

B O N N E V I L L E   P O W E R   A D M I N I S T R A T I O N

# Hood River Monitoring and Evaluation Project

Annual Report 2002 - 2003

February 2004

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# Hood River Production M&E

## Hood River Monitoring and Evaluation Project

Annual Report

October 2002 – September 2003

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## EXECUTIVE SUMMARY

The Hood River Production Program Monitoring and Evaluation Project is co-managed by the Confederated Tribes of Warm Springs (CTWSRO) and the Oregon Department of Fish and Wildlife. The program is divided up to share responsibilities, provide efficiency, and avoid duplication. From October 2002 to September 2003 (FY 03) project strategies were implemented to monitor, protect, and restore anadromous fish and fish habitat in the Hood River subbasin. A description of the progress during FY 03 is reported here. Additionally an independent review of the entire program was completed in 2003. The purpose of the review was to determine if project goals and actions were achieved, look at critical uncertainties for present and future actions, determine cost effectiveness, and choose remedies that would increase program success. There were some immediate changes to the implementation of the project, but the bulk of the recommendations will be realized in coming years.

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## INTRODUCTION

The Hood River subbasin supports four species of anadromous salmonids: chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), steelhead (*Oncorhynchus mykiss*), and sea run cutthroat trout (*Salmo clarki*). Indigenous spring chinook salmon were extirpated in the late 1960's. The naturally spawning spring chinook salmon currently present in the subbasin are progeny of Deschutes River stock. Historically, the Hood River subbasin hatchery steelhead program utilized out-of-basin stocks. Indigenous stocks of summer and winter steelhead were listed as a "Threatened Species" in March 1998 by National Marine Fisheries Service (NMFS) under the Endangered Species Act (ESA) as part of the genetically similar steelhead in the Lower Columbia Basin.

Measure 703(f)(5) of the Northwest Power Planning Council's (NPPC) 1987 Fish and Wildlife Program recommended Bonneville Power Administration (BPA) investigate the feasibility of developing artificial production facilities for chinook salmon and steelhead in the Hood, Umatilla, Walla Walla, Grande Ronde, and Imnaha rivers (Northeast Oregon Hatchery Project). The Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) and the Oregon Department of Fish and Wildlife (ODFW) began the Hood River Production Master Plan process in 1988 under the planning umbrella of the Northeast Oregon Hatchery Project (NEOH). However, in 1991 the NPPC separated out and linked the Hood River portion of the NEOH to the Pelton Ladder Project on the Deschutes River. The Pelton Ladder Project converted an unused section of the fish ladder into a rearing facility for spring chinook salmon destined for the Hood.

In 1992, the NPPC approved the Hood River and Pelton Ladder Master Plans (O'Toole and ODFW, 1991a and 1991b; Smith and CTWSRO, 1991) within the framework of the Columbia River Basin Fish and Wildlife Program and recommended adoption of a phased approach consisting of evaluation studies, project implementation, and follow-up monitoring and evaluation studies. A comprehensive monitoring and evaluation (M&E) program was implemented in the Hood River subbasin in late 1991, including information on the life history and production of stocks of anadromous salmonids returning to the Hood River subbasin (Olsen et al., 1994). Information collected for the Hood River Production Program (HRPP) was used to prepare an environmental impact statement evaluating the effect of the HRPP (DOE and BPA, 1996a and 1996b).

The HRPP is jointly implemented by the CTWSRO and the ODFW. The primary goals of the HRPP are to: (1) re-establish naturally sustaining spring chinook salmon using Deschutes River stock in the Hood River subbasin, (2) rebuild naturally sustaining runs of summer and winter steelhead in the Hood River subbasin, (3) maintain the genetic characteristics of the populations, (4) protect high quality habitat and restore degraded fish habitat, and (5) contribute to tribal and non-tribal fisheries, ocean fisheries, and the NPPC's interim goal of doubling salmon runs. Data collected by the HRPP has been summarized annually in the following progress reports: Olsen et al., 1994; Olsen et al., 1995; CTWSRO and ODFW, 1996; Lambert et al., 1998; Olsen et al., 2000; Lambert et al., 2001; and this report.

The HRPP Program Review was completed in December 2003. This review was a requirement of the Draft Hood River Fisheries Program Environmental Impact Statement of March 1996. The primary objective of the Program Review was to comprehensively determine the need, nature, and opportunity for adaptive management actions within the HRPP. S.P. Cramer and Associates conducted this review with input and data from ODFW and CTWSRO. Following the completion of the document, ODFW and CTWSRO discussed management options following the recommendations of the Program Review. Collectively the two entities decided that the HRPP should not sustain any changes to fish production levels until Powerdale Dam is removed. Further, CTWSRO supports and is planning to pursue the recommendation of moving the spring chinook production from the Pelton Ladder on the Deschutes River, to the Parkdale Fish Facility on the Middle Fork Hood River.

This report summarizes the work for the fiscal year 2003 (FY03). Work implemented during this period included: (1) acclimation of hatchery summer and winter steelhead smolts and hatchery spring chinook salmon, (2) Hood River water temperature studies, (3) estimates of the spring chinook returns in 2003, (4) spring chinook salmon spawning ground surveys on the West Fork Hood River, (5) monitoring of ecological concentrations and analysis of the effects of organophosphate pesticides on steelhead



[contractual service with ODEQ and PSU], (6) salvage activities in irrigation canals, (7) project implementation of early action habitat protection and restoration projects utilizing habitat surveys, (8) management oversight and guidance to BPA and ODFW engineering on HRPP facilities, and (11) preparation of this annual report.

## ACCLIMATION

### **Introduction**

Acclimation procedures implemented by the HRPP are designed to reduce straying, mortality, and residualism as much as possible. Winter and summer steelhead and spring chinook salmon were acclimated near primary spawning habitat in spring of 2003 with the intent that they would imprint and home back to ideal spawning areas. Typically smolts were acclimated a minimum of six days prior to volitional release from the acclimation ponds to reduce stress and improve survival. The smolts were allowed to emigrate volitionally when physiologically and morphologically ready. Non-migrants were then sampled for length and weight, and transported to the mouth of the Hood River, and then released. This is done to reduce residualism and instream competition between hatchery and wild fish.

All hatchery produced spring chinook salmon and winter steelhead smolts have been acclimated and volitionally released since 1996, and all Hood River hatchery summer steelhead smolts have been acclimated and volitionally released into the Hood River subbasin since 1999. Both permanent and temporary facilities were used for acclimation and release in 2003. Two concrete raceways were used for hatchery winter steelhead acclimation. One raceway was on the East Fork Hood River (Rm 20.5) and the other was on the Middle Fork Hood River (Rm 18). Two portable acclimation raceways on the West Fork Hood River (Rm 21 and Rm 26.5) and one concrete raceway on the Middle Fork Hood River (Rm 18) were used for acclimating hatchery spring chinook salmon. One portable acclimation raceway was used for acclimating hatchery summer steelhead on the West Fork Hood River (Rm 21). Prior to the acclimated release of hatchery winter steelhead and spring chinook salmon smolts in 1996 and hatchery summer steelhead in 1999, all smolts were directly released into the Hood River subbasin.

The current target hatchery production goal for the HRPP is 50,000 winter steelhead and 40,000 summer steelhead smolts. Juvenile hatchery winter and summer steelhead (Hood River broodstock) are reared at Oak Springs Hatchery on the Deschutes River. The Hood River summer steelhead brood collection began during the 1997-98 run. Approximately 61,000 to 100,000 Foster (Skamania) stock summer steelhead smolts have been released annually into the Hood River subbasin above Powerdale Dam (Rm 4.5) from the 1987-1997 broods. Beginning with the 1998 brood all Foster stock hatchery summer steelhead smolts were released below Powerdale Dam (Olsen et al., 2000).

The current target hatchery production goal for the HRPP is 125,000 spring chinook salmon smolts. Beginning with the 1991 brood of spring chinook, Carson stock was not released and the HRPP began using Deschutes stock. Juvenile hatchery spring chinook salmon have been reared at Round Butte Hatchery (RBH) since the 1993 brood. Prior to the 1993 brood, spring chinook salmon juveniles were reared at Bonneville Hatchery, except for a small number that was reared at RBH for the 1991 brood. Facilities at RBH and the Pelton Ladder (cells 4 and 5) were used to rear the spring chinook 2003 Hood River releases.

### **Methods**

#### *Winter Steelhead*

Hatchery winter steelhead smolts were acclimated and volitionally released on the East Fork and Middle Fork Hood Rivers (Figure 1). Hatchery winter steelhead smolts were acclimated in two groups and then volitionally released from the concrete raceways using a stop log system at both the East Fork Irrigation District (EFID) sand trap (Figure 2) and the Parkdale Fish Facility. Approximately 23,000 smolts averaging 5.8 fish/lb were released into the East Fork Hood River in spring 2003 from the EFID sand trap. In the Middle Fork Hood River, approximately 26,000 smolts averaging 5.7 fish/lb were volitionally released in 2003 from the Parkdale Fish Facility.

An acclimation caretaker was on site 24 hr/d at the EFID sand trap and at the Parkdale Fish Facility. Water temperatures and dissolved oxygen were recorded regularly during the 2003 acclimations. Winter steelhead smolts were weighed (g) and measured (mm) and condition factors calculated ( $\text{weight [g]} \times 100 / \text{length}^3 [\text{mm}]$ ) prior to transfer to the acclimation sites. Smolts that remained in the acclimation raceways (non-migrants) were counted, weighed (g), and measured (mm), and then hauled by truck in a portable liberation tank in May and released near the mouth of the Hood River.

Post-acclimated outmigrating smolts were sampled at rotary screw traps by ODFW at their respective forks and at Rm 4.5 on the mainstem Hood River (Figure 1). Outmigration timing was monitored and compared to naturally produced rainbow/steelhead migrants. Comparisons were made between acclimated hatchery winter steelhead smolts and wild rainbow/steelhead migrants. ODFW project staff cannot differentiate between naturally produced summer and winter steelhead smolts and resident rainbow. All trapped fish were anesthetized, sorted by species, examined for fin marks, and counted. ODFW used mark and recapture methods to estimate the abundance of wild, natural, and hatchery produced anadromous salmonid smolts that migrated from the Hood River subbasin. Only captured numbers will be considered in this report. Outmigration timing was based on daily numbers at the migrant trap.

### *Summer Steelhead*

Hatchery summer steelhead smolts have been acclimated and volitionally released on the West Fork Hood River (Rm 9.0) since 1999 at the Blackberry Creek acclimation site (Figure 1). Unlike the East Fork, the West Fork Hood River and Blackberry Creek water is not heavily influenced by glacial runoff or irrigation withdrawal. However, the Blackberry Creek acclimation site is in a remote canyon with no electricity, making acclimation set-up more difficult.

The Blackberry Creek acclimation site is an old rock quarry near Dry Run Bridge and is within preferred spawning and rearing habitat for summer steelhead. In 2003, smolts were acclimated in a portable acclimation raceway, with dimensions of 11'9" x 60'7" x 4'9". The portable raceway was purchased from ModuTank, Inc. and is constructed from four foot galvanized steel panels bolted together, "L" braces and stainless steel cables for support, a 36 mm reinforced polypropylene liner, and a six inch PVC bulkhead for draining the raceway (Figure 3). ODFW has previously used this type of portable raceway on the Siuslaw River (Lindsay et al., 1991; Lindsay et al., 1992; Lindsay et al., 1993; Lindsay et al., 1994).

Assembly of the two (one for summer steelhead and one for spring chinook) ModuTank portable raceways and piping began in mid March and took two weeks to complete with the help of a six person contracted crew. Water for the raceways was diverted from Blackberry Creek through a screened intake box and a 930 ft gravity flow pipeline of 8" pipe (Figure 4). There was approximately 38 ft of head differential between the intake box and the raceways. The return flow back to the West Fork Hood River consisted of 360 feet of 8" pipe. Control valves regulated water at the intake box, the junction of the two raceways, and at each raceway outlet. A bracing and support system was constructed for the pipeline. Once the raceways were erected, a four-foot high, six-inch diameter PVC standpipe was connected to the outlet bulkhead of each raceway to control the water level. The standpipes were also used to release fish and to drain the raceways when needed. The raceways were covered with a fine mesh net and fabric discs to prevent fish from jumping out, protect them from predators, and create shade refuge. A battery operated flotation alarm system was attached to each raceway during acclimation. The alarm system sounded when the water level increased or decreased. The contact points of the alarm could be adjusted to trigger at various water depths.

Hatchery summer steelhead smolts were acclimated in three groups in 2003 at the Blackberry Creek acclimation site. There were problems with the ODFW transport truck, which caused delays in receiving the second group. The second group of fish was delivered in multiple trips with smaller trucks, which spread out the arrival over the course of a week. Instead of delaying all of the releases, we continued with the original schedule, which meant that some of the late fish from the second group were only acclimated for a short period. Smolts were volitionally released from the portable raceway utilizing an aluminum hopper. The hopper was constructed with a rectangular "V" shaped bottom, three vertical sides, one open side and the "V" bottom connected to a six-inch diameter pipe.

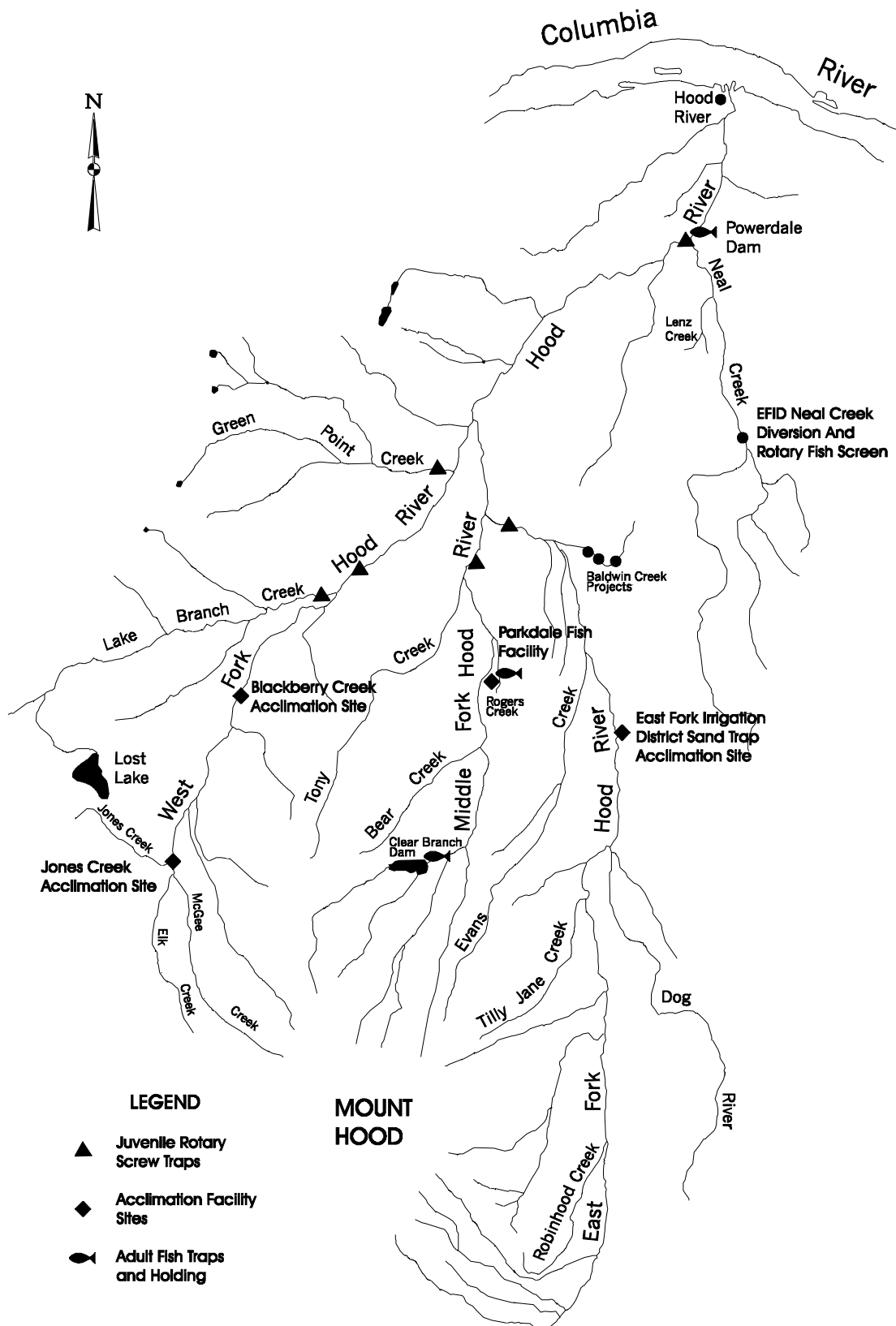


Figure 1. CTWSRO and ODFW project sites in the Hood River subbasin.

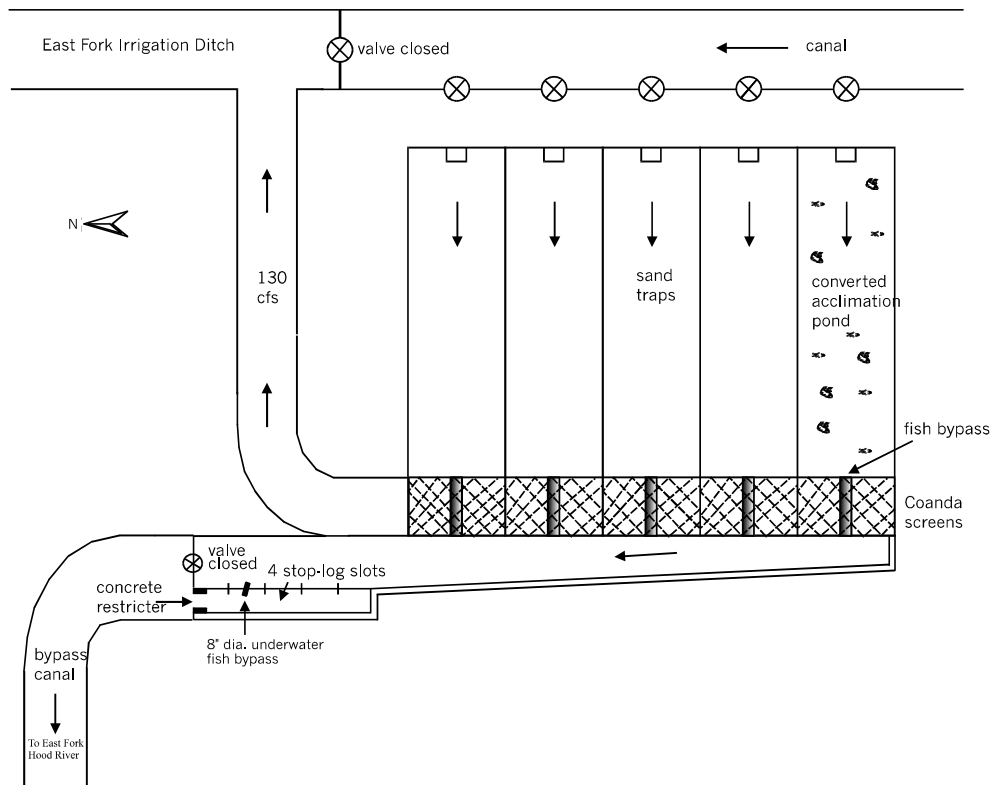


Figure 2. East Fork Irrigation District sand trap acclimation site schematic, East Fork Hood River (Rm 20.5).



Figure 3. Portable raceways at the Blackberry Creek acclimation site, used to acclimate and volitionally release hatchery summer steelhead and spring chinook salmon smolts on the West Fork Hood River. The pond liners were replaced in 2001 with black polypropylene instead of the yellow as shown in this photo.

An acclimation caretaker was on site 24 hr/d at the Blackberry Creek acclimation site. Water temperature and dissolved oxygen were recorded regularly during the 2003 acclimations. Hatchery summer steelhead smolts were weighed (g) and measured (mm) and condition factors calculated ( $\text{weight [g]} \times 100 / \text{length}^3 [\text{mm}]$ ) prior to acclimation. Smolts that remained in the acclimation raceway (non-migrants) were counted, weighed (g), measured (mm), and then hauled by truck in a portable liberation tank in May and released near the mouth of the Hood River.

Post-acclimated smolts that migrated from the acclimation ponds were sampled at rotary screw traps by ODFW on the West Fork and at Rm 4.5 on the mainstem Hood River (Figure 1). Outmigration timing was monitored. Comparisons were made between acclimated hatchery summer steelhead smolts and wild steelhead smolt migrants. ODFW project staff cannot differentiate between wild summer and winter steelhead smolts and resident rainbow. All trapped fish were anesthetized, sorted by species, examined for fin marks, and counted. ODFW used mark and recapture methods to estimate the abundance of wild, natural, and hatchery produced anadromous salmonid smolts that migrated from the Hood River subbasin. Outmigration timing was based on daily numbers at the migrant trap.

