytes. At typical application rates the peak modeled stream concentration of 0.0009 Mg/L exceeded the NOEC value of 0.00021 Mg/L for aquatic macrophytes. The magnitude of difference between the expected exposure concentrations at the high application rates for aquatic macrophytes is 9 times that of the typical application rate. It comes as no surprise as sulfonureas are quite toxic to non-target vegetation. There was no concern for algae at the typical application rate. There is a very low likelihood of impacting algae and aquatic macrophytes under the proposed action because of PDF and buffers, as well as label directions. If any sulfometuron methyl were to come in contact with water, impacts to aquatic macrophytes under the proposed action would be localized and of short duration, directed at the individual organism where the herbicide comes in contact with water. It is unlikely that impacts would be of a magnitude that would lead to an adverse affect on fish or invertebrates. Therefore, there is a very low probability of indirectly adversely affecting fish via the food web under the action alternatives.

Sethoxydim (Poast product, Higher Risk Category)

Sethoxydim was associated with some levels of concern in the R6 2005 FEIS; however risk assessments incorporated the toxicity of the naptha solvent in the Poast® formulation of this herbicide. The toxicity of the sethoxydim alone is about 100 times less for fish than that of the Poast® formulation. Since the naptha solvent tends to volatilize or adsorb to sediments, using Poast® formulation data to predict effects from runoff may overestimate potential effects (SERA 2001). Adverse affects to fish and other aquatic organisms are not likely because the amount of sethoxydim used for this project would be lower than toxic levels, even if the Poast® formulation were used.

- Sethoxydim is degraded by soil microbes, with an estimated half-life of 1 to 60 days. Adsorption of sethoxydim varies with organic material content.
- Modeling results indicate sethoxydim runoff is highest in clay and loam soils with peaks after the first rainfall.

There is no probability of exceeding levels of concern for invertebrates, algae, or aquatic macrophytes under the proposed action because expected exposure concentrations (EEC) in the SERA risk assessments did not exceed NOEC values. However, at both high and typical application rates the peaks modeled stream concentrations of 0.19 Mg/L and 0.15 Mg/L, respectively, did exceed the NOEC value of 0.06 Mg/L for fish and were nearly equal in difference between the EEC and NOEC value. There is very little concern for the magnitude of difference between the EEC and NOEC because it is highly unlikely that sethoxydim (Poast® formulation) would come in contact with water at toxic levels due to the restricted use in riparian areas. Therefore, there is a very low probability of adversely affecting fish.

Picloram (Higher Risk Category)

Picloram is a restricted use pesticide in the states of Washington and Oregon. The persistence of picloram increases with soil concentration, thus increasing the likelihood that it becomes toxic to soil microorganisms in the short-term.

- Since picloram is toxic to microorganisms at low levels, toxic effects can last for some time after application.
- Persistence in soils could affect soil microorganisms by decreasing nitrification.
- Long-term effects to soil microorganisms are unknown.
- Picloram applied at a typical application rate is likely to change microbial metabolism, though detectable effects to soil productivity are not expected.
- Field studies have not noted substantial adverse effects associated with the normal application of picloram that might be expected if soil microbial activity were substantially damaged.
- Substantial effects to soil productivity from the use of picloram over the last 40 years have not been noted.
- Picloram has been studied on a number of soil invertebrates.
- Metabolites may increase toxicity for some soil microorganisms
- Picloram has a typical half-life of 90 days.

- Soil degradation rates vary in soil, depending on application rate and soil depth.
- Picloram is water soluble, poorly bound to soils that are low in clays or organics, has a high leaching potential, and is most toxic in acidic soil.
- Picloram should not be used on coarse-textured soils with a shallow water table, where groundwater contamination is most likely to occur.
- Picloram percolation is highest in loam and sandy soils. However, modeling results indicate picloram runoff (not percolation) is highest in clay soils.