### *Spring Chinook Salmon*

Hatchery spring chinook salmon smolts have been acclimated and volitionally released into the West Fork Hood River since 1996. From 1996 to 2003, smolts have been released at the Blackberry Creek acclimation site (Figure 1). In 1998, the Jones Creek acclimation site (Figure 5) was established on the West Fork Hood River (Rm 14.0) [Figure 1]. This site is located at the upper end (elevation 2,300 ft) of the West Fork Hood River where Jones Creek flows into a moderate terrace/hillslope confinement habitat type with a low stream gradient; and ideal spring chinook salmon habitat in the Hood River subbasin. As described above for summer steelhead, the water quality and quantity in the West Fork is considerably better than the East Fork Hood River and acclimation sites are within preferred spawning and rearing habitat.

Portable raceways were used to acclimate and volitionally release hatchery spring chinook salmon smolts at the Blackberry Creek and Jones Creek sites. One portable raceway was used to acclimate spring chinook at the Blackberry Creek site with dimensions of 11'9" x 60'7" x 4'9" (Figure 4). Approximately 45% of the spring chinook production was acclimated and volitionally released at the Blackberry Creek acclimation site. At the Jones Creek site, a portable raceway was used with dimensions of 11'9" x 49'3" x 4'9". Approximately 30% of the spring chinook production is acclimated and volitionally released at the Jones Creek acclimation site. Raceways were constructed, and the smolts were released from the portable raceway utilizing an aluminum hopper similar to the one described for the summer steelhead acclimations. In addition, a mobile stop log set up was designed, built, and tested at the Jones Creek site. This set up will be modified and implemented at the Blackberry ponds for 2004.

In the fall of 1998, the Parkdale Fish Facility was completed near Rm 4.0 on the Middle Fork Hood River. The facility includes two concrete acclimation ponds with dimensions of 80 ft x 8 ft x 4 ft (Lambert et. al., 1998). In 2003 a portion of the hatchery spring chinook salmon production (about 25% of the total production) was delivered to the Parkdale Fish Facility for acclimation and release into the Middle Fork Hood River (Rm 4.0) [Figure 1]. A caretaker was on-site 24 hr/d. Water temperatures and dissolved oxygen were recorded regularly during the 2003 acclimation. Mean fork length (mm) and weight (g) were measured and condition factors calculated ( $\text{weight [g]} \times 100 / \text{length}^3 [\text{mm}]$ ) prior to acclimation. Non-migrant smolts were counted, weighed (g), measured (mm) and trucked to the mouth of the Hood River. Downstream migrant anadromous salmonids were trapped by ODFW using rotary screw traps located on the respective forks and at the mainstem Hood River [Rm 4.5] (Figure 1). Outmigration timing was based on daily counts at the migrant trap, and was not adjusted for trapping efficiency due to low numbers of naturally produced spring chinook salmon smolts and poor survival of hatchery smolts from handling.

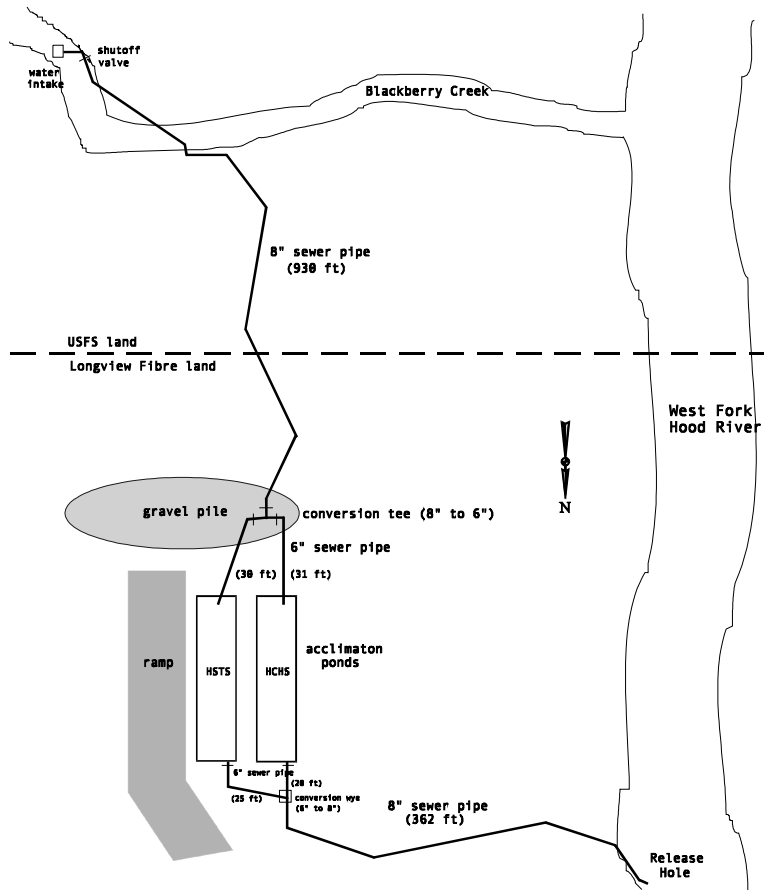


Figure 4. Blackberry Creek acclimation site schematic, West Fork Hood River (Rm 9.0).

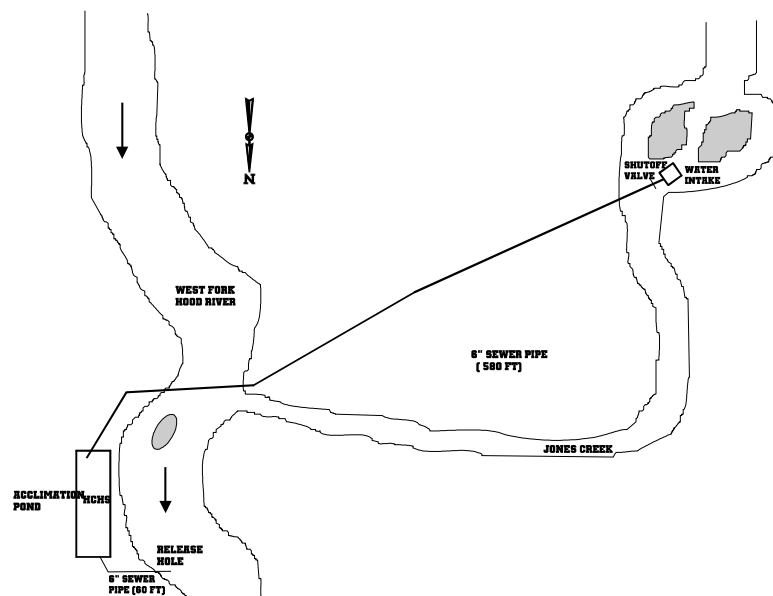


Figure 5. Jones Creek acclimation site schematic, West Fork Hood River (Rm 14.0)

## Results and Discussion

### Winter Steelhead

In 2003, 25,120 Hood River stock hatchery winter steelhead smolts were acclimated from early April to mid May in the East Fork Hood River. There were 30 mortalities, and 1,756 of the acclimated fish did not leave the ponds. A total of 23,334 winter steelhead smolts were released volitionally to the East Fork Hood River (Table 1). In the Middle Fork Hood River, 26,449 smolts were acclimated at the Parkdale Fish Facility from early April to mid May (Table 1). Of the smolts acclimated in the Middle Fork Hood River in 2003, there were 106 mortalities, and 200 fish did not leave the facility. A total of 26,143 emigrated volitionally from the Parkdale Fish Facility. All of the hatchery winter steelhead smolts were acclimated prior to release for a minimum of 7 days.

The mainstem Hood River rotary screw trap (RM 4.5) was operational by April 5 in 2003, and was fished by ODFW until July 31. The median date of arrival of hatchery winter steelhead smolts was May 13 (Figure 6) compared to May 14 for wild rainbow/steelhead (Figure 7). Temporal distribution of hatchery winter steelhead and wild rainbow/steelhead smolts to the mainstem Hood River rotary screw trap has shown a similar pattern since acclimation began in 1996. The mainstem rotary screw trap was periodically not operated in 2003 due to algal blooms.

ODFW has annually estimated the percent of acclimated and volitionally released smolts migrating past the mainstem rotary screw trap since 1996. Increased outmigration of acclimated smolts may be the result of fish having time to recover from stress after they were hauled in liberation trucks. Transportation of steelhead smolts has been shown to increase physiological stress responses in coho salmon (Schreck et al., 1989) and steelhead (Whitesel et al., 1994). Schreck et al. (1989) also found that fish not allowed to recover adequately from transport were less capable of surviving in a natural environment.

Table 1. Hood River stock hatchery winter steelhead acclimated in the East Fork and Middle Fork Hood River drainage, 1996-2003 releases.

Drainage, Location, Release year, Release group	Date transferred to raceway	Number transferred to raceway	Fish/lb	Number of days acclimated	Mortality in accl. raceway	Number volitionally released	Number Trucked <sup>b</sup>	Total released
East Fork, Toll Bridge Park, 1996,								
Group 1	Apr 1-4	24,057	5.7	9-12	26	24,031		24,031
Group 2	Apr 22-24	26,965	5.0	8-10	92	20,885	5,988	26,873
EFID Sand Trap, 1997 <sup>a</sup> ,								
Group 1	Apr 11-15	27,740	5.7	6-10	29	27,711		27,711
Group 2	Apr 29	32,578	8.3	6	452	32,126		32,126
1998,								
Group 1	Apr 7	29,510	5.2	7	0	29,510		29,510
Group 2	Apr 21	32,626	7.5	7	0	31,707	919(1)	32,625
1999,								
Group 1	Apr 6	13,439	5.6	9	4	12,430	1005(1)	13,434
Group 2	Apr 29	13,630	5.8	6	2,052	10,572	1006(1)	11,577
2000,								
Group 1	Apr 12	14,599	7.3	5	1	13,852	746	14,598
Group 2	Apr 25-26	16,558	7.8	5-6	20	15,694	844	16,538
2001,								
Group 1A	Apr 24-25	13,265	5.3	5-6	0	0	0	13,265
Group 1B	May 7	3,782	4.4	7	0	0	0	3,782
Group 2	May 7	8,557	6.4	7	0	0	0	8,557
2002,								
Group 1	Apr 4	14,659	6.1	8	54	14,436		
Group 2	Apr 22	16,572	5.4	7	6	16,396	339	31,171
2003,								
Group 1	Apr 4	11,255	5.7	7	5	10,372		
Group 2	Apr 21	13,865	5.9	9	25	12,962	1,756	25,090

Drainage, Location, Release year, Release group	Date transferred to raceway	Number transferred to raceway	Fish/lb	Number of days acclimated	Mortality in accl. raceway	Number volitionally released	Number Trucked <sup>b</sup>	Total released
Middle Fork, Parkdale Fish Fac., 1999,								
Group 1	Apr 6-7	10,012	5.5	8-9	2	9,857	153	10,010
Group 2	Apr 28	9,975	6.0	7	7	9,816	152	9,968
2000,								
Group 1	Apr 11	15,912	7.3	6	8	15,279	625(50)	15,854
Group 2	Apr 25	16,235	7.7	6	20	15,578	637(50)	16,165
2001,								
Group 1	Apr 26	14,696	5.6	4	13	14,535	148	14,683
Group 2	May 8	10,648	5.9	6	56	10,484	108	10,592
2002,								
Group 1	Apr 5	14,142	6.3	7	75	13,809		
Group 2	Apr 23	17,758	5.5	6	75	17,425	516	31,750
2003,								
Group 1	Apr 3	11,256	6.5	8	53	11,103		
Group 2	Apr 22-23	15,193	4.9	7-8	53	15,040	200	26,343

<sup>a</sup> In 1997 2,545 of the 59,837 winter steelhead smolts did not emigrate volitionally. These fish were then forced out into the East Fork Hood River.

<sup>b</sup> Number trucked indicates hatchery winter steelhead which did not emigrate volitionally from the acclimation raceways and were hauled and released near the mouth of the Hood River. Numbers in parentheses indicate mortalities from fish truck liberations.

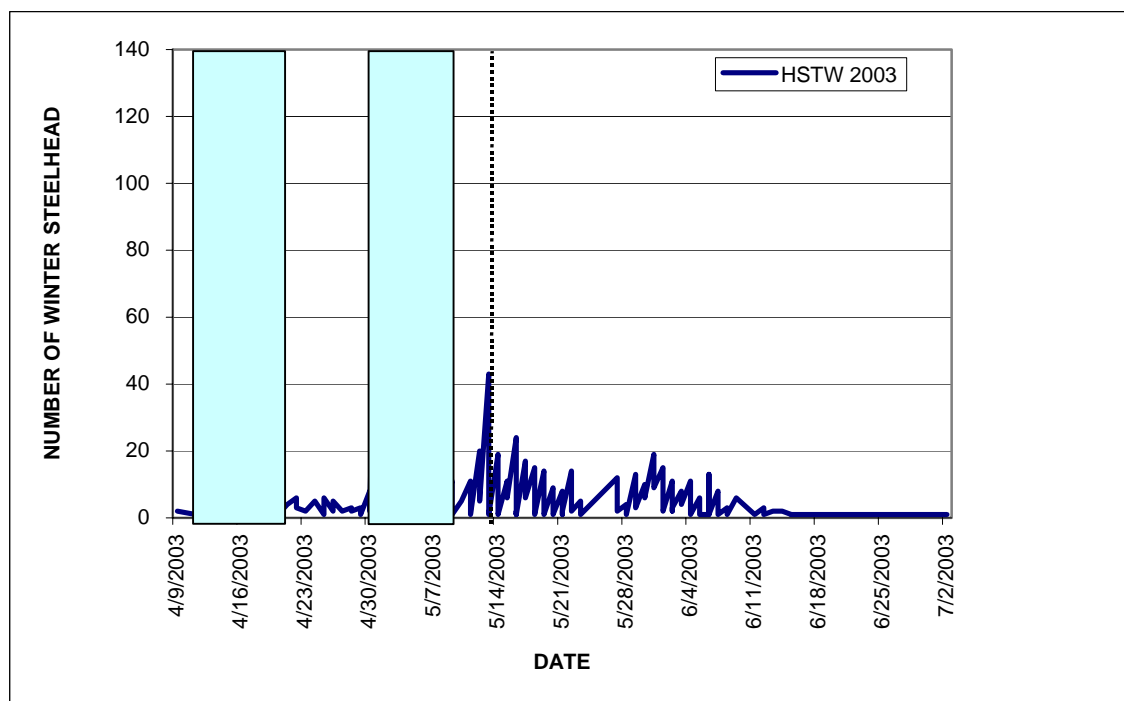


Figure 6. Migration timing of hatchery winter steelhead at the mainstem rotary screw trap for the 2003 migration year. Numbers displayed show actual numbers caught, and were not adjusted for trapping efficiency. The shaded areas represent periods of volitional release from the acclimation raceways and the dotted line represents the median date of hatchery winter steelhead arrival to the mainstem Hood River screw trap.



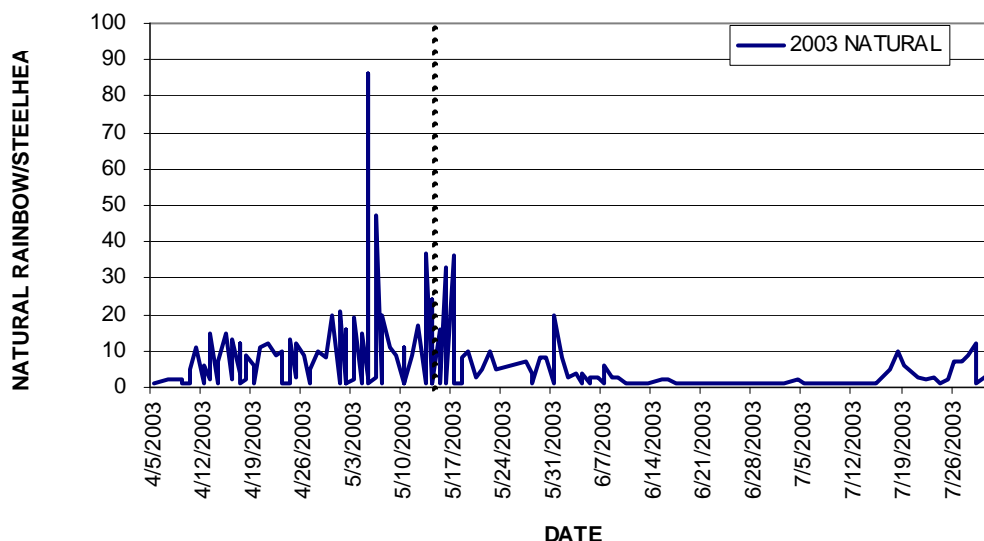


Figure 7. Migration timing of naturally produced rainbow trout/steelhead at the mainstem Hood River rotary screw trap for the 2003 migration year. This graph represents all rainbow/steelhead juveniles that were caught in the mainstem Hood River rotary screw trap. Numbers were not adjusted for trapping efficiency. The dotted line represents the median date of arrival of naturally produced rainbow/steelhead to the mainstem Hood River screw trap.

#### *Summer Steelhead*

In 2003, 47,662 summer steelhead smolts were acclimated in the West Fork Hood River (Table 2). Hood River stock hatchery summer steelhead smolt size at release was between 5.1-5.3 fish/lb in 2003. An estimated 41,438 emigrated volitionally and 6,074 non-migrants remained in the raceway and were hauled by truck and released into the mainstem Hood River. The percentage of non-migrant hatchery summer steelhead (15%) was higher than the percentage of non-migrant hatchery winter steelhead (4%). This may possibly be a result of different release techniques. Hatchery winter steelhead are released from concrete diversions with a stop-log system, whereas the hatchery summer steelhead are released from the portable acclimation ponds with an aluminum hopper set-up. A portable stop-log system was designed and tested in 2003 for the portable ponds. An improved version of this set-up will be implemented in the portable ponds for both the chinook and summer steelhead in 2004.

Hatchery summer steelhead were volitionally released from the Blackberry Creek acclimation site, West Fork Hood River, from early April to mid-May. There was a gradual increase in hatchery smolt outmigration past the mainstem screw trap that peaked near the time of the third release (Figure 8). The median date of hatchery summer steelhead arrival to the mainstem Hood River screw trap was very similar to both the hatchery winter steelhead and the naturally produced rainbow/steelhead migrants. Temporal distribution in 2003 for hatchery summer steelhead smolts was similar to both hatchery winter steelhead and wild rainbow/steelhead, with a more gradual outmigration pattern.

Table 2. Hood River stock hatchery summer steelhead acclimated in the West Fork Hood River drainage, 1999-2003.

Drainage, Release Location, Release year, Release group,	Date transferred to raceways	Number transferred to raceways	Fish/lb	Number of days acclimated	Mortality in raceway	Number volitionally released	Number trucked <sup>a</sup>	Total released
West Fork, Blackberry Creek, 1999, Group 1	Apr 2	19,532	5.5	13	19	15,616	3,897	19,513
2000, Group 1A	Apr 6	18,165	6.2	7	19	15,611	2,535	18,146
Group 1B	Apr 21-24	15,775	5.2	3-6	31	13,541	2,203	15,744
2001, Group 1A	Apr 5	15,046	7.2	7	3	11,517	3,526	15,043
Group 1B	Apr 13	15,126	6.8	5	8	11,575	3,543	15,118
Group 1C	Apr 24	7,516	6.4	6	12	5,745	1,759	7,504
2002, Group 1A	Apr 2-3	21,000	5.1	7-8	20	19,047		
Group 1B	Apr 18	19,372	4.3	8	21	17,418		
Group 1C	Apr 29	5,395	4.7	3	18	3,444	5,799	45,708
2003, Group 1A	Mar 27-28	15,934	5.1	6-7	49	13,860		
Group 1B	Apr 10-18	15,895	5.3	2-9	76	13,794		
Group 1C	Apr 24-25	15,833	5.3	7-8	24	13,784	6,074	47,512

<sup>a</sup> Number trucked indicates hatchery summer steelhead which did not emigrate volitionally from the acclimation raceways and were hauled and released near the mouth of the Hood River.

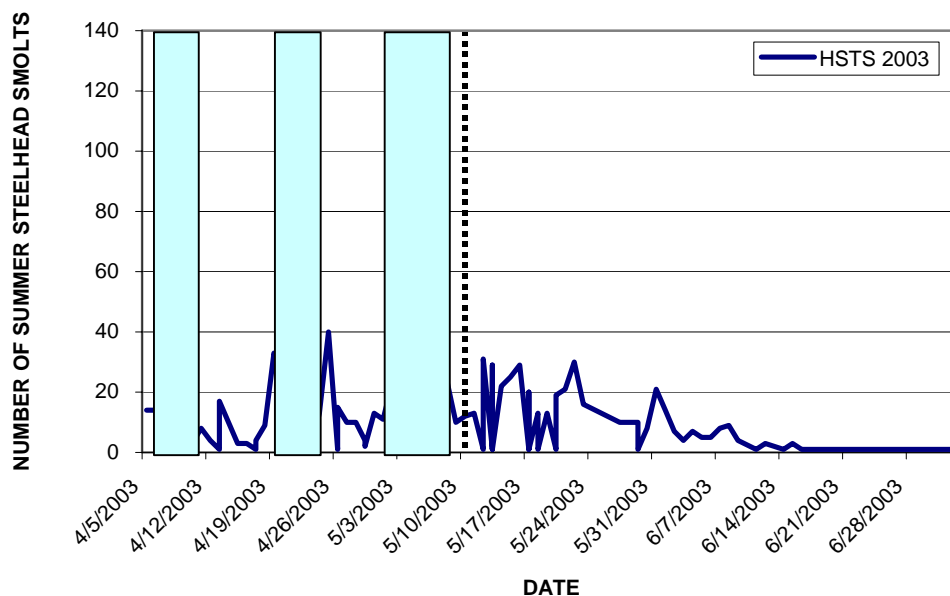


Figure 8. Migration timing of hatchery summer steelhead at the mainstem rotary screw trap for the 2003 migration year. Numbers were not adjusted for trapping efficiency. The shaded areas represent periods of volitional release from the Blackberry acclimation raceways and the dotted line represents the median date of hatchery summer steelhead arrival to the mainstem Hood River screw trap.

#### Spring Chinook Salmon

Hatchery spring chinook salmon smolts were released into the West Fork and Middle Fork Hood River in 2003. Hatchery spring chinook salmon smolts were volitionally released from early April until mid May. All of the spring chinook released in the West Fork Hood River were reared in Pelton Ladder on the Deschutes River. A total of 55,978 Deschutes River stock hatchery spring chinook salmon smolts were

transferred by truck to the West Fork Hood River Blackberry Creek acclimation site in 2003 (Table 3). There were 4,027 chinook that did not emigrate out of the Blackberry Creek acclimation pond and were trucked to the mouth of the Hood River, and there were 351 mortalities. A total of 40,231 Deschutes River stock hatchery spring chinook salmon smolts were transferred by truck to the West Fork Hood River Jones Creek acclimation site in 2003 (Table 3). There were 9,037 chinook that did not emigrate out of the Jones Creek acclimation pond and were trucked to the mouth of the Hood River, and there were 158 mortalities. The West Fork smolts showed outward signs of disease and descaling most likely from outbreaks of BKD, and loading for transport at Pelton Ladder. The West Fork released spring chinook salmon smolts were acclimated for a minimum of six days in 2003.

All of the spring chinook released in the Middle Fork Hood River in 2003 were reared at Round Butte Hatchery (in a typical hatchery raceway) on the Deschutes River. These smolts were transported to Parkdale Fish Facility on the Middle Fork Hood River in early March. This arrangement allows for a longer acclimation period and a longer release period. A total of 30,720 smolts were released in the Middle Fork Hood River (Table 4). In 2003, 30,638 emigrated volitionally, 67 died in the raceway, and 15 fish did not migrate and were hauled by truck and released at the mouth of the Hood River.

The 2003 outmigration timing for hatchery spring chinook salmon smolts was similar to past years (Figure 9). Typically, when hatchery spring chinook salmon smolts have been released into the Hood River, they have moved out of the system very quickly. This trend held true in the 2003 outmigration period. An estimate was not collected by ODFW for the number of spring chinook salmon smolts leaving the subbasin, because they tend to migrate out in large numbers. Due to the sensitivity to handling and the large numbers of chinook moving out of the system, ODFW does not operate the screw traps during these periods. A total of 78 wild smolts were captured in the mainstem Hood River rotary screw trap in 2003. The 2003 migration of natural spring chinook shows a distinct pattern of two different migration periods (Figure 10).

Table 3. Deschutes and Hood River stock spring chinook salmon acclimated in the West Fork Hood River drainage, 1996-2003.

Drainage, Release Location, Release year, Release group,	Date transferred to raceways	Number transferred to raceways	Fish/lb	Number of days acclimated	Mortality in accl. Raceway	Number volitionally released	Number trucked <sup>a</sup>	Total released
West Fork, Blackberry Creek, 1996,								
Group 1	Apr 8-10	85,080	10.1	6-8	180	84,900		84,900
Group 2	Apr 22-23	44,838	9.5	7-8	527	44,311	0	44,311
1997,								
Group 1	Apr 7-8	46,446	8.0	6-7	679	45,767		45,767
Group 2	Apr 16-17	56,380	8.4	4-5	1054	55,326	0	55,326
1998,								
Group 1	Apr 1-2	63,130	9.8	8-9	1073	62,057		62,057
Group 2	Apr 15-16	55,485	9.7	7-8	944	54,541	0	54,541
1999,								
Group 1	Mar 30-Apr 1	25,474	7.5	7-9	155	22,232	3,087	25,319
Group 2	Apr 13	26,837	6.7	7	334	23,415	3,088	26,503
2000,								
Group 1	Apr 4-5	33,343	7.6	5-6	61	30,277	3,005	33,282
Group 2	Apr 18-19	31,410	6.4	5-6	358	28,222	2,830	31,052
2001,								
Group 1	Mar 29	22,018	9.6	6	32	20,451	1,535	21,985
Group 2	Apr 17	26,445	10.5	6	47	24,554	1,844	26,397
2002,								
Group 1	Mar 28	23,520	14.7	8	92	18,579		
Group 2	Apr 16	25,632	14.4	9	565	20,218	9,698	48,495
2003,								
Group 1	Apr 1	27,474	11.4	6	139	25,322		
Group 2	Apr 15	28,504	11.2	7	212	26,278	4,027	55,627
Jones Creek, 1998,								

Drainage, Release Location, Release year, Release group,	Date transferred to raceways	Number transferred to raceways	Fish/lb	Number of days acclimated	Mortality in accl. Raceway	Number volitionally released	Number trucked <sup>a</sup>	Total released
Group 2 1999,	Apr 16	8,245	9.7	6	60	8,185	0	8,185
Group 1	Mar 30-Apr 1	19,982	7.6	7-9	462	12,937	6,583	19,513
Group 2	Apr 13	19,991	6.7	7	309	13,104	6,578	19,675
2000,								
Group 1	Apr 4-5	20,085	8	5-6	216	17,420	2,449	19,865
Group 2	Apr 18-19	19,529	6.3	5-6	959	16,189	2,381	18,566
2001,								
Group 1	Mar 29	20,037	9.8	6	35	20,002		20,002
Group 2	Apr 17	17,940	9.0	6	69	17,871	0	17,871
2002,								
Group 1	Mar 28	16,170	14.7	8	2,080	14,090	0	14,090
2003,								
Group 1	Apr 1	20,235	11.4	6	67	15,650		
Group 2	Apr 15	19,996	11.4	7	91	15,386	9,037	40,073

<sup>a</sup> Number trucked indicates hatchery spring chinook salmon that did not emigrate volitionally from the acclimation raceways and were hauled and released near the mouth of the Hood River.

Table 4. Deschutes and Hood River stock spring chinook salmon acclimated in the Middle Fork Hood River drainage, 1999-2003.

Drainage, Release Location, Release year, Release group,	Date transferred to raceways	Number transferred to raceways	Fish/lb	Number of days acclimated	Mortality in accl. raceway	Number volitionally released	Number trucked <sup>a</sup>	Total released
Middle Fork, Parkdale Fish Facility,								
1999,								
Group 3	Mar 29	30,600	6.4	14	191	30,195	214	30,409
2000,								
Group 3A	Apr 3	15,334	6.7	7	12	15,293	29	15,322
Group 3B	Apr 20	15,176	5.7	5	12	15,136	28	15,164
Group 4	Mar 20	4,170	14.9	RA	10	4,126	34	4,160
2001,								
Group 3	Mar 7-8	31,362	9.6	28	20	31,319	23	31,342
Group 4	Apr 2	7,082	14.2	RA	0	7,066	16	7,082
2002,								
Group 3	Mar 5-6	31,293	13.2	29-30	50	30,941	302	31,243
2003,								
Group 3	Mar 3	30,720	12.9	33	67	30,638	15	30,653

<sup>a</sup> Number trucked indicates hatchery spring chinook salmon that did not emigrate volitionally from the acclimation raceways and were hauled and released near the mouth of the Hood River.

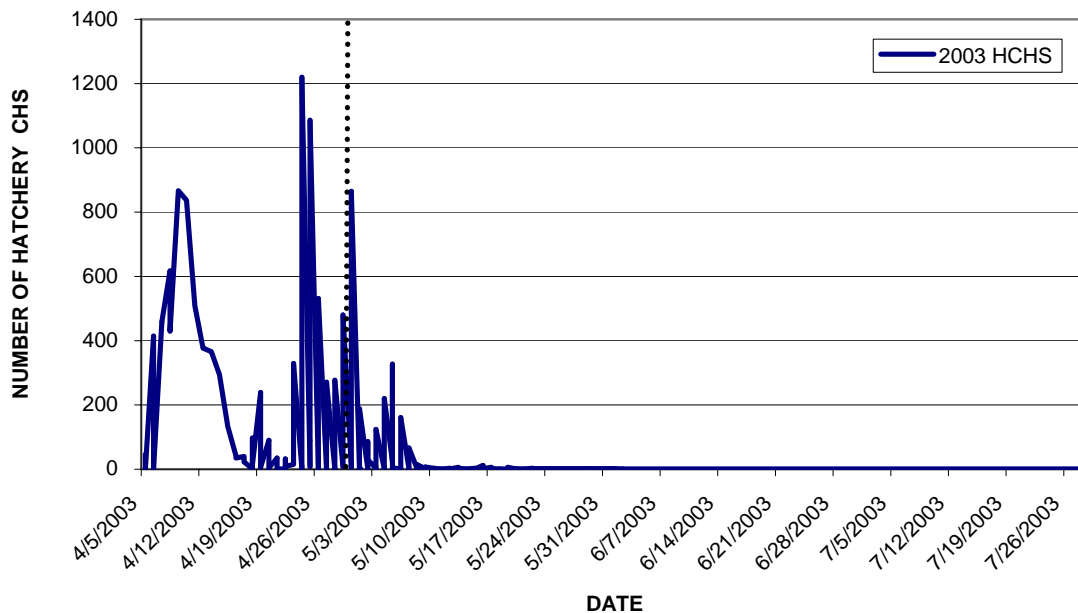


Figure 9. Migration timing of hatchery spring chinook at the mainstem rotary screw trap for the 2003 migration year. Numbers were not adjusted for trapping efficiency. The dotted line represents the median date of hatchery spring chinook arrival to the mainstem Hood River screw trap.

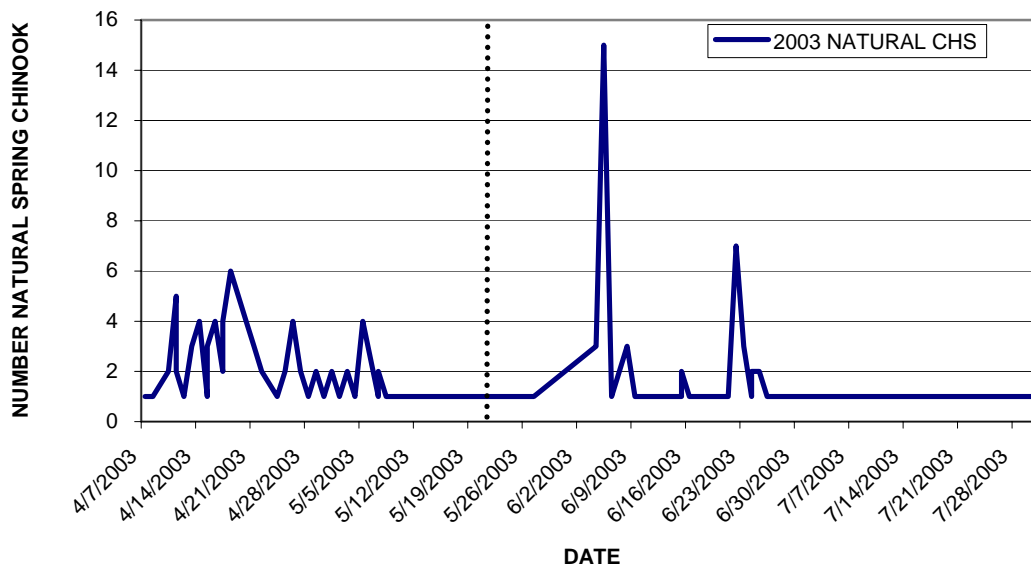


Figure 10. Migration timing of naturally produced spring chinook at the mainstem rotary screw trap for the 2003 migration year. Numbers were not adjusted for trapping efficiency. The dotted line represents the median date of hatchery spring chinook arrival to the mainstem Hood River screw trap.

## WATER TEMPERATURE MONITORING

Water temperature monitoring continued throughout the Hood River subbasin during 2003. Seven sites were monitored including the mainstem Hood River, East Fork Hood River, West Fork Hood River, Middle Fork Hood River, Baldwin Creek, Neal Creek, and Lake Branch. Temperature data was processed through the ERVB 97.7 program to produce summations, including violations of the Oregon Department of Environmental Quality (ODEQ) water temperature standards.

Record highs were detected in 2003 for the period of record, as shown in Table 5. All sites experienced a two-degree increase in the monthly average water temperature for the month of October. The Mainstem, West Fork, and Lake Branch ran approximately one degree higher than usual from May through September and most sites experienced record highs for June and October. These higher than average temperatures may be attributed to drought conditions experienced in 2003. Data is not available for the Middle Fork or the East Fork in 2003.

Table 5. Average monthly temperatures (°C) in the Hood River subbasin by site for 2003. Average monthly temperatures for the period of record shown in parentheses.

Month	Mainstem Hood River	West Fork Hood River	Baldwin Creek	Neal Creek	Lake Branch
Period of record	1990-2003	1990-2003	2000-2003	1998-2003	1999-2003
May	10.2 (9.6)	7.6 (7.5)	10.6 (11.1)	11.2 (10.9)	7.6 (6.9)
June	13.5 (11.9)	10.2 (9.4)	13.3 (13.1)	13.9 (13.4)	10.1 (8.5)
July	15.7 (14.3)	12.1 (11.4)	14.7 (14.7)	15.7 (15.6)	11.4 (10.2)
August	15.6 (14.3)	12.1 (11.4)	14.8 (14.7)	15.1 (15.2)	10.9 (9.9)
September	13.1 (12.0)	10.3 (9.9)	13.2 (12.9)	13.1 (12.8)	9.5 (8.5)
October	10.9 (8.7)	9.1 (7.6)	11.5 (9.3)	11.5 (9.6)	8.6 (6.9)

ODEQ water temperature standards of 17.8°C for salmonid fish rearing and 12.8°C for salmonid spawning and egg incubation have been established for the Hood River subbasin according to the appropriate species distribution and life history. The 17.8°C standard applies to all sites for the entire year and the 12.8°C standard varies for different areas and different time periods (Table 6).

Table 6. Oregon Department of Environmental Quality 12.8°C water temperature standards for various areas in the Hood River subbasin.

Site	Time Period
Mainstem	September 1 – July 15
East Fork, Neal Creek, and Baldwin Creek	September 15 – July 15
West Fork and Lake Branch	Entire year

Water temperatures remained within the 17.8°C standard for all sites with the exception of violations occurring on three days in July in the Mainstem and nine days in July in Neal Creek. The 12.8°C standard was exceeded at some point at all sites (Table 7). The number of days of violation applies to the appropriate time period for each particular site as defined by the ODEQ temperature standards.

Table 7. Number of days exceeding the Oregon Department of Environmental Quality 12.8° water temperature standard by month and site in 2003.

Site,	May	June	July	August	September	October
Mainstem	13	all days	all days	NA	all days	2
West Fork	0	7	all days	28	1	0
Baldwin	13	all days	all days	NA	all days	4
Neal	15	all days	all days	NA	all days	3
Lake Branch	0	0	27	6	0	0

### SPRING CHINOOK ESCAPEMENT

Three models were used to forecast the number of spring chinook estimated to return to the Hood River during the summer of 2003. This information was used to make management decisions regarding the tribal and non-tribal fisheries, and the proposed chinook telemetry study. All three models use the number of jacks from the previous year to forecast the number of adults expected to return. The three models are based on jack returns to the Hood River, the Deschutes River, and to Warm Springs National Hatchery. Regression is used on past data to characterize the correlation between the jacks and four year olds, and between four year olds and five year old fish. Since a longer period of record is available for the Deschutes and Warm Springs returning fish, the correlations are stronger than the Hood River returns. This also results in the Hood River model output giving a larger confidence intervals.

The models were run separately for natural and hatchery returns using independent data for each group. In 2003, program co-managers evaluated the output of the three models, and agreed upon run estimates. We forecasted 97 natural chinook, and 346 hatchery chinook to escape to Powerdale Dam (Figure 11). The tribal and sport fisheries were not opened in 2003 because these forecasts were low, and harvest would have impacted both broodstock needs and escapement above Powerdale Dam. The actual spring chinook returns to the Hood River in 2003 ended being 44 natural fish and 333 hatchery fish, which was just below the predicted run.

Since there was not a tribal fishery there is no creel information to report for 2003. Additionally, the telemetry work that was planned for the Middle Fork chinook was not implemented. It was determined that the information that would be returned from a run with such few individuals would not adequately represent the distribution of chinook within the Middle Fork Hood River. This work is planned for the 2004 run year; again dependent upon the number of chinook estimated to return.

## HOOD RIVER SPRING CHINOOK RETURNS vs. ESTIMATES

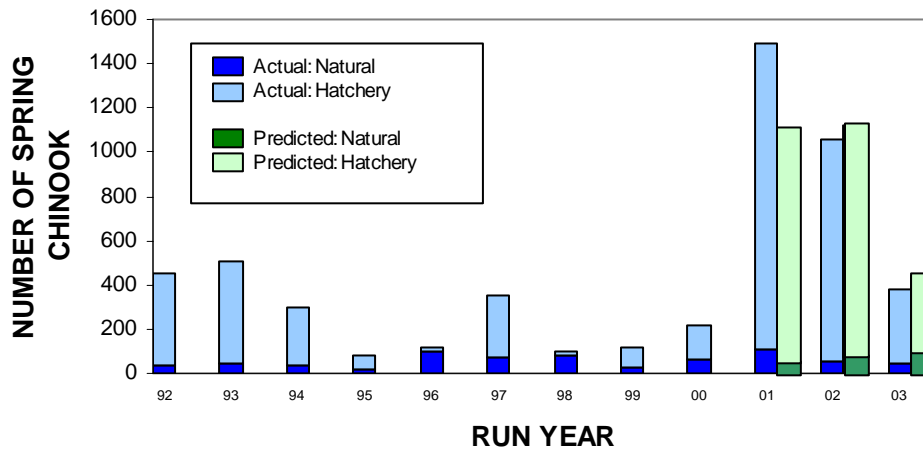


Figure 11. Actual and forecasted returns for spring chinook in the Hood River for naturally produced and hatchery origin fish.

### SPRING CHINOOK SPAWNING GROUND SURVEYS

#### **Introduction**

The West Fork Hood River extends approximately twenty miles from the confluence with the mainstem Hood River to the base of Mt. Hood. The Middle Fork Hood River extends approximately six miles from its confluence with the East Fork Hood River to Laurance Lake Dam. The native run of spring chinook salmon, which utilized the West Fork and Middle Fork, has been extinct since the mid-1960's (O'Toole and ODFW, 1991). In an effort to re-establish spring chinook salmon into the Hood River subbasin, the Oregon Department of Fish and Wildlife (ODFW) began direct releases of Carson stock spring chinook salmon into the West Fork in 1986 and later switched to Deschutes stock in 1991 (Olsen et al., 1995).

In 1996, as part of the HRPP, CTWSRO began acclimating and volitionally releasing Deschutes stock spring chinook salmon into the West Fork Hood River (CTWSRO and ODFW, 1998). Beginning in 1999, Deschutes stock spring chinook salmon have been released from the Parkdale Fish Facility into the Middle Fork Hood River. The Parkdale Fish Facility releases the hatchery spring chinook salmon into Rogers Creek, which extends approximately one mile from Rogers Spring to the Middle Fork Hood River at Rm 4.0.