There is no probability of exceeding levels of concern for invertebrates or aquatic macrophytes under the proposed action because expected exposure concentrations (EEC) in the SERA risk assessments did not exceed NOEC values. However, at high and typical application rates the peak modeled stream concentrations of 0.20 Mg/L and 0.07 Mg/L, respectively, did exceed the NOEC value of 0.04 Mg/L (1/20th LC50) for fish. The HQ at typical application rate is 2 compared to 5 at the high application rate for fish, suggesting that exceedances are within the same low range of difference.

Acute exposures can affect fish development, growth, swimming response, and liver histopathology; all referred to as sublethal effects. To account for the potential of sublethal effects, the 1/20th of the LC50 was used in the SERA risk assessment. Exposures that lead to such sublethal effects use an amount of picloram much greater than what would be applied at each treatment site on the Umatilla National Forest.

Acute toxicity of picloram varies considerably with formulation and with fish species. Formulations like Tordon 22K (potassium salt) is known to be considerably less toxic to several fish species compared to ester formulations. Although leached picloram may be transported to aquatic ecosystems as a result of rainfall, studies have shown that less than 5 percent of the picloram applied to a watershed are transported in surface runoff (Norris et al. 1991). Where soil compaction has occurred or where intermittent streams have been treated, residues of picloram could be mobilized following heavy rainfalls.

Adverse affects to fish from the use of picloram under the proposed action are not likely to occur because the probability of picloram contacting water at levels of concern is low. The PDFs and buffers established for picloram greatly reduce the potential for drift, leaching, and runoff. Any amount of picloram in water as a result of drift from spot spray or hand/select applications would be negligible and more than likely not detected because of vegetation interception and distance from the ordinary high water line or bankfull.

For aquatic macrophytes, only the high application rate exceeded the NOEC value of 0.10 (LOEC), resulting in a HQ of 2. Given the low magnitude of difference in EEC and NOEC, as well as the low range of HQs for picloram, it is unlikely that NOEC values for fish and aquatic macrophytes would be exceeded under the proposed action because of the PDFs and buffers established for streams and roads with high potential for herbicide delivery.

Glyphosate (Higher Risk Category)

Glyphosate has been extensively studied and is commonly used by State and Federal agencies within riparian areas. This section includes more information than for previous herbicides because of it's proposed use within aquatic influence zones with spot and hand/select applications of aquatic formulations.

Glyphosate is highly soluble in water but much less so in organic solvents. In general, it is very immobile in soil, being rapidly adsorbed by soil particles, and subject to some degree of microbial degradation. The degree of glyphosate decomposition varies by soil types. Glyphosate is readily metabolized by soil microorganisms and some species can use glyphosate as a sole source of carbon.

- It is degraded by microbial action in both soil and water.
- Glyphosate degrades in soil, with an estimated half-life of 30 days.
- Glyphosate is highly soluble, but adsorbs rapidly and binds tightly to soil.
- Glyphosate has low leaching potential because it binds so tightly to soil.
- Modeling results indicate glyphosate runoff is highest in loam soils with peaks after the first rainfall.

The SERA 2003 risk assessment provides results for two formulations of glyphosate; glyphosate with surfactant (terrestrial formulation, most toxic formulation) and glyphosate without surfactant (aquatic, less toxic formulation).

In aquatic species, the acute lethal potency of glyphosate and glyphosate formulations has been relatively well-defined. The formulation of glyphosate with surfactants, especially the POEA surfactant commonly used in glyphosate formulations, has a pronounced effect on the acute lethal potency of glyphosate.

The primary hazards to fish appear to be from acute exposures to the more toxic formulations. At high and typical application rates, the hazard quotients for the more toxic formulation at the upper ranges of plausible exposure indicate that the 1/20th LC50 values for listed fish will be exceeded under worst-case conditions. The more toxic formulation did exceed the toxicity endpoints for invertebrates and aquatic plants at the high application rate of 7 lbs a.e./acre. In the worst-case scenarios, the exposure estimates are based on a severe rainfall (about 7 inches over a 24 hour period) in an area where runoff is favored – a slope toward a stream immediately adjacent to the application site. This is a standard worst-case scenario used in Forest Service risk assessments to guide the Forest Service in the use of herbicides. The SERA 2003 risk assessment strongly suggests that the use of the more toxic formulations near surface water is not prudent. Therefore, the proposed action has included a 100 ft buffer for broadcast applications and a 50 foot buffer for spot and hand/select applications for the more toxic formulations of glyphosate. In addition, no broadcasting is permitted on roads with high potential for herbicide delivery. This greatly lowers the probability of toxic formulations of glyphosate coming in contact with water at levels of concern.

The less toxic formulation did slightly exceed the toxicity endpoint used for fish at high and typical application rates, 6 and 2 respectively. However, there are no exceedances for invertebrates or aquatic plants. Exceedance is based on the 1/20th LC50 value rather than a NOEC. Thus, the use of less toxic formulations of glyphosate (aquatic) near bodies of water where salmonids may be found is limited to spot and hand/select methods up to the edge of water.

Sub-lethal Effects

In the SERA 2003 risk assessment, the term “sub-lethal” is intended to designate effects that may impact reproduction, behavior, or the ability to respond to other stressors. For chronic exposures to glyphosate, the most relevant study remains the life cycle toxicity studies done in fathead minnow. As summarized in the U.S. EPA/OPP (1993c), no effect on mortality or reproduction was observed at a concentration of 25.7 mg/L using 87.3% pure technical grade glyphosate. The full life-cycle toxicity study was conducted in fathead minnow, a standard chronic toxicity that was required by and accepted by the U.S. EPA (1993a). In this study, the NOEC was 25.7 mg/L (U.S. EPA, 1993a, p. 41). It is important to note that the NOEC from this full life-cycle toxicity study not only indicates a lack of mortality but also indicates that the fish were able to reproduce normally. The life cycle NOEC of 25.7 mg/L was used as the most appropriate basis for risk characterization in the SERA 2003 risk assessment.

To account for uncertainty regarding sub-lethal effects, an amount of 0.5 Mg/L was used as the toxicity threshold for listed fish under the R6 2005 FEIS. This amount is the 1/20th of the acute LC50 (U.S. EPA, 2004) for glyphosate, which is 51 times less than the chronic (long-term exposures) toxicity threshold of 25.7 Mg/L.

If a full life-cycle of fish showed no adverse affects at a long-term exposure of 25.7 Mg/L (NOEC endpoint), the probability of a fish adversely affected at short-term exposure of 0.5 Mg/L is low (See the BE for this EIS, available upon request from the Project Record at the Umatilla NF in Pendleton, OR).

Effects of Surfactants

Appendix 3c of the SERA 2003 risk assessment summarizes the available ecological information from all of the Material Safety Data Sheets (MSDS) for the formulations that are labeled for forestry applications. It is apparent that these formulations fall into relatively clear groups. The most toxic formulations appear to be Credit Systemic, Credit, Glyfos, Glyphosate, glyphosate Original, Prosecutor Plus Tracker, Razor SPI, Razor, Roundup Original, Roundup Pro Concentrate, and Roundup UltraMax. It may be presumed that these formulations contain the most toxic surfactants. Other formulations such as Aqua Neat, Aquamaster, Debit TMF, Eagre, Foresters' Non-Selective Herbicide, Glyphosate VMF, and Roundup Custom are much less acutely toxic.

For the SERA 2003 risk assessment, the uncertainties involving the presence or absence of a surfactant and the possibly differing effects of using various surfactants cannot be resolved with certainty. Toxicity of glyphosate is characterized based on the use of a surfactant, either in the formulation or added as an adjuvant in a tank mixture. The R6 2005 FEIS addresses this uncertainty through Standard #18.