The HRPP began extensive spring chinook salmon spawning surveys on the West Fork in 1997 and Rogers Creek in 2000. The goal of these surveys is to develop baseline information and index areas to determine:

1. spawning distribution and abundance
2. spawn timing
3. pre-spawning mortality and fish health
4. spawner origins and sex ratios.

Data gathered from these surveys, combined with upper West Fork spawning data gathered by the U.S. Forest Service (USFS) from 1992-95 and telemetry data gathered by ODFW in 1994 and 1995 (Olsen et al., 1995; ODFW and CTWSRO, 1996), will be used to evaluate supplementation and the effects of acclimating and volitionally releasing Deschutes stock spring chinook salmon into the Hood River subbasin. These data will also help determine how the West Fork and Middle Fork can best be utilized for natural production of spring chinook salmon.



## Methods

Geographic distribution, timing, and magnitude of natural spawning have been documented for the spawning survey index areas. Survey index areas and timing of surveys were developed based on prior spring chinook spawning surveys (USFS, unpublished data 1992-1995); ODFW radio telemetry distribution surveys (Olsen et al., 1995; ODFW and CTWSRO, 1996); run timing and abundance data collected by ODFW at the Powerdale Dam fish trap (ODFW and CTWSRO, 1998); and stream reconnaissance. As a result of this information, the West Fork Hood River was divided into nine index areas (Figure 12). Rogers Spring Creek was included in the surveys in anticipation of adult returns to the Parkdale Fish Facility. The following is a list of the index reaches, approximate river mile, and length:

Index 1 - Punchbowl Falls (Rm 0.0-Rm 0.25) [0.25 miles]. From the confluence of the West Fork and the mainstem Hood River to Punchbowl Falls.

Index 2 - Moving Falls (Rm 0.25-Rm 2.5) [2.25 miles]. From immediately above Punchbowl Falls to immediately below the fish ladder at Moving Falls.

Index 3 - Moving Falls/Dee Diversion (Rm 2.5-Rm 6.1) [3.6 miles]. From immediately below the fish ladder at Moving Falls to the Dee Irrigation diversion.

Index 4 - Lake Branch (Rm 0.0-Rm 0.8) [0.8 miles]. From the confluence of Lake Branch and the West Fork to Rm 0.8 of Lake Branch.

Index 5 - Dee diversion/Dry Run (Rm 6.1-Rm 8.2) [2.1 miles]. From the rapids directly above the Dee Irrigation diversion to Dry Run Bridge.

Index 6 - Dry Run/Red Hill (Rm 8.2-Rm 11.3) [3.1 miles]. From Dry Run Bridge to 0.2 miles below Red Hill Creek.

Index 7 - Red Hill/Ladd (Rm 11.3-Rm 13.1) [1.8 miles]. From 0.2 miles below Red Hill Creek to Ladd Creek.

Index 8 - Ladd (Rm 13.1-14.0) [0.9 miles]. From Ladd Creek to the confluence of Elk and McGee Creeks.

Index 9 - McGee (Rm 0.0-Rm 0.75) [0.75]. From the mouth of McGee Creek to Rm 0.75 of McGee Creek.

Rogers Spring Creek (Rm 0.0-Rm 0.75) [0.75 miles]. From the confluence of Rogers Spring Creek and the Middle Fork Hood River to a weir preventing adult fish passage beyond the Parkdale Fish Facility.

In 2003 only index reaches 1, 2, 3, 8, 9, and Rogers Creek were surveyed. Index reaches 4-7 were not surveyed for safety, distribution, and visibility reasons. These reaches were surveyed every two weeks from the beginning of August to the end of October. Surveys generally required a crew of two and were conducted downstream by foot. Narrow canyon walls provided poor access and required dry suits for swimming portions of these areas. Surveys began prior to any evident spawning activity and continued until no spawning activity was apparent. General daily field notes included date, surveyors, start/end time of survey, water temperature (°C), and water visibility (high>6', 3'>mod<6', low<3'). Redds, carcasses, and live fish were counted and recorded along with the accompanying river mile. Redds were flagged on the adjacent streambank with the date and surveyors initials which allowed the identification of old and new redds. Carcasses were examined for fin marks, sexed, and checked for bacterial kidney disease and spawning success. Snouts were removed from carcasses with missing fins for the purposes of coded wire tag recovery. Lengths were measured to the nearest fork and MEPS (middle eye-posterior scale) and scales were collected from non-floy-tagged carcasses. Finally, the caudal peduncle was severed from carcasses to indicate which fish had been sampled.

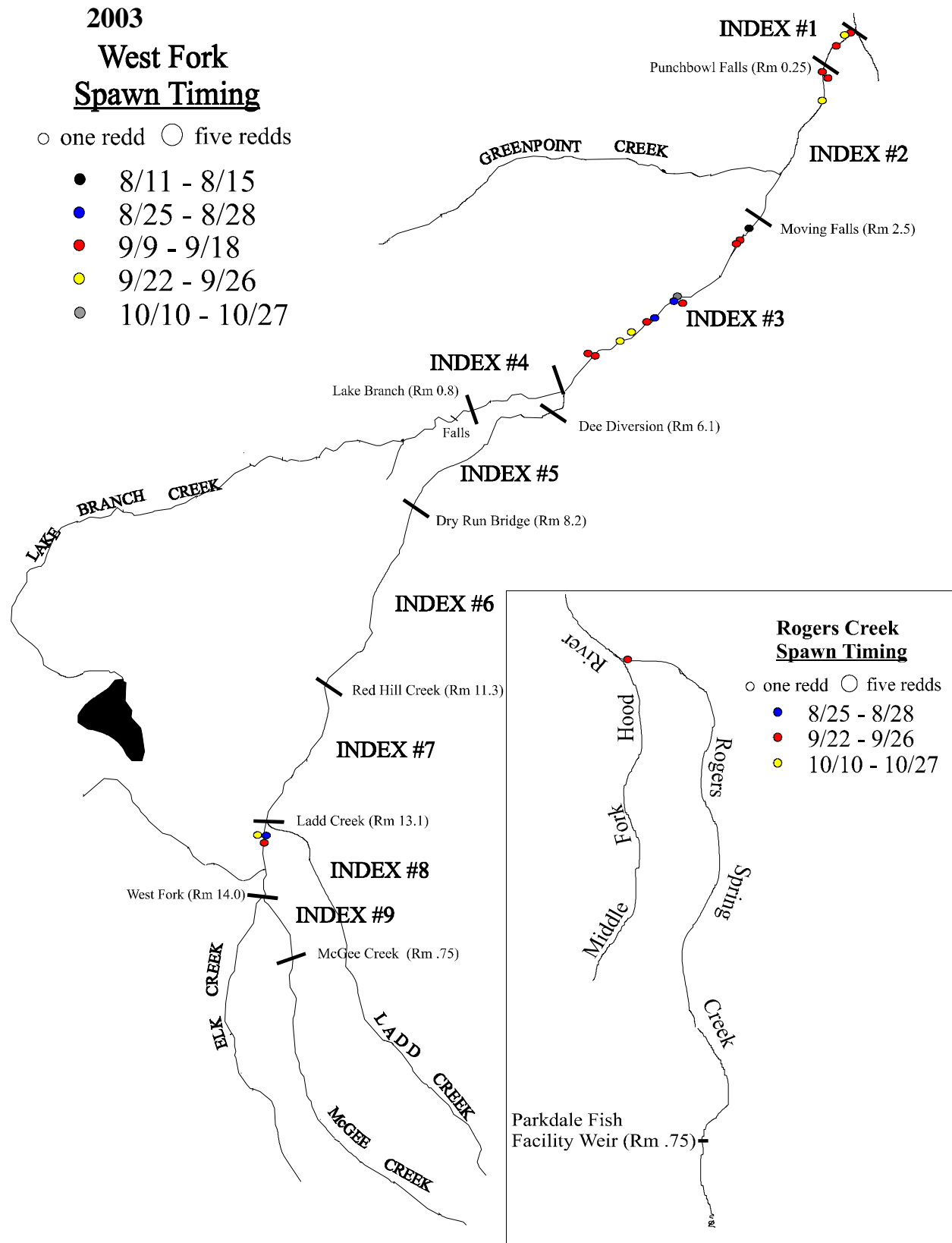


Figure 12. 2003 West Fork survey index areas and redd locations by date. Index areas 4, 5, 6, and 7 were not surveyed in 2003.

## Results and Discussion

Spring chinook salmon spawning occurred throughout the West Fork Hood River from August 12 to October 14, 2003 (Figure 12). Peak spawning occurred in 2003 between September 9 and September 22 (Figure 13). Index reach 3 had the greatest number of redds and showed a very even temporal distribution throughout the spawning season (Figure 14). There were 21 spring chinook salmon redds documented in the surveyed index areas in 2003 (Table 8). Spring chinook salmon redds per mile for the entire West Fork have averaged from a low of 0.7 in 1999 to a high of 6.2 in 2002 (Table 9). The greatest spawning activity in 2003 occurred in index areas three (3.3 redds/mile) and eight (3.3 redds/mile). There were a total of 17 spring chinook carcasses recovered in 2003, inclusive of pre-spawning mortality (Table 10).

Surveys on Rogers Spring Creek began in 2000. There was only a one time survey completed in 2001 due to high water and turbidity which prevented observation of the redds. Therefore in 2001 there was no data taken. In 2002 and 2003 full scale surveys continued. In 2003 the surveys began and only one redd was observed on September 24 (Figure 15).

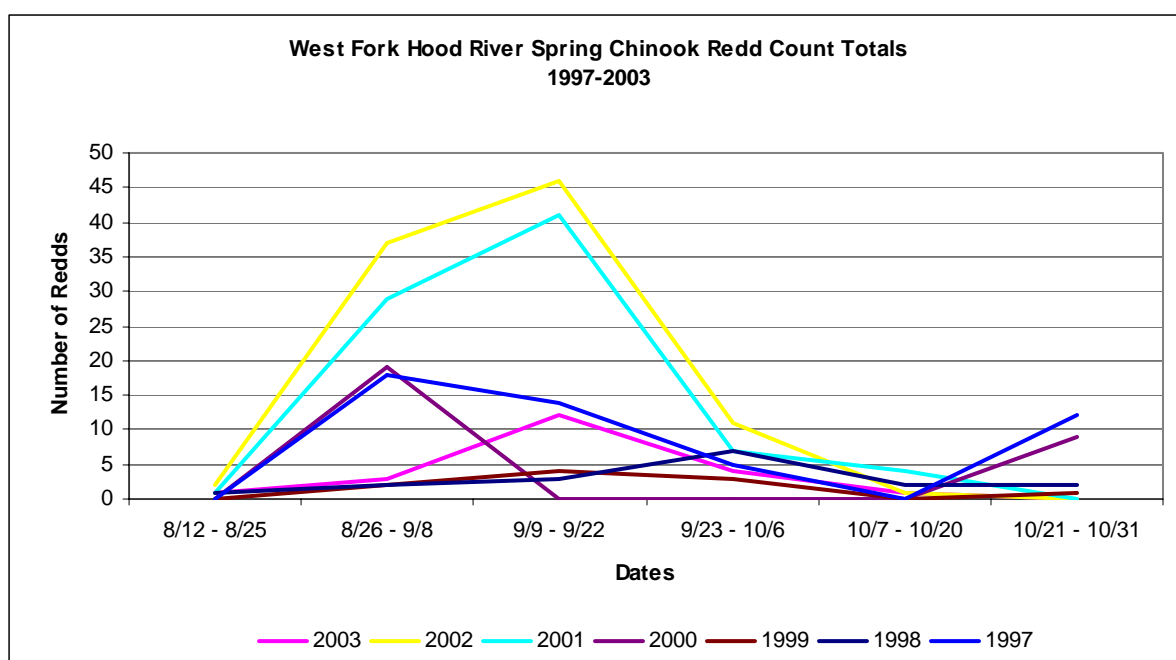


Figure 13. Spring chinook salmon redd counts (1997-2003) on the West Fork Hood River by two week survey cycle.

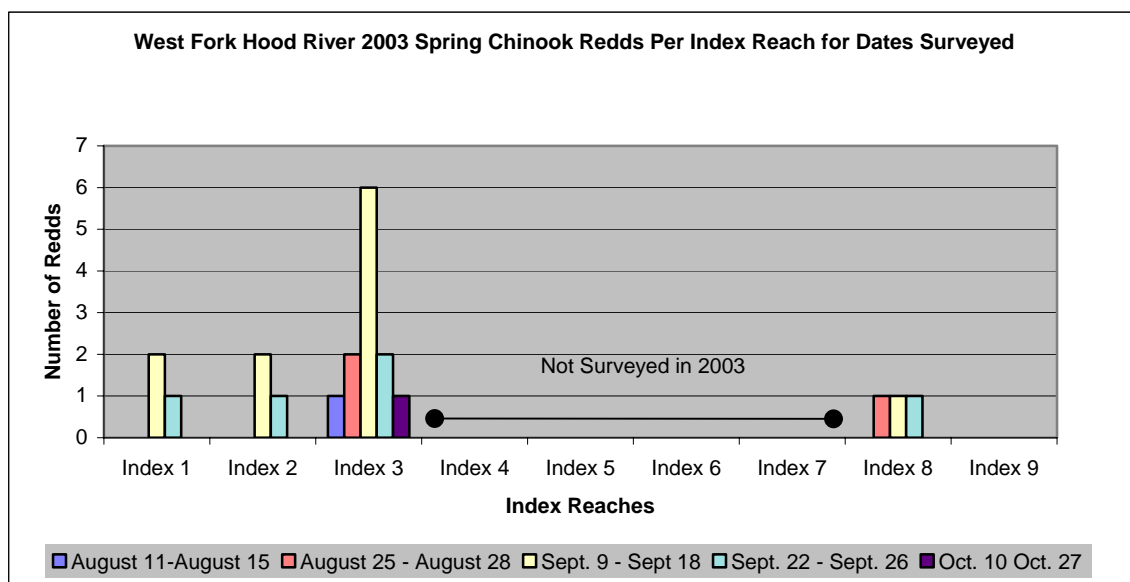


Figure 14. The 2003 spring chinook redd distribution by index reach and time period.

Table 8. Spring chinook salmon redd counts by index area in the West Fork Hood River 1997-2003.

Run Year	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9	Total
1997 <sup>a</sup>	5	-	6	6	1	5	3	13	1	40
1998	4	1	5	0	1	2	2	2	0	17
1999	2	1	3	2	0	1	1	1	0	11
2000	5	4	7	2	3	2	0	5	0	28
2001	4	11	11	2	8	8	0	34	5	83
2002	6	5	9	0	8	5	0	56	8	97
2003 <sup>b</sup>	3	3	12	-	-	-	-	3	0	21

<sup>a</sup> Index area two was not included in surveys in 1997.

<sup>b</sup> Index areas 4, 5, 6, and 7 were not included in surveys in 2003.

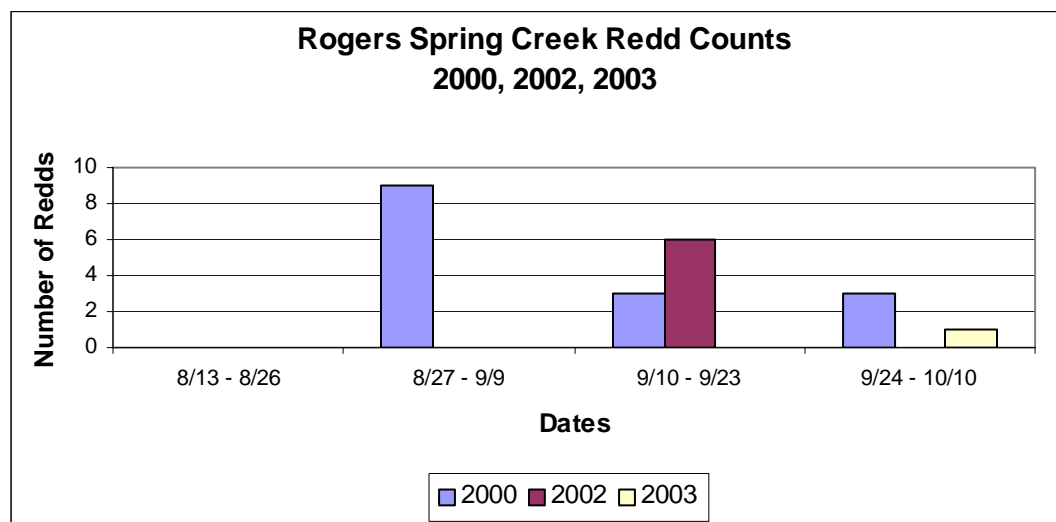
Table 9. Spring chinook salmon redds per mile and percentage of total redds by index area in the West Fork Hood River 1997-2003.

Run year, Statistic	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9
1997 <sup>a</sup>									
redds/mile	20.0	-	1.9	7.5	0.5	1.6	0.6	14.4	0.5
% of redds	12.5	-	15.0	15.0	2.5	12.5	7.5	32.5	2.5
1998									
redds/mile	16.0	4.0	1.4	0.0	0.5	0.6	1.1	2.2	0.0
% of redds	23.5	5.8	29.8	0.0	5.8	11.7	11.7	11.7	0.0
1999									
redds/mile	8.0	0.4	0.8	2.5	0.0	0.3	0.5	1.1	0.0
% of redds	18.2	9.1	27.2	18.2	0.0	9.1	9.1	9.1	0.0

Run year, Statistic	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9
2000									
redds/mile	20.0	1.8	1.9	2.5	1.4	0.6	0.0	15.5	0.0
% of redds	17.8	14.2	25.0	7.1	10.7	7.1	0.0	17.8	0.0
2001									
redds/mile	16.0	4.9	3.1	2.5	3.3	2.6	0.0	37.8	6.7
% of redds	4.9	13.4	13.4	2.4	8.5	9.8	0.0	41.5	6.1
2002									
redds/mile	24	2.2	2.5	0.0	3.8	1.6	0.0	62.2	10.7
% of redds	6.2	5.2	9.3	0.0	8.2	5.2	0.0	57.7	8.2
2003 <sup>b</sup>									
redds/mile	12.0	1.3	3.3	-	-	-	-	3.3	0.0
% of redds	14.3	14.3	57.1	-	-	-	-	14.3	0.0

<sup>a</sup> Index area two was not included in surveys in 1997.

<sup>b</sup> Index areas 4, 5, 6, and 7 were not included in surveys in 2003.



<sup>a</sup> The survey for 2001 generated no data due to high water and turbidity and has been excluded.

<sup>b</sup> Only one survey was conducted in 2000.

Figure 15. Spring chinook salmon redd counts for the Rogers Spring Creek by two week survey cycle 2000-2003.<sup>a</sup>

Table 10. Number of spring chinook carcasses collected during spawning ground surveys in the West Fork Hood River by sex and origin. 1997-2003.

Year	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9	Total
1997	9	-	5	7	5	2	0	11	1	40
1998	1	0	0	0	0	1	0	4	0	6
1999	2	2	3	0	2	1	0	1	0	11
2000	1	0	0	0	1	1	0	0	0	3
2001	2	9	9	1	8	6	0	21	2	58
2002	19	0	5	1	4	4	1	29	2	65
2003	2	2	13	-	-	-	-	0	0	17
Total	36	13	35	9	20	15	1	66	5	

## PESTICIDE MONITORING

Oregon Department of Environmental Quality (ODEQ) and Portland State University (PSU) have monitored pesticide concentrations, steelhead acetylcholine esterase (an enzyme biomarker), and macroinvertebrate assemblages in the Hood River basin since 2000. The work completed in 2003 encompassed the spring and summer spray periods in Hood River orchards, and included water, macroinvertebrate, and caged fish studies. Past water quality results have shown concentrations of chlorpyrifos, azinphos methyl, and simazine in areas with predominant agriculture in the uplands. This work has been cost shared with Oregon Water Enhancement Board (OWEB), Environmental Protection Agency (EPA), and Bonneville Power Administration (BPA). A full report of this work including results through 2002 is included in Appendix A.

## FISH SALVAGE

### **Introduction**

The purpose of the HRPP salvage activities is to collect fish from irrigation canals that would otherwise be stranded, and to monitor and evaluate the effectiveness of fish screens used at specific diversions for the canals surveyed. Salvage operations have been supported by agencies (ODFW and CTWSRO); interest groups (Hood River Soil and Water Conservation District, Hood River Watershed Group, Hood River High School, and NW Steelheaders); and irrigation districts (Farmers Irrigation District and East Fork Irrigation District). In 2002, fish salvages were planned on some of East Fork Irrigation District's canals and Farmers Irrigation District's main canal.