The polyethoxylated tallow amine (POEA) surfactant used in some glyphosate formulations is substantially more toxic to aquatic species than glyphosate and substantially more toxic than other surfactants that may be used with glyphosate. Two aquatic toxicity studies (Folmar et al. 1979, Wan et al. 1989) have been conducted on glyphosate, the POEA surfactant, and a Roundup formulation which permit a quantitative assessment of the relative toxicities of glyphosate and POEA as well as an assessment of potential for toxicologic interactions (i.e., synergism or antagonism) in combined exposures to these agents. Both of these studies indicate that POEA is substantially more toxic than glyphosate and that POEA surfactant is the primary toxic agent of concern. Therefore, the proposed action PDF F3 does not allow the use of POEA within 150 feet of surface water, wetlands, or on roads with high potential for herbicide delivery.

Toxicity of Roundup to aquatic organisms because of the POEA surfactant was known by Monsanto when Roundup was originally labeled in 1978 and data were provided to the Environmental Protection Agency (EPA). This is why the formulation was not registered for aquatic use; nor are glyphosate-containing products with POEA now registered for aquatic use. Most glyphosate-containing products that are registered for aquatic use are manufactured without surfactant. Standard #18 of the R6 2005 FEIS states that only those surfactants reviewed in Forest Service hazard and risk assessment documents would be approved for use.

Nonyphenol polyethoxylate (NPE) based surfactants were also analyzed under the R6 2005 FEIS and did not exceed any LOC for fish, invertebrates, algae, or aquatic macrophytes.

Off-site drift

Estimates of drift for ground applications are included in the SERA risk assessments. In ground broadcast applications, glyphosate will typically be applied by low boom ground spray and thus these estimates are used in the SERA risk assessment. Drift associated with backpack (directed foliar applications) are likely to be much less than from broadcast.

In typical backpack ground sprays, droplet sizes are greater than 100 µ, and the distance from the spray nozzle to the ground is 3 feet or less. In mechanical sprays, raindrop nozzles might be used. These nozzles generate droplets that are usually greater than 400 µ, and the maximum distance above the ground is about 6 feet. In both cases, the sprays are directed downward.

For most applications, the wind velocity will be no more than 5 miles/hour, which is equivalent to approximately 7.5 feet/second (1 mile/hour = 1.467 feet/second). Assuming a wind direction perpendicular to the line of application, 100 µ particles falling from 3 feet above the surface could drift as far as 23 feet (3 seconds @ 7.5 feet/second). A raindrop or 400 µ particle applied at 6 feet above the surface could drift about 3 feet (0.4 seconds @ 7.5 feet/second). This suggests that there is a reasonable probability of some off-site drift from spot applications that occur up to the water's edge. Label requirements as well as PDFs and buffer distances account for significant off-site drift that could occur from broadcasting under the proposed action. For spot applications, the amount of drift is likely to be significantly less than from broadcast, therefore, the magnitude of effects on fish, invertebrates, and aquatic plants as a result of drift is very low. When spot treatments of herbicide using hand-held equipment are made, the applicator has direct control of where the spray solution is applied and little, if any, herbicide comes in contact with standing water.

Runoff

Glyphosate or any other herbicide may be transported to off-site soil by runoff or percolation. Both runoff and percolation are considered in estimating contamination of ambient water. For assessing off-site soil contamination, however, only runoff is considered. This is similar to the approach used by U.S. EPA (1995) in their exposure assessment for terrestrial plants. The approach is reasonable because off-site runoff will contaminate the off-site soil surface and could impact non-target plants. Percolation, on the other hand, represents the amount of the herbicide that is transported below the root zone and thus may impact water quality but should not affect off-site vegetation.

Based on the results of the GLEAMS modeling for the Blue Mountain Ecotype, the proportion of the applied glyphosate lost by runoff was estimated for clay, loam, and sand at rainfall rates ranging from 5 inches to 250 inches per year. Results indicate that there is the potential for glyphosate to reach streams at or above the toxicity value for fish, invertebrates, and aquatic plants under the worst-case scenario model.

In the flatter areas of UNF, such as valley bottoms, slope is likely to be less than the 10% modeled, decreasing the potential for stream herbicide concentrations. In the upper portions of the watersheds on UNF slopes exceed the 10% modeled, therefore there would be an increase of the potential for herbicide delivery from broadcast situations. However, it is highly unlikely that estimates from the GLEAMS model scenarios would be reached under the proposed action because actual application does not match well the scenario used in the model. Examples of scenario inputs that would differ at actual treatment sites include: interception of herbicide by vegetation, prohibited use of broadcasting in riparian areas, and the presence of organic matter in the soil. The presence of organic matter in soil significantly reduces delivery of glyphosate to streams.

Dose Response Assessment

The U.S. EPA/OPP (1993c) classified technical grade glyphosate as non-toxic to practically non-toxic in freshwater fish and LC50 values for glyphosate are in the range of 70 to 170 mg/L. In addition, the U.S. EPA/OPP (1993c) used the NOEC of 25.7 mg/L from life cycle toxicity study on technical grade glyphosate using fathead minnow and concluded that: "technical glyphosate should not cause acute or chronic adverse effects to aquatic environments. Therefore, minimal risk is expected to aquatic organisms from the technical glyphosate".

The selection of the 1/20th of the LC50 as the toxicity values by U.S. EPA (2004) addresses the higher sensitivity of some species of fish to technical grade glyphosate. Trout and other salmonids have much lower LC50 than those cited by U.S. EPA/OPP in 1993, with the lowest LC50 value for salmonids of 10 mg glyphosate/L, for trout in soft-water. The use of 0.5 Mg/L for the less toxic formulation was used as the toxicity value for listed fish and accounts for potential sub-lethal effects. For the more toxic formulation a toxicity value of 0.065 Mg/L was used.

There is a magnitude of difference in toxicity between glyphosate without surfactant and glyphosate with surfactant. Using the toxicity values, glyphosate with surfactant is more toxic than glyphosate without surfactant by a factor of about 8 (HQ 43 ÷ HQ 6). It is unlikely that the proposed action would result in HQ of 6 for the less toxic formulation because of the limitations on application methods. In addition, field studies done by DOA support the expectation that amounts would not exceed any level of concern.

Eyed eggs of fish seem to be a resistant life stage, with sensitivity increasing as the fish enters the sac-fry and swim-up stages.

For invertebrates and algae, there is a very low probability of adverse affects at the highest application rates for glyphosate with surfactant. Results for the worst-case scenario using the 1/10th of the LC50 for invertebrates (1.1 Mg/L) and 0.89 NOEC for aquatic plants are not likely to be reached because there will be no broadcasting within riparian areas.

Triclopyr (Higher Risk Category)

Five commercial formulations of triclopyr, either as the triethylamine (TEA) salt or the butoxyethyl ester (BEE) are currently registered for forestry applications and are covered in the SERA 2003 risk assessment. Physical, chemical, and biochemical properties of triclopyr can be found on page 2-10 and 2-11 in the SERA 2003 Triclopyr Risk Assessment. This section includes more information than for previous herbicides because of its proposed use within aquatic influence zones with spot and hand/select applications of aquatic formulations. For aquatic formulations, there is a 15 ft buffer on waterbodies for spot applications and hand/select methods can be used up to the water's edge.

Triclopyr BEE is much more toxic to aquatic organisms than triclopyr TEA. A breakdown product, TCP (3,5,6-trichloro-2-pyridinol), is more toxic than either form of triclopyr. In forestry applications, the primary concern is the formation of TCP as a soil metabolite. TCP is more persistent than triclopyr in soil and is relatively mobile in soil, thus able to come in contact with water near the site of application. TCP is of concern to the SERA 2003 risk assessment both because it is a metabolite of triclopyr and because the aggregate risks of exposure to TCP from the breakdown of both triclopyr and chlorpyrifos (insecticide) must be considered.