### **Methods**

ODFW and NOAA Fisheries take permits were secured prior to the 2002 salvage activities, which occurred during late fall. Each respective irrigation district coordinated their shut down period with CTWSRO so that we scheduled the salvage within 24 hours of turning down the water source. This provides enough habitat for the fish to survive while minimizing the stress of capture. Salvage was conducted using backpack electrofishing units and portable fish tanks. In every case fish were identified, counted, and released into the nearest free flowing water body in relation to their capture location.

### **Results and Discussion**

#### *East Fork Irrigation Salvage*

CTWSRO has been performing fish salvages for the East Fork Irrigation District (EFID) since 1999. The East Side lateral is a canal that has an inadequate rotary drum screen that does not meet NOAA Fisheries criteria. The number of fish salvaged from this area tend to fluctuate, and may depend on the number of high flow events that occur in Neal Creek. High flows cause water to top the screen and allow access to the irrigation canal. This inadequate screen is an issue that is currently being resolved by EFID with the East Fork Central Canal Pipeline project. The completion of this project will remove the need for the Neal Creek Lateral fish screen and provide unimpeded fish passage to Neal Creek. The second area salvaged is the East Fork Main Canal. This area is downstream of a Coanda Fish Screen. CTWSRO continues to salvage this canal to monitor the effectiveness of the screen. The area from the headgate downstream to the fish screen is unscreened and has a fairly consistent level of fish present.

Salvage of the East Fork Irrigation canal was scheduled for October 31<sup>st</sup> and November 1<sup>st</sup> - 4<sup>th</sup> in 2002. This was a challenging this year. A week of cold temperatures froze the surface layer on most of the ditch below the sand trap. Over the course of five days the CTWSRO crew, EFID, ODFW, and several volunteers salvaged the East Side Ditch, the East Fork main, and from the headgate to the sand trap (Table 11). However, numbers above the screen (headgate to the sandtrap), were lower than in previous years (Figure 16).

Table 11. East Fork Irrigation District 2002 fish salvage species distribution.

Location	Date	St/Rbt <sup>a</sup>	Cutthroat	Sculpin	Total
Neal Creek	11/2/02	553	19	1	573
East Fork Main- Below fish screen	11/1/02	11	0	62	73
Headgate to Sandtrap- Above fish screen	10/31/02	317	4	0	321
<b>Total</b>	---	881	23	63	967

<sup>a</sup> St/Rbt: steelhead/rainbow trout

### EAST FORK IRRIGATION DISTRICT: Fish Salvage

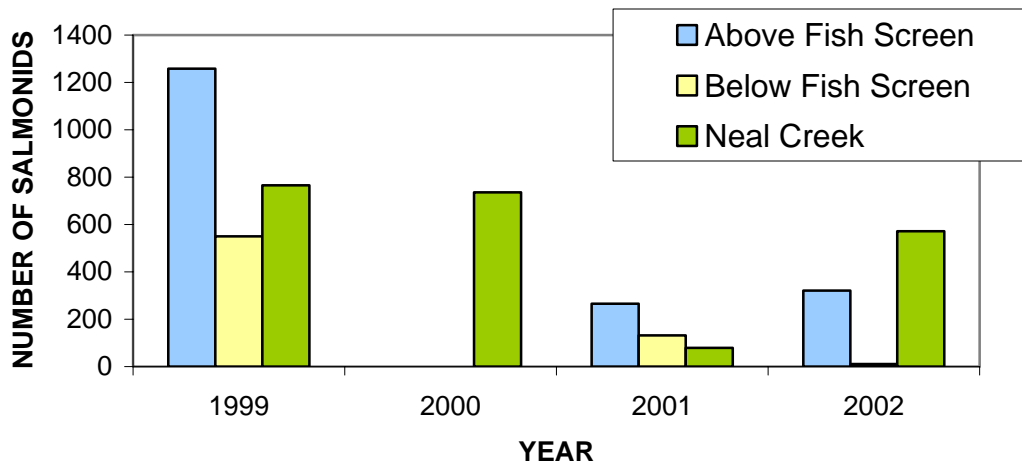


Figure 16. Number of salmonids salvaged from East Fork Irrigation District's irrigation canals for 1999-2002.

#### Farmer's Irrigation Salvage

Salvage of the Farmers Irrigation District canal occurred over three days, October 1<sup>st</sup> – 4<sup>th</sup>, 2002. Many volunteers showed up to help out the project. Species found included steelhead/rainbow trout (St/Rbt), chinook, coho, cutthroat, mountain whitefish, dace, sculpin, and brown trout. Salvage at the headgate occurred on the day the canal was shut down. The remainder was spot checked by Farmers staff and was salvaged in the following days. There were 3,604 total fish rescued, of which 3,108 were salmonids (Table 12). This was the highest number of salmonids collected from the Farmer's canal to date (Figure 17). This may be an artifact of higher salvage pressure than in the past. This was a result of planned activities to install a fish screen at the diversion. All fish from the Farmer's canal were released above Powerdale dam the day they were caught.

Table 12. Farmer's irrigation district 2002 fish salvage species distribution.

Location	Date	St/Rbt <sup>a</sup>	Ch <sup>b</sup>	Coho	Cutt <sup>c</sup>	Whtfs <sup>d</sup>	Dace	Sclp <sup>e</sup>	Brwn <sup>f</sup>	Total
Headgate	10/1/02	129		3				13		145
Above Reed Road	10/2/02	1,055		204	19	1		114		1,393
Above Portland Dr	10/3/02	459	6	146	158	10	1	152	3	935
Below Portland Dr	10/4/02	662	45	63	147	1	10	203		1,131
<b>Total</b>		<b>2,305</b>	<b>51</b>	<b>416</b>	<b>324</b>	<b>12</b>	<b>11</b>	<b>482</b>	<b>3</b>	<b>3,604</b>

<sup>a</sup> St/Rbt: steelhead/rainbow trout

<sup>b</sup> Ch: chinook

<sup>c</sup> Cutt: cutthroat trout

<sup>d</sup> Whtfs: mountain whitefish

<sup>e</sup> Sclp: sculpin

<sup>f</sup> Brwn: brown trout

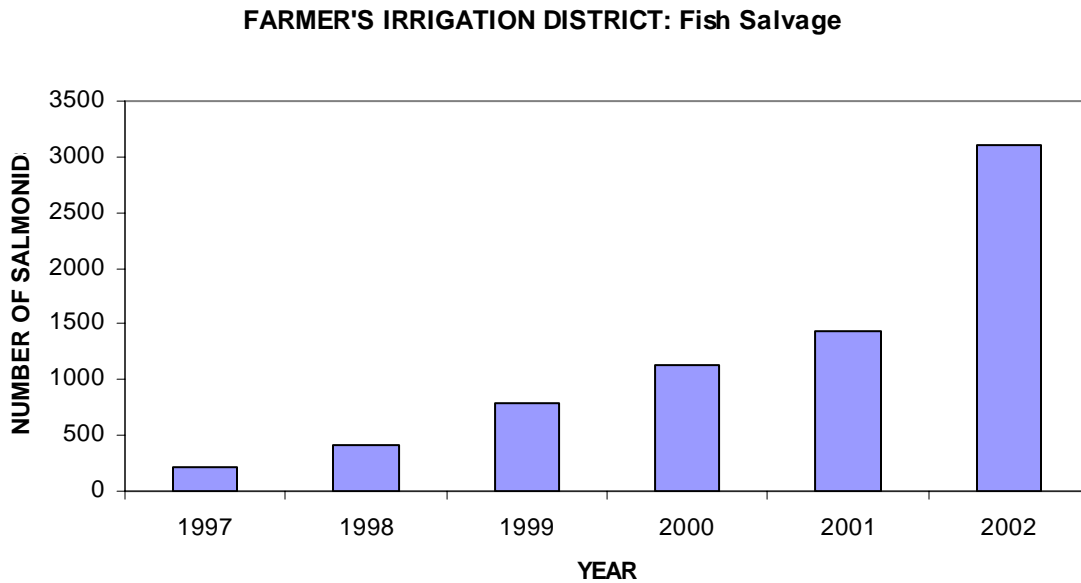


Figure 17. Number of salmonids salvaged from Farmer's Irrigation District (FID) irrigation canals for 1997-2002.

#### HABITAT SURVEYS

ODFW aquatic habitat inventories were conducted on three Hood River tributaries during the summer of 2002, Emil, Wisehart, and Lenz Creeks, and additionally data collected from 2002 for McGee and Evans Creeks was analyzed. These aquatic inventories are designed to provide quantitative information on habitat condition. This information will be used to provide basic information in areas where there are information gaps, to supplement the established monitoring program in the Hood subbasin, and to direct and focus habitat restoration efforts. A modified Hankin and Reeves methodology was utilized. This methodology is widely used by ODFW's Aquatic Inventories Project and was designed to be compatible with other stream habitat inventory and classification systems (i.e., Rosgen 1985, Frissell et al. 1986, Cupp 1989, Ralph 1989, USFS Region 6 Level II Inventory 1992, and Hawkins et al. 1993). Systematically identifying and quantifying valley and stream geomorphic features achieve this compatibility. The resulting matrix of measurements and spatial relationships can then be generalized into frequently occurring valley and channel types or translated into the nomenclature of a particular system. The process of conducting these stream surveys involved collection of general information from maps and other sources and the direct observation of stream characteristics in the field. This information is both collected and analyzed based on a hierarchical system of regions, basins, streams, reaches, and habitat units. The reports from the surveys conducted are available both online (<http://oregonstate.edu/Dept/ODFW/freshwater/inventory/basinwid.html>) and in hard copy. This data will primarily assist in the population of the EDT model and habitat restoration project selection.



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## Monitoring and Effects of Pesticides on Threatened Steelhead (*Oncorhynchus mykiss*) in the Hood River Basin, Oregon

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### Introduction

Wild salmonid populations in the Hood River Basin have been declining. Because of the population declines, steelhead (*Oncorhynchus mykiss*) in the Hood River Basin were listed in 1998 as threatened under the federal Endangered Species Act by the National Marine Fisheries Service. The causes of steelhead population declines were unknown but pesticides were identified as one potential stressor. The mid and lower Hood River Basin have extensive orchards of pear and apple, some peach and cherry orchards, and alfalfa hay. Typically, orchards use organophosphate pesticides (op-pesticides) in the spring and summer to control insects (Table 1).

**Table 1.** Hood River Basin: Some of the pesticides used and the time of year. Compiled from unpublished data and discussions with orchardists.

Pesticide Application	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Azinphos Methyl												
Chlorpyrifos												
Carbaryl												
Imidan												
Diazinon												
Simazine												
Fungicides												
Pyrethroids												
<div style="display: flex; justify-content: space-between; width: 100%;"> <span>Represents periods of peak use</span> <span>Represents lesser level of use</span> </div>												

These insecticides are mildly to very toxic to fish and other aquatic life. Organophosphate pesticide use in the Hood River Basin overlaps with the occurrence of a variety of wild winter steelhead life stages including: reproductively mature wild winter steelhead migration upstream to spawn and spawning; early life stage development and juvenile rearing; and migrations of smolts downstream (Table 2). Although there was a potential for exposure of steelhead to op-pesticides and toxicity to occur there was very little water chemistry data available on the occurrence of these pesticides in waters of the Hood River Basin prior to the spring of 1999 and there was no data on the in-stream aquatic life effects.

**Table 2.** Salmonid life stage and time of year found in the Hood River Basin. Adapted from Western Hood Subbasin Total Maximum Daily Load (TMDL) DEQ (2001).

Life Stage/Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>Winter Steelhead</b>												
Adult Upstream Migration												
Adult Spawning												
Egg Incubation												
Larval Development												
Juvenile Rearing												
Juvenile Downstream Migration												
Hatchery Smolt Releases												
<b>Other Salmonid Species</b>												
Spawning/egg incubation												
Juvenile rearing												
Migration												
	Represents periods of peak use						Represents lesser level of use					

Water samples were collected in March, April, and June of 1999, 2000, and 2001 from locations downstream of agriculture, forestry, urban areas, and mixed use areas within the Hood River Basin. Sample collection was timed to the apple and pear orchard use of chlorpyrifos (Lorsban) in March/April and azinphos methyl (Guthion) in June. These samples were analyzed for total and dissolved op-pesticides. Chlorpyrifos was above the method reporting limits (MRL) in the March and April samples at Neal Creek (agricultural area), Indian Creek (mixed use), East Fork Hood River (agricultural area), Trout Creek (agricultural area), Hood River (mixed use) but not the West Fork Hood River (forest area). In June, azinphos methyl concentrations were above the MRL at Neal Creek, Indian Creek, Trout Creek, and Hood River but not the West Fork Hood River or East Fork Hood River. These compounds were detected during rain and non rain events. Chlorpyrifos and azinphos methyl concentrations in Neal and Indian Creeks were above the state water quality standard and some of the concentrations detected may be high enough to cause toxicity to aquatic life.

The state water quality standard for chlorpyrifos is 0.041 ug/l for chronic and 0.083 ug/l for acute exposures and 0.010 ug/l for chronic exposures to azinphos methyl. The state standard for chlorpyrifos was adopted from the U.S. Environmental Protection Agency water quality criteria for chlorpyrifos that is contained in Quality Criteria for Water 1986 (EPA 440/5-86-001) and the azinphos methyl criteria are contained in the Quality Criteria for Water (EPA-440/9-76-023). The chlorpyrifos chronic criteria was developed from data on eight species only one of which was a freshwater species, the fathead minnow (*Pimephales promelas*). The acute criteria was developed from data on seven freshwater species and eleven invertebrates. Rainbow trout

(*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarkii*), and lake trout (*Salvelinus namaycush*) were the salmonids with available data used for acute criteria development. There was not information available on chlorpyrifos or azinphos methyl effects on salmonid reproduction, early life stage development, growth, or smoltification from long term or intermittent exposures. In addition, the standards do not take into account multiple exposures to individual or complex mixtures of op- or carbamate insecticides. Carbamate insecticides, such as carbaryl, have a similar mode of toxicity as op-insecticides and when they co-occur the toxicity would be expected to be additive.

Preliminary in-stream aquatic life effects assessments were conducted during the water chemistry sampling in 2000 and 2001. Hatchery steelhead were placed in cages at selected water chemistry sampling locations and were held for two to three weeks in-stream during the time of orchard use of OP-insecticides and water chemistry sampling. Brain acetylcholine esterase (AChE) activity was measured in these fish and AChE activity was lower in fish from areas with frequent detections of OP-insecticides in water samples (Grange, 2002). OP-insecticides reduce AChE activity and have been used as a measure of exposure and effects from these compounds. Macroinvertebrates were collected at the caged fish locations before and after orchard use of OP-insecticides. There were spatial and temporal macroinvertebrate assemblage differences observed (DEQ unpublished results).

The in-stream aquatic life monitoring results are preliminary but indicate that OP-insecticides may be having an effect on aquatic life. More work was needed to further document the occurrence of OP-insecticides in small streams, the co-occurrence of AChE activity depression and changes in macroinvertebrate assemblages in the Hood River Basin.

The goal of this project was to monitor the occurrence of OP-insecticides and evaluate the potential for in-stream effects on threatened steelhead in the Hood River Basin. Potential effects were evaluated by measuring op-insecticides in small streams supporting salmonids and the depression of AChE activity in caged steelhead. Macroinvertebrates were sampled and evaluated for changes in assemblage.

The information from this project could be used by fishery and water quality managers as well as the agricultural community to help restore threatened steelhead in the Hood River Basin. The data from this project would be useful to the Confederated Tribes of the Warm Springs, National Marine Fisheries Service, and Oregon Department of Fish & Wildlife for managing listed steelhead. This data would also be useful to the Oregon Department of Environmental Quality and the U.S. Environmental Protection Agency for determining compliance with the state water quality standards and federal water quality criteria. In addition, this data would be used by the agricultural community for determining if changes are needed in management practices during pesticide application.

## **Methods**

### **Station Locations**

Sample station locations were selected to represent similar streams with and without upstream agricultural activity. Reference locations were selected to represent forested influences, without upstream agricultural activity (Table 3). Because of the gradient change in the Hood River basin, experimental sites were grouped by elevation to account for gradient differences in pesticide application periods. Lower Neal Creek is influenced by extensive orchards along its banks throughout the valley floor. A tributary to Lower Neal Creek, Lenz Creek is a small, groundwater-fed valley stream, surrounded by orchard activity. Upper Neal

Creek, used as a comparison site for these locations, is influenced by forested areas and logging, without upstream agricultural activity. East Fork Hood River and Middle Fork Hood River are substantially larger tributaries influenced by orchards and forested areas. West Fork Hood River, used as a comparison site, is located in an undeveloped, forested area without upstream agricultural activity. Located in the upper valley, glacially fed Evans Creek is influenced by both orchard and forested areas. Dog River is primarily influenced by forest lands.

**Table 3.** Hood River watershed characteristics. (\*discharge data not available).

Site	Elevation (m)	Influential Land Use Upstream of Station	Drainage Area (square kilometers)	Mean Annual Discharge (cubic meters/sec)
Lower Neal Creek	120	Orchard	78	1.1
East Fork Hood River	366	Orchard	407	15.8
Lower Neal Creek	120	Orchard	78	1.1
Lenz Creek	190	Orchard	28	*
Evans Creek	538	Orchard	47	*
Upper Neal Creek	367	Forest	78	1.1
Dog River	668	Forest	65	*

#### Water Sample Collection

Surface water grab samples were collected at each site at regular intervals throughout the spray periods. Samples for total organophosphate and triazine analysis were collected in factory-cleaned, 2.5 liter amber jars with Teflon-coated lids. Other samples were collected in separate polyurethane bottles for hardness, nutrients, total metals, total organic carbon and total suspended solids. Field pH, conductivity and temperature were measured. The outside of each jar was rinsed in-stream, then filled 10 to 15 cm under the water surface. Samples were stored on ice in coolers to maintain sample temperatures at or below 4°C, and transported to the ODEQ laboratory for analysis. Rainfall data for the Hood River basin was collected from the USGS website at <http://waterdata.usgs.gov/or/nwis/discharge>.

#### Organophosphate and Triazine Pesticide Analysis

There were nine pesticides analyzed for in this study (Table 4). Analysis of total organophosphate and triazine pesticides was conducted by ODEQ using liquid-liquid extraction in accordance with USEPA method 8141B (USEPA, 1998a). The method detection limits for the pesticides were 0.025  $\mu\text{g/L}$ .

**Table 4.** Pesticides analyzed for in water samples collected from the Hood River Basin.

<u>Insecticides</u>	<u>Herbicides</u>
Azinphos-methyl	Atrazine
Chlorpyrifos	Simazine
Diazinon	
Dimethoate	
Imidan	
Malathion	
Methyl parathion	

Water Sampling Quality Assurance

Quality assurance procedures included inclusion of trip blanks for each field collection date, duplicate assay samples and matrix spike duplicate samples on 10% of all water samples collected. Precision of the analyses was determined by comparison of replicate samples. Accuracy was determined using percent recovery of spiked laboratory samples. Field meters were calibrated at regular intervals throughout the field sampling periods.

Biological Monitoring

Fish were held in stream cages during orchard post dormant spray application of chlorpyrifos in March and April. Other fish were held in cages during orchard codling moth spray application of azinphos methyl in June and July. One year old steelhead smolts from Oak Springs fish hatchery were held in cages for approximately a two week period during the spring spray event in the year 2002 at Lower Neal Creek and the Upper Neal Creek, Lenz Creek, Evans Creek, and Dog River. Juvenile steelhead (<4 months old) were placed in cages and sampled weekly for three to four weeks during the summer spray event at Lower Neal Creek, Lenz Creek, Evans Creek, Upper Neal Creek, East Fork Hood River, and Dog River. Cages were rectangular and constructed from PVC piping and HDPE plastic mesh and lined with river stones. Fish were transported from Oak Springs hatchery in aerated tanks to the stream cages within one week of initiation of organophosphate spray application as reported by the OSU Extension Agent based in Hood River.

Cages were visited 2 to 3 times per week to feed fish and to visually assess fish health. Fish were fed commercial trout chow, ad libitum. Mortalities and moribund fish were removed (without replacement) upon discovery. Cages were cleaned weekly to remove waste, otherwise cages were left undisturbed. Fish were sampled for brain acetylcholine esterase activity after exposure.

Macroinvertebrates were collected pre- spray and post- spray at lower Neal Creek, upper Neal Creek, Lenz Creek, Evans Creek, Dog River, and East Fork Hood River. Macroinvertebrates were collected with a Hess sampler. Samples were composited and preserved with ethanol. Identifications were made to determine assemblage.