Data indicate that Garlon 3A (the triethylamine salt of triclopyr) is only slightly toxic or practically non-toxic to organisms tested. Garlon IV (butoxyethyl ester of triclopyr), however, is highly toxic to fish, whereas unformulated triclopyr is only slightly toxic. Project Design Features do not allow the use of Garlon IV within 50 feet of surface waters, thereby reducing the probability of fish coming in contact with Garlon IV. The long-term persistence of triclopyr does not seem to be a significant problem in forest settings because of its rapid disappearance. Photo-degradation is a major reason for the disappearance of triclopyr from water (Norris et al. 1991).

Exposure scenarios modeled in the SERA risk assessments are likely to significantly overestimated the risk of acute adverse affects from the application of triclopyr because triclopyr would only be applied by spot or hand methods (as per R6 2005 ROD standard 16), and not broadcast sprayed over 10 acres as depicted in the model scenario. The likelihood of toxic levels of triclopyr coming in contact with water is very low.

- Triclopyr has an average half-life in soil of 46 days, while TCP has an average half-life in soil of 70 days. Warmer temperatures decrease the time to degrade triclopyr.
- Soil adsorption is increased as organic material increases and decreased as pH increases. Triclopyr is weakly adsorbed to soil, though adsorption varies with organic matter and clay content. Both light and microbes degrade triclopyr.

Fish - There is a substantial difference between the toxicity of triclopyr acid and the toxicity of triclopyr BEE formulations, and the difference is reflected in the toxicities of the Garlon formulations (SERA 2003). As shown by Wan et al. (1989), Garlon 4 is more toxic than Garlon 3A by a factor of about 200 (150-230). This difference in toxicity is substantially greater than the difference in toxicity between triclopyr BEE and triclopyr acid. As indicated by Wan et al. (1989), the increased difference appears to be attributable to the toxicity of Garlon 3A, based on the level of triclopyr acid in this formulation. The level of triclopyr BEE in Garlon 4 appears to account for practically all of the toxicity of Garlon 4 (i.e., the ratios of observed to predicted LC50 values do not vary remarkably from unity for Garlon 4). Although Garlon 4 contains kerosene (see section 2.2 of the SERA 2003), the toxicity of kerosene to aquatic species is approximately 100-1,000 fold less than triclopyr BEE [LC50 values of approximately 200-3,000 mg/L (SERA 2003)], supporting the observation that the toxicity of Garlon 4 can be completely accounted for by the toxicity of triclopyr BEE.

Sub-lethal Effects

The sublethal effects of Garlon 4 on salmonid (rainbow trout) has been examined by Johansen and Geen (1990) using flow-through systems. Fish were found to be lethargic at concentrations of 0.32-0.43 mg/L. At levels <0.1 mg/L, fish were hypersensitive over 4-day periods of exposure. This is reasonably consistent with the threshold for behavioral changes in rainbow trout for Garlon 4 of 0.6 mg/L (Morgan et al. 1991). The corresponding threshold for behavioral changes to Garlon 3A was 200 mg/L (Morgan et al. 1991) is consistent with the relative acute lethal potencies of these two agents (SERA 2003).

Subchronic toxicity data are available only on the triethylamine salt of triclopyr and only in fathead minnows (Mayes et al. 1984; Mayes 1990c). In this study, fathead minnow eggs were exposed to concentrations of 26, 43, 65, 104, 162, and 253 mg/L for 28 days covering the development from egg to fry. The survival of fathead minnows (embryo-larval stages) was significantly reduced at 253 mg/L compared with control animals. At 162 mg/L, there was a slight decrease in body length. No effects were noted at any of the lower concentrations (SERA 2003). Janz et al. (1991) noted that sublethal exposures of coho salmon to various formulations of triclopyr do not appear to cause signs of physiological stress.