***AChE Analysis***

Brains were excised and homogenized in 0.1M phosphate buffer with 0.1% Triton-X 100 at pH 8.0 (25mg/ml) and centrifuged at 3,500 rpm for 5 min. The supernatant was either diluted 1:22 with phosphate buffer or was undiluted and stored at -80°C until analysis. Acetylcholine esterase activity was measured according to Ellman et al. (1961) with some modification (Sandahl & Jenkins, 2002). Briefly, 50  $\mu$ l of 6mM 5,5'-Dithio-bis(2-nitrobenzoic acid) (DTNB) was added to 950  $\mu$ l of tissue homogenate and incubated for 10 min, and then 200  $\mu$ l was transferred into microtiter plate wells. The reaction was initiated with the addition of 50  $\mu$ l of 15mM acetylthiocholine iodide. Absorbance was measured at 412 nm in 19 sec intervals for 10 min at 28°C using a BioTek Ultra Microplate Reader (Model ULX808IU). Protein content was measured and compared to standards according to Bradford et al. (1976). Assays were run in triplicate with substrate blanks for each plate and tissue blanks for each sample. AChE activity was expressed as nmol/min/mg protein. Samples with a coefficient of variation between replicates >5% were immediately re-analyzed.

***Data Analysis***

Location differences in brain AChE for normally distributed data sets were detected using one-way ANOVA using Fisher's least significant difference (LSD) procedure to discriminate among the means.

**Results**

**Collection & Exposure Dates for Water, Fish, & Macroinvertebrates**

Water samples were collected in spring and summer 2002 from lower Neal Creek, upper Neal Creek, and Lenz Creek in the Lower Basin and from East Fork Hood River, Evans Creek, and Dog River in the Upper Basin (Table 5).

**Table 5.** Water sample collection beginning and ending dates.

<b>Location</b>	<b>Season</b>	<b>Begin Date</b>	<b>End Date</b>
Lower Basin	Spring	3/20	4/3
Upper Basin	Spring	4/4	4/22
Lower Basin	Summer	6/13	7/3
Upper Basin	Summer	6/27	7/18

Caged fish spring exposures used steelhead smolts from the Oak Springs Fish Hatchery that were placed in-stream at the Lower Basin stations (lower Neal Creek, upper Neal Creek, and Lenz Creek) on May 18<sup>th</sup> and at the Upper Basin stations (East Fork Hood River, Evans Creek, and Dog River) on April 4<sup>th</sup>. Summer caged fish exposures using juvenile steelhead from Oak Springs Fish Hatchery began in the Lower Basin on June 13<sup>th</sup> and were sampled on June 20<sup>th</sup>, June 26<sup>th</sup>, and July 3<sup>rd</sup>. The Upper Basin exposures began on June 25<sup>th</sup> and were sampled on July 3<sup>rd</sup>, July 11<sup>th</sup>, and July 18<sup>th</sup> (Table 6).



**Table 6.** Caged fish deployment and sampling dates.

<b>Location</b>	<b>Season</b>	<b>Date Deployed</b>	<b>Date Sampled</b>
Lower Basin	Spring	3/18	4/10
Upper Basin	Spring	4/4	4/24
Lower Basin	Summer	6/13	6/20
Lower Basin	Summer	6/13	6/26
Lower Basin	Summer	6/13	7/3
Upper Basin	Summer	6/25	7/3
Upper Basin	Summer	6/25	7/11
Upper Basin	Summer	6/25	7/18

Macroinvertebrates were collected from the Lower Basin (lower Neal Creek, upper Neal Creek, and Lenz Creek) and the Upper Basin (Evans Creek and Dog River) in Spring and Summer of 2001 (Table 7).

**Table 7.** Macroinvertebrate pre- and post- spray sampling.

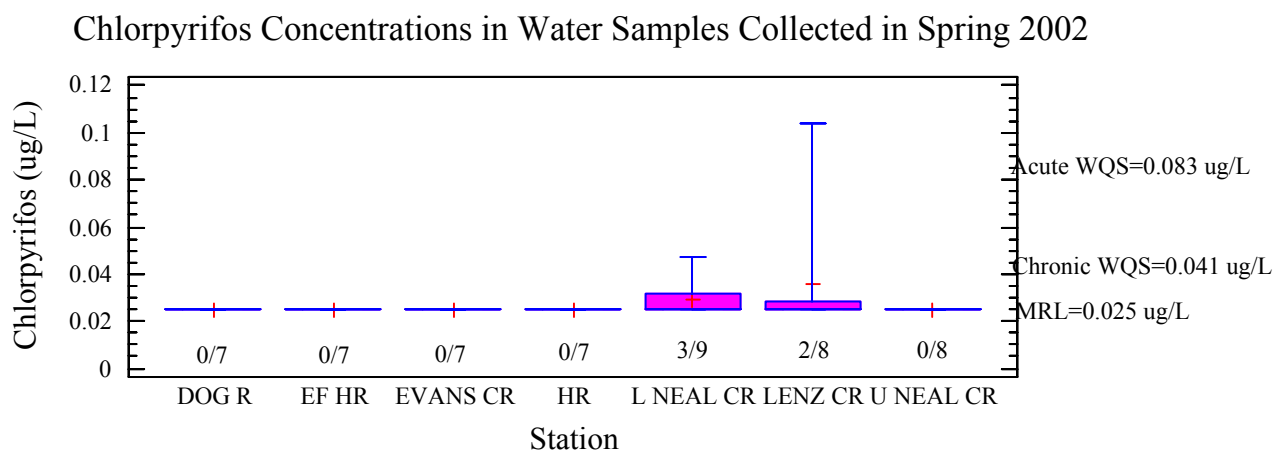
<b>Location</b>	<b>Season</b>	<b>Pre- Spray</b>	<b>Post- Spray</b>
Lower Basin	Spring	3/12	4/10
Upper Basin	Spring	3/12	4/10
Lower Basin	Summer	5/23	7/10
Upper Basin	Summer	6/6	7/10

### **Spring Water Sample Pesticide Analytical Results**

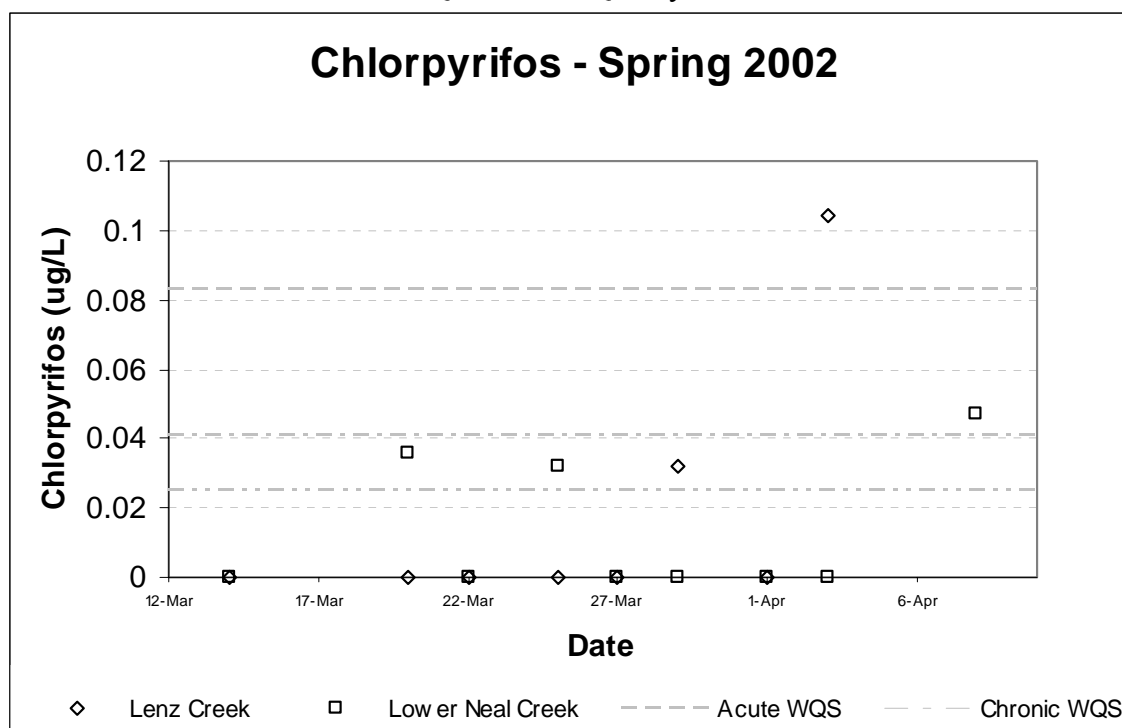
The pesticides detected in water samples collected in the spring were chlorpyrifos and simazine. Chlorpyrifos was detected in three of nine and two of eight samples collected at Lower Neal Creek and Lenz Creek, respectively (Figure 1). One sample at Lower Neal Creek was above the chronic water quality standard for chlorpyrifos and one sample at Lenz Creek was above the acute water quality standard (Figure 2). Simazine was detected in six of eight samples collected at Lenz Creek but was not detected at any other locations (Figure 3). Concentrations of Simazine ranged between 0.025 to 0.05 ug/L (Figure 4)

**Figure 1.**

DOG R = Dog River; EFHR = East Fork Hood River; EVANS CR = Evans Creek; HR = Hood River; L NEAL CR = Lower Neal Creek; U NEAL CR = Upper Neal Creek. WQS = Water Quality Standard. MRL = Method Reporting Limit. ## = number of detections / number of samples collected.

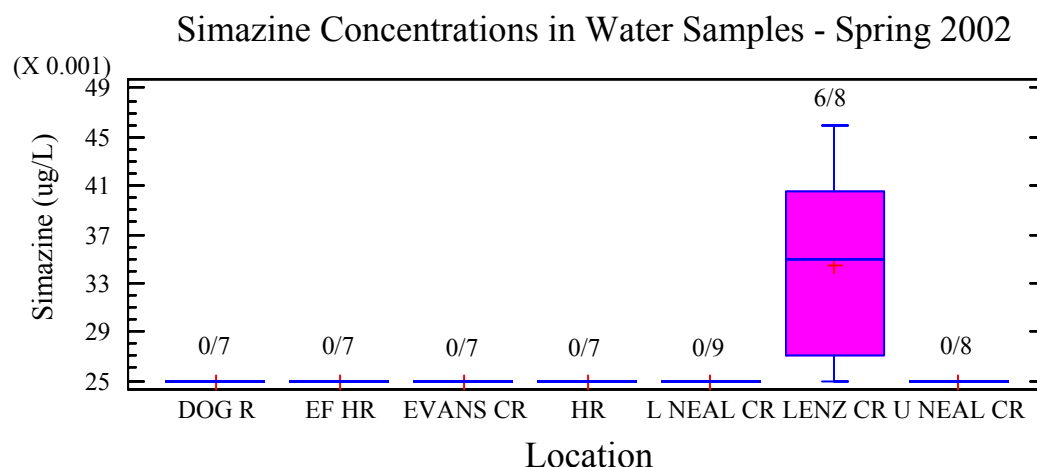


**Figure 2.** Chlorpyrifos concentrations in water samples collected in Spring 2002 from Lenz Creek and Lower Neal Creek. WQS = Water Quality Standard.

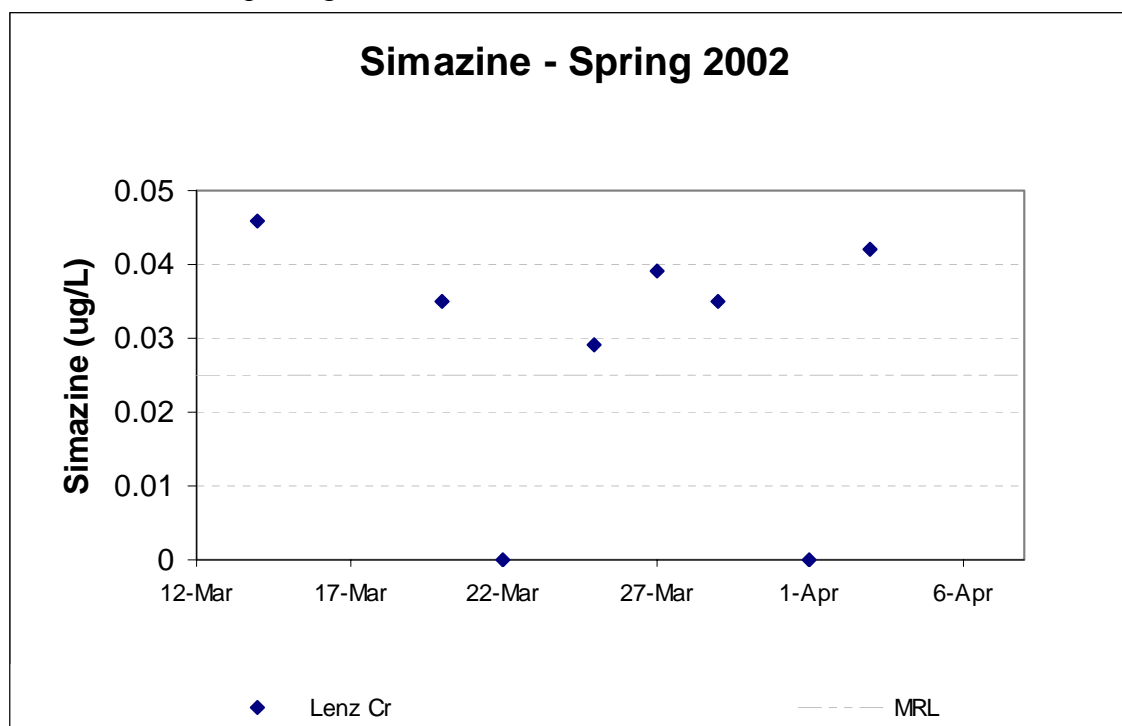


**Figure 3.**

DOG R = Dog River; EFHR = East Fork Hood River; EVANS CR = Evans Creek; HR = Hood River; L NEAL CR = Lower Neal Creek; U NEAL CR = Upper Neal Creek. WQS = Water Quality Standard. MRL = Method Reporting Limit. ## = number of detections / number of samples collected.



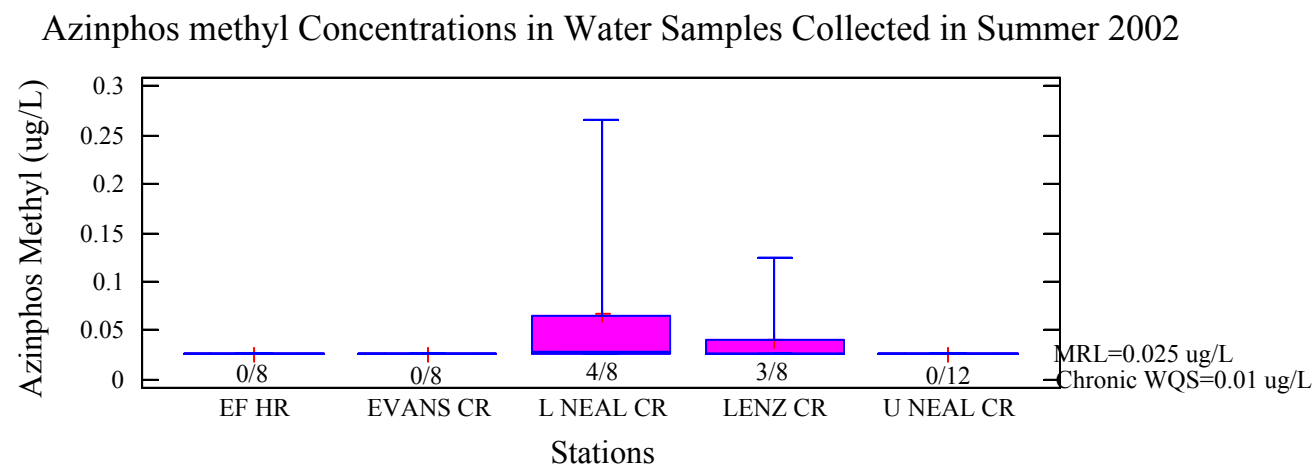
**Figure 4.** Simazine concentrations in water samples collected in Spring 2002 from Lenz Creek. MRL = Method Reporting Limit.



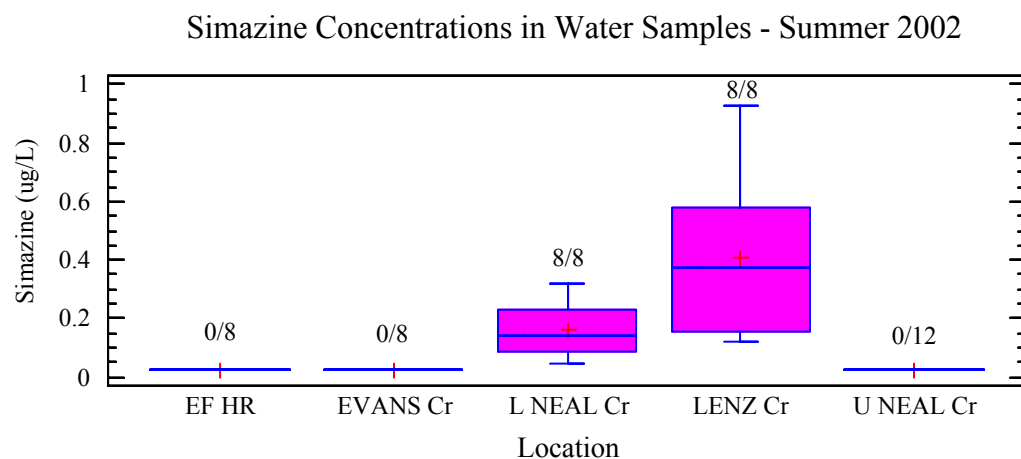
### Summer Water Sample Pesticide Analytical Results

Azinphos methyl and simazine were the most commonly detected pesticides in the water samples collected in the summer. There were less frequent detections of imidan, malathion, and atrazine. Azinphos methyl was detected in four of eight and three of eight samples from lower Neal Creek and Lenz Creek, respectively (Figure 5). Simazine was detected in all samples collected from lower Neal Creek and Lenz Creek (Figure 6). Water samples with detectable azinphos methyl were above the chronic water quality standard (Figure 7). Simazine concentrations were higher at Lenz Creek than lower Neal Creek (Figure 8). Imidan was detected twice, once at Evans Creek and once at Lenz Creek (Figure 9).

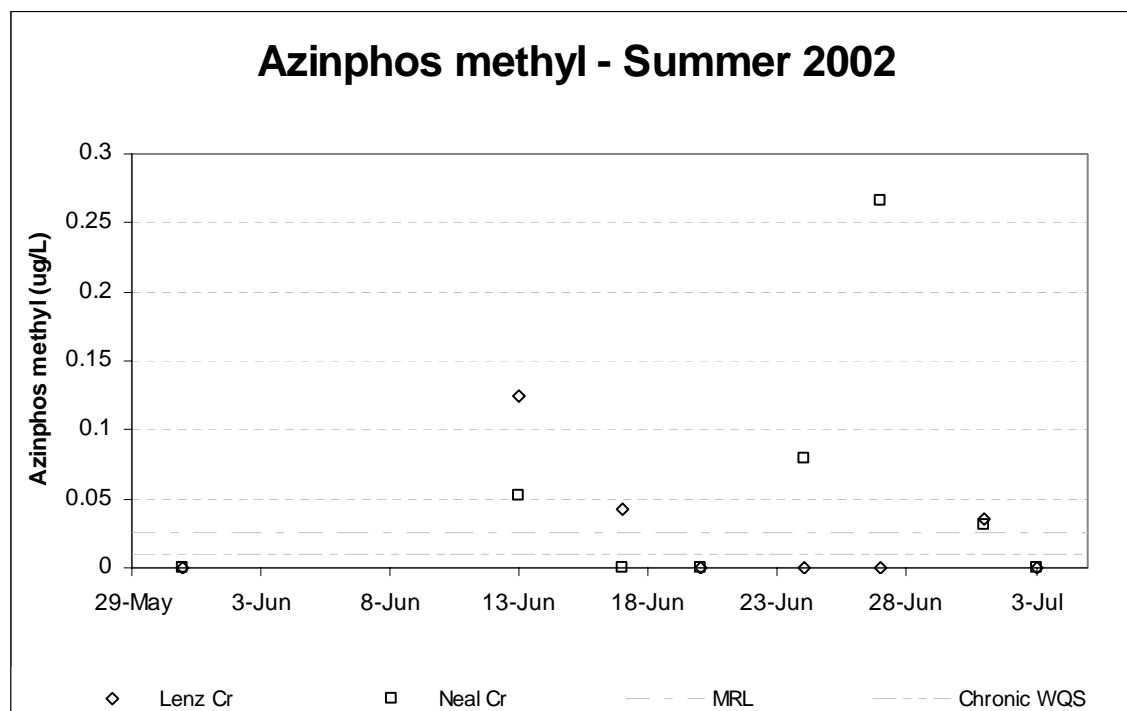
**Figure 5.** (See Figure 1 for descriptions of abbreviations).