To account for uncertainty regarding sub-lethal effects from triclopyr acid and triclopyr BEE, the toxicity values of 0.26 Mg/L and 0.012 Mg/L, respectively, was for the R6 2005 FEIS. Both amounts are the 1/20th of the acute LC50 (U.S. EPA, 2004) for triclopyr, compared to the chronic NOEC of 104 Mg/L.

Aquatic Invertebrates

The available LC50 values cited in SERA 2003 suggest that most invertebrates are about equally or somewhat less sensitive than fish to the various forms of triclopyr. Some families of invertebrates (Ephemeroptera, Plecoptera, Trichoptera, Odonata) are much more resistant than fish to Garlon 4 (SERA 2003). The 1/10th of the LC50 (0.855 Mg/L) was used for the R6 2005 FEIS and was barely exceeded by 0.645 for triclopyr BEE at the high application rate.

Aquatic Plants

Triclopyr and triclopyr formulations have been subject to a standard set of bioassays in aquatic plats, both algae and macrophytes, that are required for the registration of herbicides. Based on EC50 values, triclopyr TEA is about equally toxic to both algae (lowest EC50 of 5.9 ppm a.i.) and macrophytes (lowest EC50 of 8.8 ppm a.i.). As with toxicity to fish and invertebrates, triclopyr BEE is more toxic with EC50 values as low as 0.88 ppm a.i. for macrophytes and 0.1 ppm for algae (SERA 2003). The R6 2005 FEIS used a toxicity value of 0.007 Mg/L (1/10th of EC50) for triclopyr BEE and 0.42 Mg/L (1/10th of EC50) for aquatic plants. There is a magnitude of difference between the exposures of triclopyr BEE and triclopyr acid at high application rates.

Off-site Drift

This is the same as for glyphosate. Under the proposed action, spot applications have a 15 foot buffer from the ordinary high water mark or bankfull.

Run-off

This is the same as for glyphosate. There are also substantial differences in the environmental fate of triclopyr TEA and triclopyr BEE. Both of these factors were considered in the SERA risk assessment. Triclopyr TEA will dissociate almost instantaneously to triclopyr acid in water. Thus, the toxicity of triclopyr TEA and triclopyr acid are essentially the same when expressed as acid equivalents. Triclopyr BEE, on the other hand, will degrade quickly but not instantaneously to triclopyr acid. This makes a substantial difference in the results from acute toxicity bioassays because, as summarized in the SERA 2003 risk assessment, the octanol water partition coefficient for triclopyr BEE (about 10,233) is higher than that of triclopyr acid (about 0.35 at pH 7) by a factor of nearly 30,000 [10,233÷0.35=29,237]. The much higher octanol water partition coefficient for triclopyr BEE will lead to much more rapid uptake of this form relative to triclopyr acid and this probably accounts for the much higher acute toxicity of triclopyr BEE relative to triclopyr acid.

Both forms of triclopyr will rapidly leach in very sandy soils after heavy rainfall. Since the maximum concentrations from the GLEAMS modeling is based on a rainfall event that occurs one day after application, relatively little triclopyr BEE is transformed to triclopyr acid and the peak concentrations are essentially equivalent. For both clay and loam soils, the maximum concentrations of triclopyr BEE (66 ppb in clay and 92 ppb in loam) are less than that of triclopyr acid (428 ppb for clay and 308 ppb for loam) because of the somewhat higher binding to organic matter in soil and consequent lesser runoff of triclopyr BEE relative to triclopyr acid in these soils. Triclopyr BEE will rapidly hydrolyze to triclopyr acid in water and "chronic" exposure to triclopyr BEE is not possible.

Dose Response Assessment

The acute risks associated with the use of triclopyr TEA are extremely low but the risks associated with the use of triclopyr BEE are obvious. TCP is about as acutely toxic to fish as triclopyr BEE.

Although triclopyr BEE is much more toxic to aquatic species than triclopyr TEA or triclopyr acid, the potential for exposure under the proposed action is much less because of the rapid hydrolysis of triclopyr BEE to triclopyr acid as well as the lesser runoff of triclopyr BEE because of it's lower water solubility and higher affinity for soils. Buffers and PDFs will reduce the likelihood of triclopyr BEE coming in contact with water.

TCP

TCP (3,5,6-trichloro-2-pyridinol) is a major metabolite of triclopyr and is found in both soil and water. In mammals, TCP has about the same toxicity as triclopyr. Whereas, in fish TCP is substantially more toxic than either triclopyr acid or triclopyr TEA, with acute LC50 values in the range of about 2 to 10 ppm, similar to the toxicity of triclopyr BEE. An early life-stage study has been conducted in rainbow trout by Marino et al. 1999 (SERA 2003). The most sensitive endpoint involved growth – i.e., length and weight– with an NOEC of 0.0808 mg/L and an LOEC of 0.134 mg/L. Thus, TCP appears to be much more toxic than triclopyr TEA, for which the corresponding values in an early life stage study in the fathead minnow are 104 mg/L and 162 mg/L.

Because triclopyr and chlorpyrifos degrade at different rates, maximum concentration in soil, and hence maximum runoff to water, will occur at different times. Thus, in order to provide the most conservative estimate of exposure to TCP, the maximum concentrations reported in SERA 2003 reflect applications of triclopyr and chlorpyrifos spaced in such a way as to result in the maximum possible concentrations of TCP in water. This extremely conservative approach is discussed further in SERA 2003.

There are substantial differences in the toxicity of triclopyr TEA and triclopyr BEE to aquatic species and substantial differences in the environmental fate of triclopyr TEA and triclopyr BEE. Thus, the SERA Risk Assessment for Triclopyr ran a separate set of GLEAMS models using triclopyr BEE as the parent compound and triclopyr acid as the metabolite.

Barron et al. (1991) investigated the pharmacokinetics and metabolism of triclopyr (BEE) in yolk-sac fry of the coho salmon (Oncorhynchus kisutch) and found that the accumulation of triclopyr BEE was limited in the fish due to rapid hydrolysis to triclopyr acid, which was the principal metabolite in fish and water, accounting for over 99% of total residue. No TCP was detected in any residue or in test water.

The risk assessment by EPA does not specifically address concerns for contamination of water wit TCP as a soil metabolite of triclopyr and chlorpyrifos. Concentrations of TCP in a small stream could reach up to 11 ppb from the use of triclopyr at a rate of 1 lb/acre and up to 68 ppb in a small stream from the use of triclopyr at a rate of 1 lb/acre and chlorpyrifos at a rate of 1 lb/acre. Much lower peak concentrations would be expected in small ponds.

There is very little monitoring data with which to assess the plausibility of the modeling for TCP (SERA 2003). As discussed by U.S. EPA/OPP (1998a, p. 65ff), TCP is seldom detected in surface water after applications of triclopyr that result in triclopyr concentrations of up to about 25µg/L, with a limit of detection (LOD) for TCP of 10 µg/L. Thompson et al. (1991) examined the formation of TCP from triclopyr in a forest stream. Consistent with the results reported by U.S. EPA, these investigators failed to detect TCP (LOD=50 µg/L) in stream water with concentrations of triclopyr up to 140 µg/L. This is at least consistent with the GLEAMS modeling of both triclopyr and TCP. As shown in SERA 2003, the maximum modeled concentrations of triclopyr in stream water range from about 161 to 428 µg/L (for sandy and clay soils respectively) and the corresponding maximum modeled concentration of TCP in stream water range from about 5 to 11 µg/L. Thus, given the LOD of 50 µg/L in the study by Thompson et al. (1991), the failure to find TCP in stream water is consistent with the GLEAM modeling (SERA 2003).

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