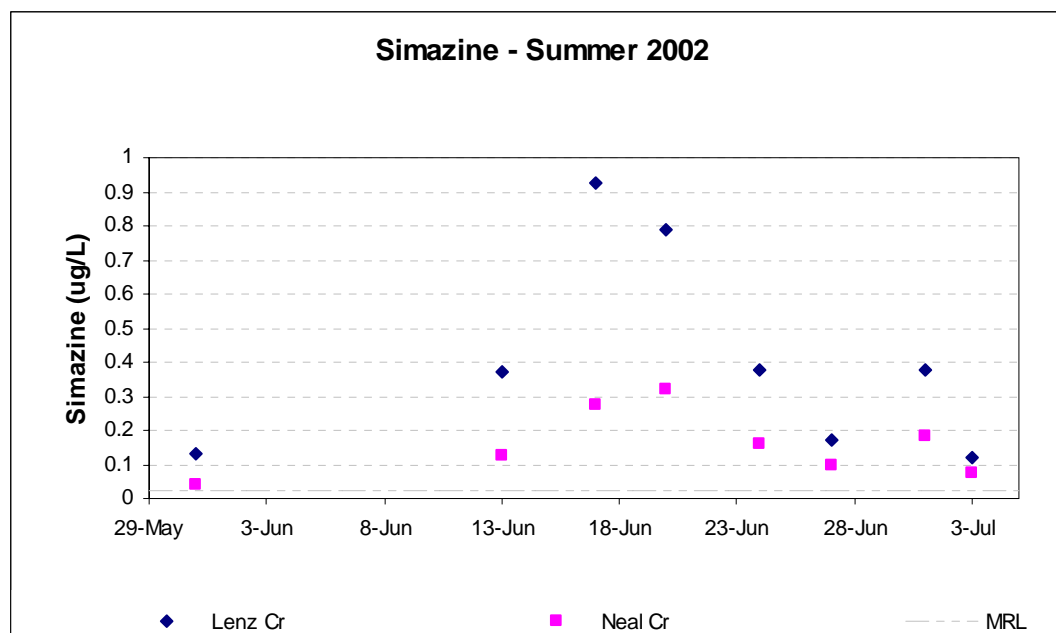
**Figure 6.** (See Figure 1 for descriptions of abbreviations).

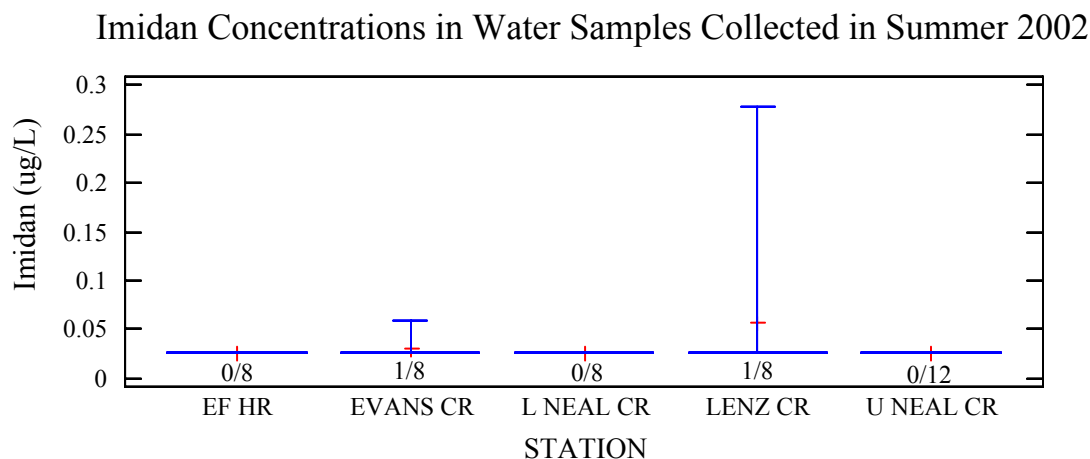


**Figure 7.** Azinphos methyl in water samples collected in summer from Lenz Creek and Lower Neal Creek.



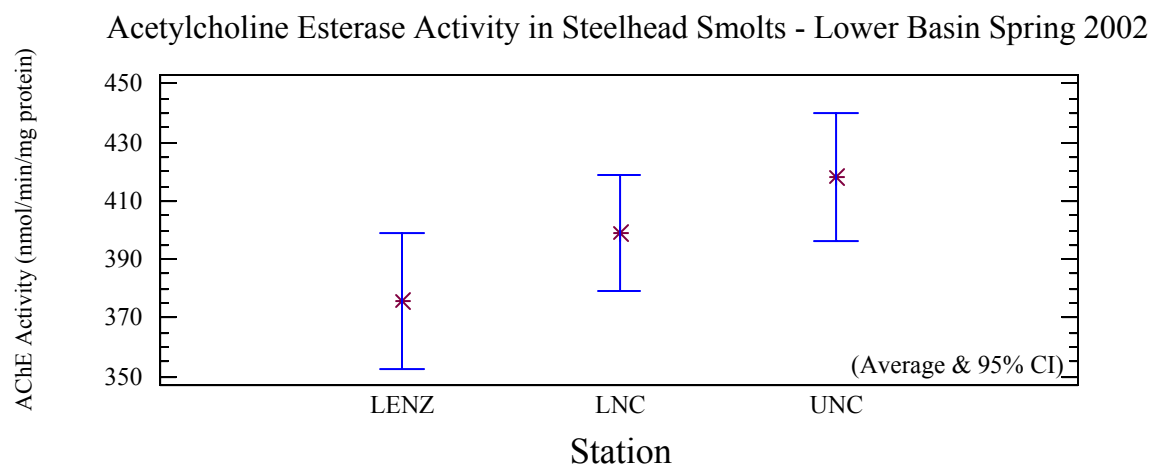
**Figure 8.** Simazine in water samples collected in summer from Lenz Creek and Lower Neal Creek.

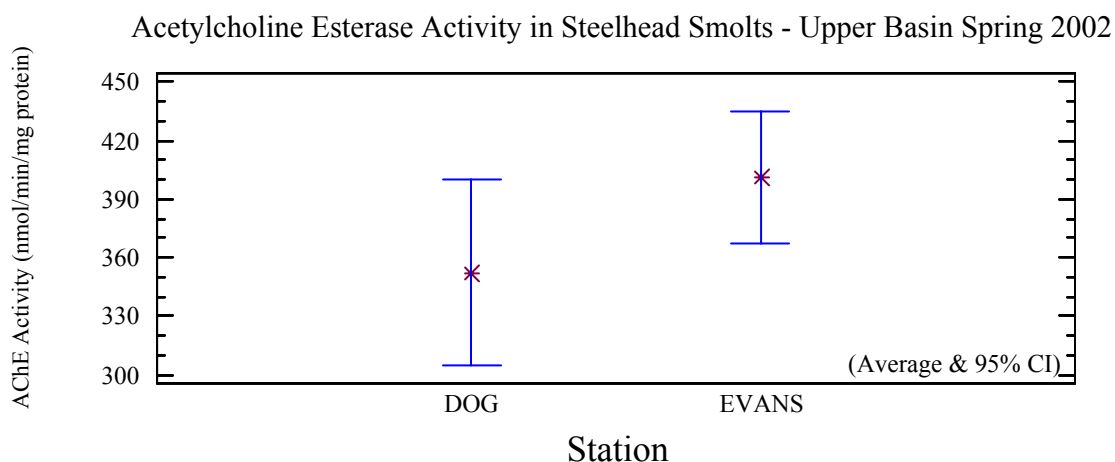


**Figure 9.** (See Figure 1 for descriptions of abbreviations).

### Results of Biological Monitoring

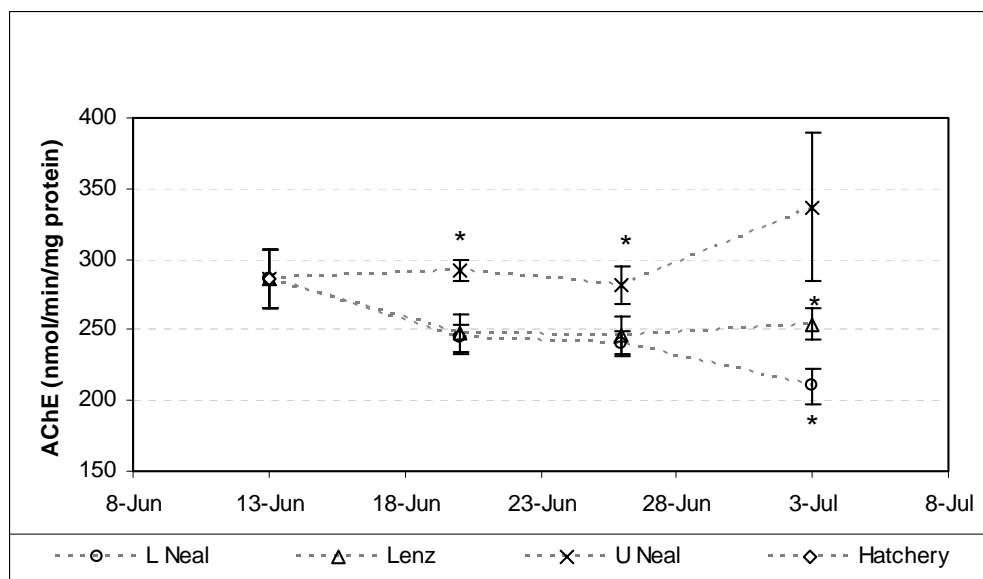
Average brain AChE activity during the spring exposure was lower at Lenz Creek and lower Neal Creek than at upper Neal Creek, but not significantly (Figure 10). The average brain AChE activity at Dog River was lower than Evans Creek, but not significantly (Figure 11).

**Figure 10.**

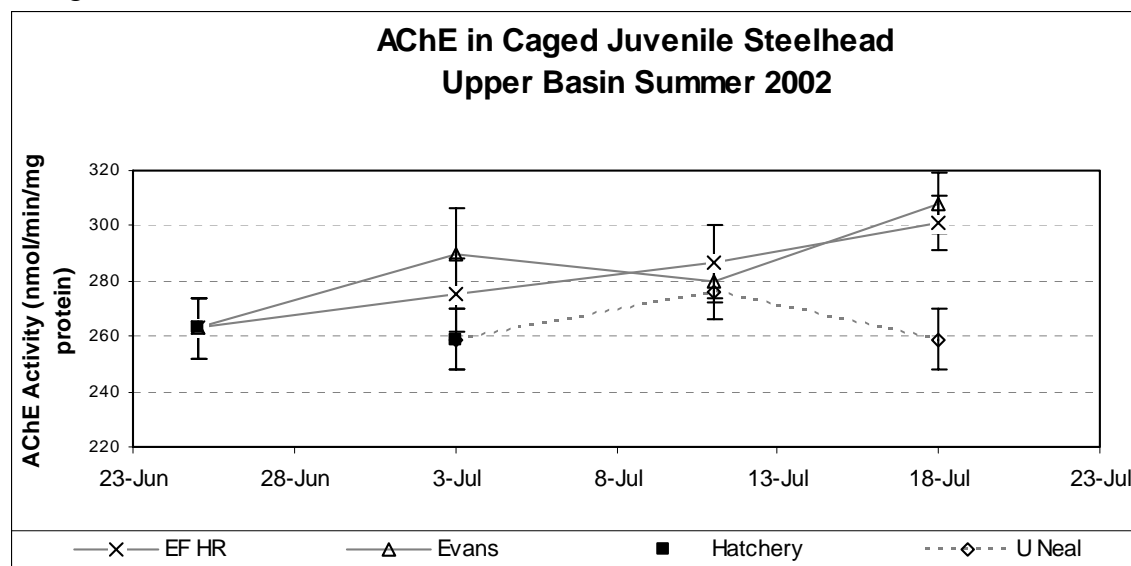
**Figure 11.**

Juvenile steelhead brain AChE activities during the summer exposure were significantly lower at Lenz Creek and lower Neal Creek than upper Neal Creek for all time points (Figure 12). Brain AChE activities were slightly elevated above baseline levels for Evans Creek and East Fork Hood River for the samples collected two and three weeks after exposure (Figure 13).

**Figure 12.** Brain AChE activity in juvenile steelhead held at the lower basin stations during the summer. \* indicates significant difference ANOVA p-value<0.05, LSD multiple range test p-value <0.05.



**Figure 13.** Brain AChE activity in caged juvenile steelhead held at the Upper Basin stations during the summer.

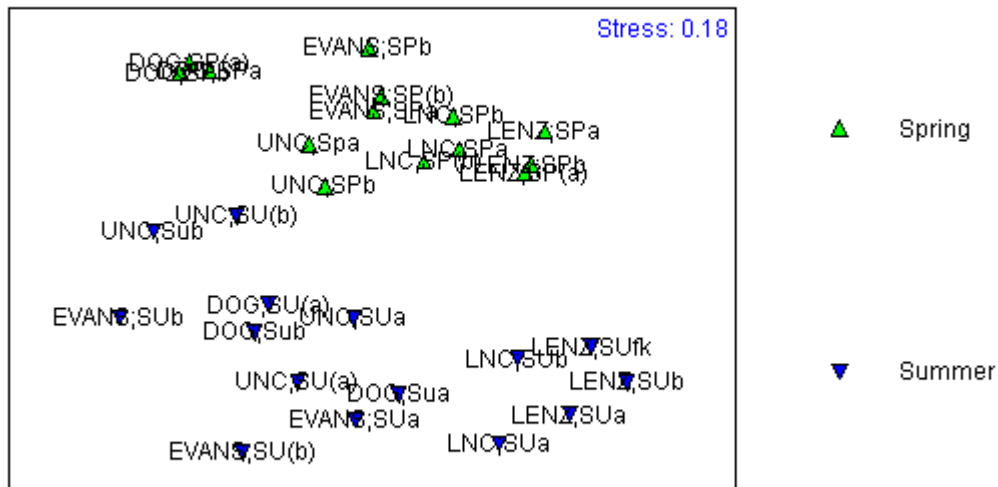


The results of the macroinvertebrate sample collections from 2001 showed site differences. The 2002 macroinvertebrate samples were collected by the same methods as 2001.

Macro-invertebrate data log transformed ( $\log x+1$ ) to reduce influence from abundant taxa. Multivariate techniques used to determine changes in macroinvertebrate assemblages include multi-dimensional scaling (MDS) ordination maps based on Bray-Curtis similarity matrices and analysis of similarities (ANOSIM) based on permutation tests (Primer 5 software). Stress is the distortion produced by measured distance between sites and actual distance (Stress  $< 0.5$  = excellent,  $< 0.1$  = good,  $< 0.1$  = useful). The R statistic (-1.0 to 1.0) is based on differences between the rank similarities between groups and within groups. R is then subjected to permutation tests to provide a test statistic.



HR 2001



Stress = 0.18,  $\alpha = 0.05$ , p value = .001

Reject Ho: no difference between treatments

Accept Ha: differences between treatments

### Global Test

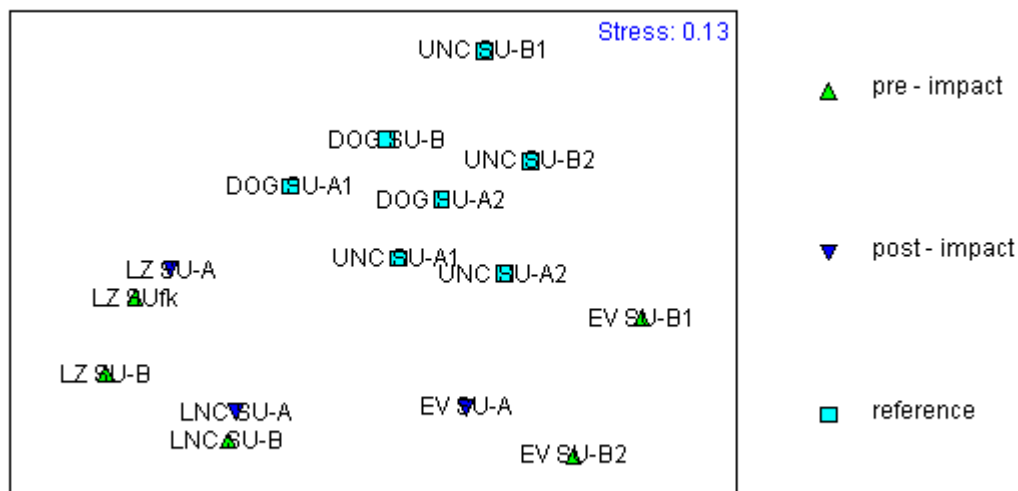
Sample statistic (Global R): 0.502

Significance level of sample statistic: 0.1%

Number of permutations: 999 (Random sample from 77558760)

Number of permuted statistics greater than or equal to Global R: 0

## HR 2001 Summer samples



Stress = 0.13,  $\alpha = 0.05$ , p value = .002

Reject Ho: no difference between treatments

Accept Ha: differences between treatments

Sample statistic (Global R): 0.454

Significance level of sample statistic: 0.2%

Number of permutations: 999 (Random sample from 360360)

Number of permuted statistics greater than or equal to Global R: 1

### Tests between groups

Groups	R statistic	Significance level %	Possible Permutations	Actual Permutations	Number > Observed
pre-impact vs. post-impact	-0.077	62.5	56	56	35
pre-impact vs. reference	0.589	0.1	792	792	1
post-impact vs. reference	0.683	0.8	120	120	1

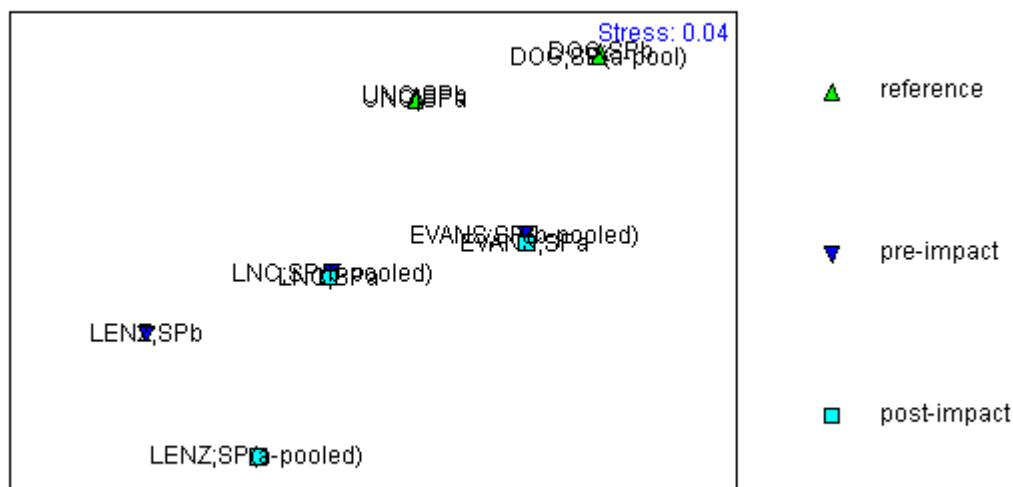
R statistic pre vs. post impact suggests high variability within the group

R statistic pre impact vs. reference significantly different (p value  $0.001 < \alpha = 0.02$  (Bonferroni corrected))

R statistic post impact vs. reference significantly different (p value  $0.008 < \alpha = 0.02$  (Bonferroni corrected))

\*\*Notice the R statistic increases between pre and post spray when tested against the reference sites, indicating further separation.

HR 2001 Spring samples



Stress = 0.04,  $\alpha = 0.05$ , p value = .015  
 Reject Ho: no difference between treatments  
 Accept Ha: differences between treatments

Global Test

Sample statistic (Global R): 0.455  
 Significance level of sample statistic: 1.5%  
 Number of permutations: 999 (Random sample from 2100)  
 Number of permuted statistics greater than or equal to Global R: 14

Groups	R statistic	Significance level %	Possible Permutations	Actual Permutations	Number > Observed
pre-impact vs. post-impact	-0.222	70.0%	10	10	7
pre-impact vs. reference	0.648	2.9%	35	35	1
post-impact vs. reference	0.722	2.9 %	35	35	1

R statistic pre vs. post impact suggests high variability within the group  
 R statistic pre impact vs. reference significantly different (p value  $0.02 \leq \alpha = 0.02$  (Bonfferoni corrected)  
 R statistic post impact vs. reference significantly different (p value  $0.02 \leq \alpha = 0.02$  (Bonfferoni corrected)  
 \*\*Notice the R statistic increases between pre and post spray when tested against the reference sites, indicating further separation.

### Quality Assurance for Water Sample Pesticide Analysis

Water samples analyzed for organophosphate insecticides achieved the quality assurance project data quality objectives. Laboratory Control Standards were within the recovery objectives of 60% - 140% with the exception of two samples and pesticides were not detected on those sampling dates (Figure 14). The Continuing Calibration Verification were within the 80% - 120% objective with the exception of one sample and pesticides were not detected on that sampling date (Figure 15). Surrogate Spike Recovery objectives of 60% - 140% were met with the exception of two samples and pesticides were not detected on those sampling dates (Figure 16). The Matrix Spike results were within the objectives of  $\pm 10\%$  (Figure 17) and the agreement between replicates met the objectives of  $<5\times$  the MRL (Figure 18).

**Figure 14.**

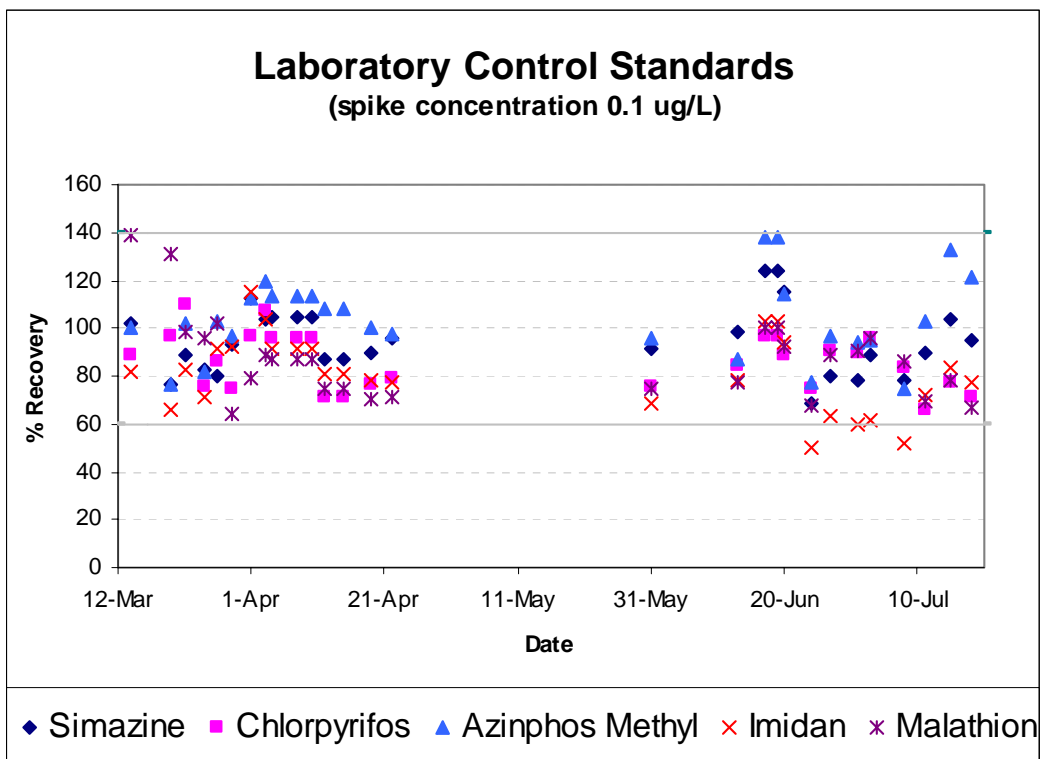


Figure 15.

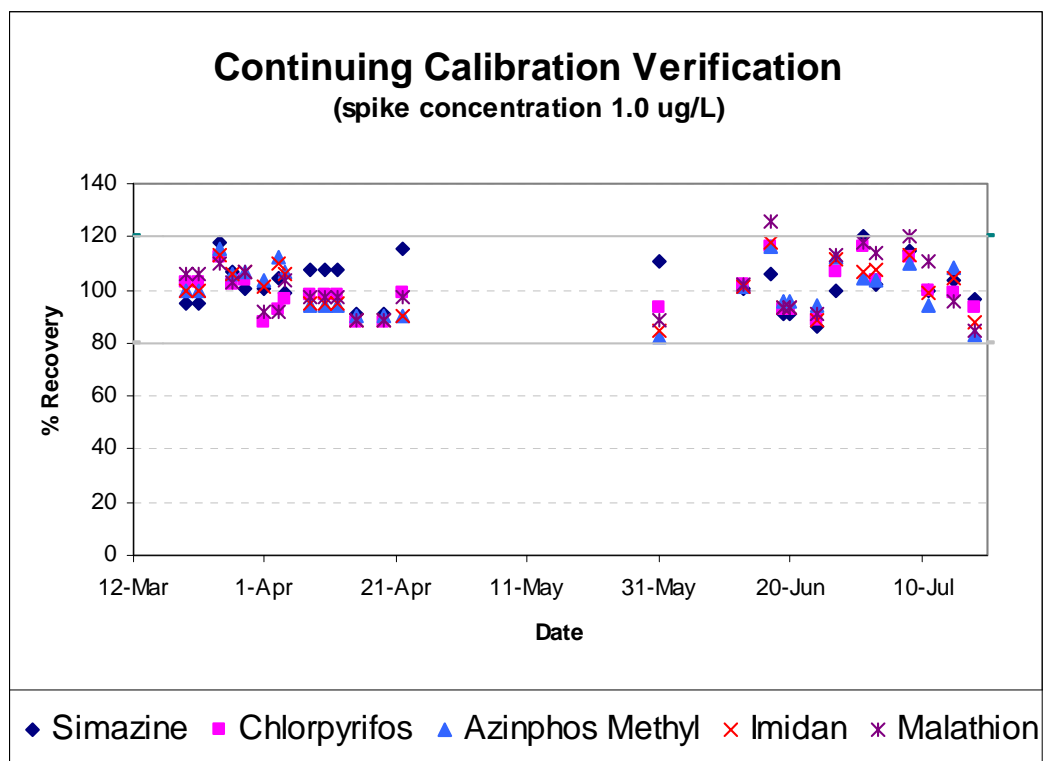


Figure 16.

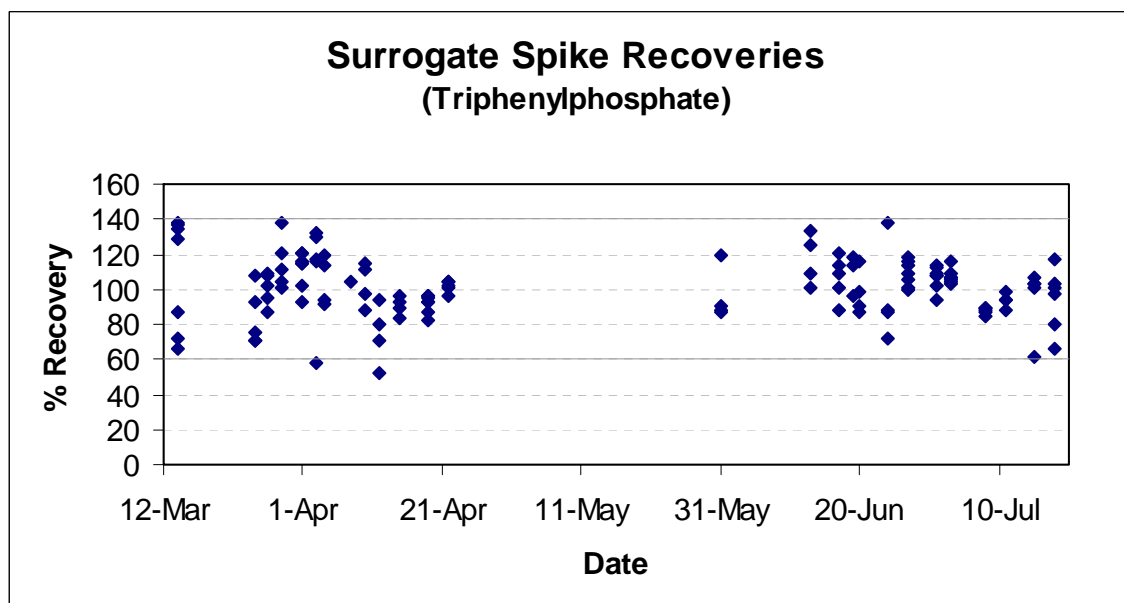


Figure 17.

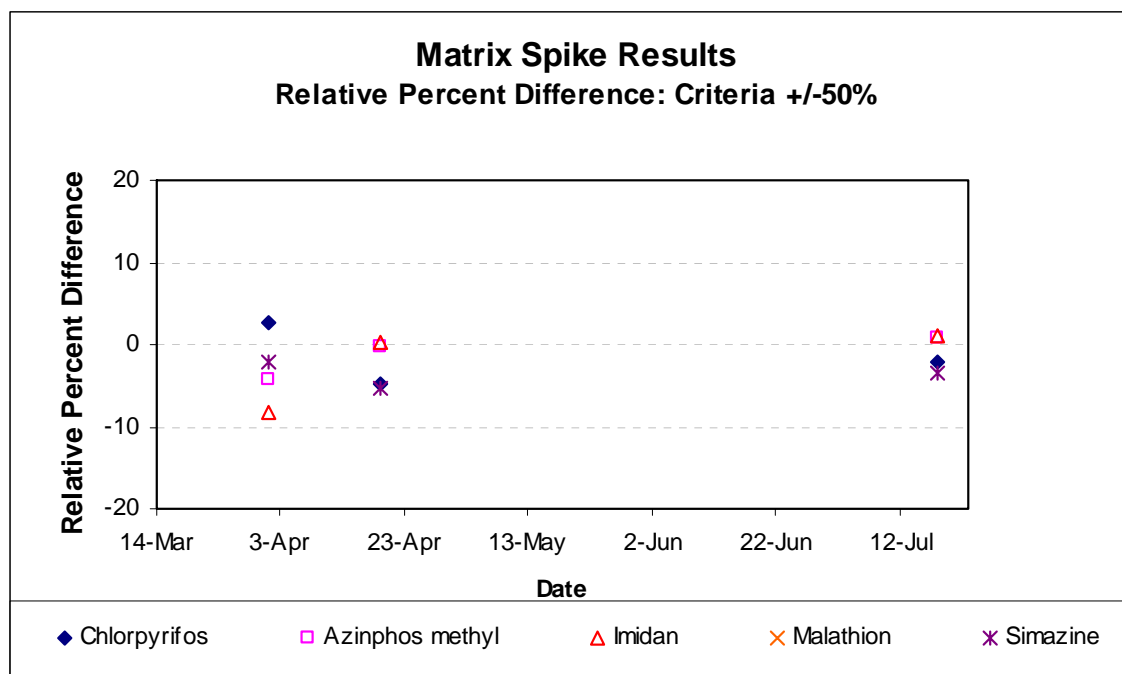
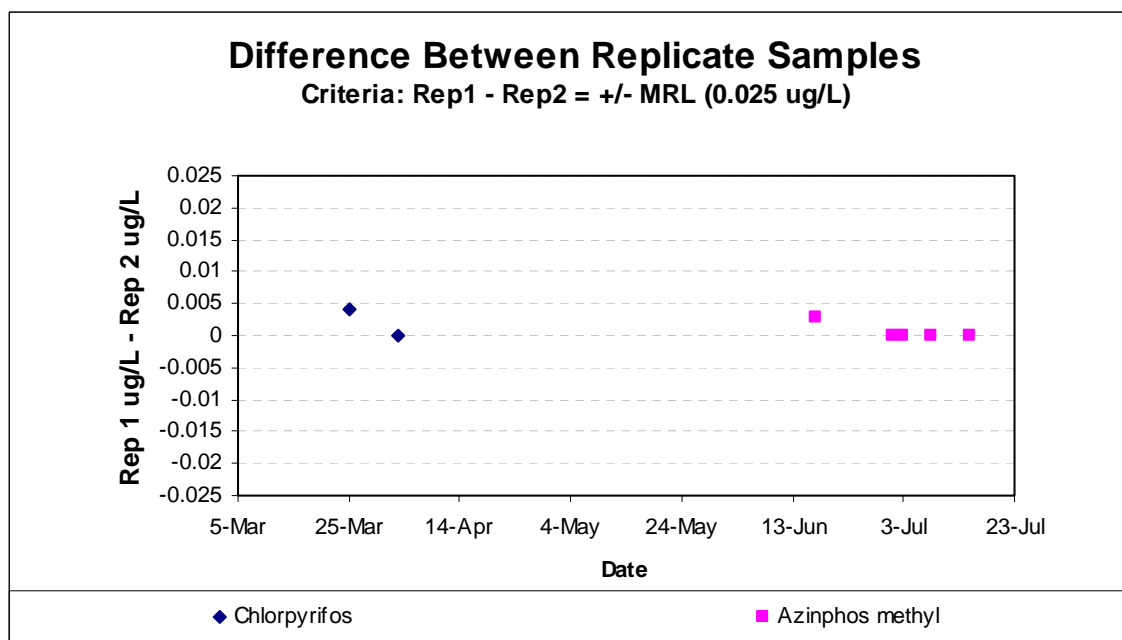


Figure 18.



## Discussion

The organophosphate insecticides chlorpyrifos and azinphos methyl were detected in water samples from small creeks in the Hood River Basin during the use of these chemicals by fruit tree orchards. In addition, there was decreased activity of the brain enzyme acetylcholine esterase in juvenile steelhead held in cages at these locations during the summer season but not spring. The water sampling results are consistent with the pesticide monitoring in 2000 and 2001 but was different for the brain enzyme activities which were depressed in both spring and summer in 2000 and 2001.

Anadromous salmonid runs occur in Hood River tributaries that may be susceptible to agricultural contamination from orchard pesticide application. Pesticide applications overlap all life stages, including adult upstream migration, spawning, egg, larval and parr development, smoltification and downstream migration. Wild juvenile steelhead remain in the small tributaries for 2-4 years before migrating to the ocean, and thus may face multi-year exposures throughout development. Smolting hatchery steelhead from wild brood stock are released into Hood River tributaries over a several week period in late April and early May. These fish are exposed to pesticide contamination during the period they remain in local tributaries prior to migrating to the ocean.

Pesticide applications occur from March through November, and include herbicides, organophosphate insecticides, pyrethroids, insect growth regulators, miticides, fungicides, and biological mating disruptors. The 2001 Pest Management Guide for Tree Fruits in the Mid-Columbia area lists 22 insecticides, 30 fungicides and 6 miticides, which may be used to provide pest control. In addition, herbicides, chemical thinning sprays, plant growth regulators and hormone ripening controls are applied to optimize crop production. Orchards are also using Integrated Pest Management (IPM) principles, designed to provide pest protection while minimizing environmental impact. Three percent of Hood River basin orchards are operated organically.

While some commonly used pesticides are used seasonally to combat predictable pest emergencies, most are targeted to specific infestations. There is considerable year to year variability in pesticide application timing based on weather patterns, pest density, appearance of resistant pest strains, and commercial introduction of more efficacious treatments. Pesticide application timing within the Basin is affected by degree-days, rain forecast and degree of infestation and may vary by as much as three weeks between orchards. Application methods include tractor-mounted blowers for insecticides and fungicides and ground application for herbicides.

Because of the neurotoxicity, prevalence of use, and potential for contamination of surface waters, OP pesticides are of particular concern. In 1999, the most widely used OPs in Hood River County, in order of application rate, were chlorpyrifos, azinphos methyl, imidan, carbaryl and diazinon. Chlorpyrifos was applied to 82% of apple and 41% of pear orchards over a three to four week period in late winter as a dormant spray for scale. Azinphos methyl was used in 79% of apple and 82% of pear orchards to control codling moth. Application begins during petal fall in late spring, with re-application every three weeks into July for pears, and into early September for apples. Imidan was an alternative treatment for codling moth in 11% of apple and 27% of pear orchards. Carbaryl was used as a blossom thinning treatment in 52% of apple orchards.

Organophosphate compounds are a broad class of chemicals that are relatively non-persistent in the environment, but highly toxic to aquatic life. The primary mode of action is

interference with cholinergic nerve transmission through inhibition of AChE activity, and is highly consistent between active forms of different OP compounds.

Chlorpyrifos was introduced in 1962 as a broad spectrum pesticide, effective against insects and arthropod pests. It is most commonly marketed under the trade names Lorsban and Dursban. 20 million pounds of chlorpyrifos are applied annually nationwide, equally dispersed in agricultural and non-agricultural applications. Predominant agricultural crops are corn, cotton and apples. Non-agricultural uses include termite and indoor pest control, turf and ornamental applications.

Chlorpyrifos is likely to contaminate surface waters through volatilization from plant foliage, aerial drift and offsite movement of sorbed sediments. Field crops present the greatest risk of offsite transport due to extensive sediment mobility. It is relatively persistent in sediments as it readily adsorbs to suspended particulate in water (Barron & Woodburn, 1995). Though not expected to be the main route of toxicity, chlorpyrifos bioaccumulates in aquatic organisms, but quickly degrades in the absence of continuous exposure. Data collected for the 1998 EPA Risk Assessment for Chlorpyrifos showed chlorpyrifos in 23% of fish samples collected from 314 sites. Bioconcentration factors of 58-5100 in embryonic through fry stages have been shown. Chlorpyrifos presents risk of contaminating the food chain during extended environmental exposures (Racke, 1992).

Azinphos methyl, commonly known by the trade name Guthion, is a broad-spectrum phosphorodithiolate organophosphate insecticide applied as a foliar spray. It is registered for use in fruit, nut, vegetable and field crops, and also in container nursery, forest and shade tree applications. Outside of US, azinphos methyl is used extensively in rice paddies. Due to high toxicity, it is regulated as a Restricted Use Pesticide.

Azinphos methyl could reach surface waters through run-off and aerial drift. It is moderately persistent in soil (half life of 27 days in aerobic soils), and degrades in water primarily by photolysis (half-life of 77 hours). The major route of dissipation is foliar wash-off and degradation. Azinphos methyl does not bioaccumulate due to its low  $K_{ow}$ . Environmental degradation products of azinphos methyl are less toxic than the parent compounds. The most toxic form of azinphos methyl is the oxon formed through biotransformation of the parent compound.

The 2001 US EPA Risk Assessment for azinphos methyl notes that "all uses of azinphos methyl pose a high acute and chronic risk to aquatic animals", and that there is considerable evidence that labeled uses of azinphos methyl kill aquatic organisms. Nationwide, azinphos methyl is associated with 50% of all fish kills reported in the EFED Incident Data Base System. Hundreds of thousands of fish were lost in 131 reported incidents, mostly associated with cotton and sugarcane uses (USEPA, 1998b). Small mammal and bird mortality has been reported in apple orchards using azinphos methyl at maximum allowable label rates. In 2000, registration was cancelled for 28 crops and is currently being phased out for seven additional crops. The remaining nine crops including apples have been granted an interim re-registration through 2005. The registration for these uses could be extended if acceptable mitigation practices are agreed upon and implemented.

Acetylcholine is an important neurotransmitter involved in transmission of nerve impulses in muscle tissue, the brain and the autonomic nervous system. Secreted by neurons into the synapse in response to a nerve impulse, acetylcholine binds to post-synaptic receptors, causing activation of the receptor and transmission of the nerve impulse. There are two general types of cholinergic receptors: muscarinic receptors found in the central and peripheral nervous systems and nicotinic receptors, found in neuromuscular junctions as well as the central and



peripheral nervous system. Cholinergic transmission is terminated when acetylcholine is removed from the post-synaptic receptor (Donald, 1998).

Acetylcholinesterase (AChE) cleaves acetylcholine through hydrolysis of the neurotransmitter into acetic acid and choline. If AChE is inhibited, acetylcholine builds up and the post-synaptic receptor continues to fire, resulting in overstimulation of the central and peripheral nervous system. Signs of acute AChE inhibition by anti-cholinesterase agents include tremors, spasms, loss of respiratory function, paralysis and death (Donald, 1998).

Organophosphate and carbamate pesticides are a potent class of neurotoxins whose mode of action has been identified as inhibition of AChE activity. Recent studies with AChE knockout mice showed symptoms of nervous system overstimulation indicative of organophosphate toxicity, despite the absence of AChE, which suggests additional mechanisms of action (Duysen, 2001). Inhibition occurs when organophosphate metabolites phosphorylate the enzyme active site, blocking binding to acetylcholine and inhibiting further AChE production. While carbamylated AChE can be spontaneously hydrolyzed and reactivated, OP-mediated phosphorylation is more persistent. In some fish species, including *O. mykiss*, restoration of AChE activity can take 30 days or more, indicating that dephosphorylation does not occur, and new synthesis of AChE is required (Giesy et al., 1999). Recovery of AChE activity is a function of the extent of inhibition, the chemical structure of the OP, the species, and the conditions of exposure. Repeated exposures have an increasingly toxic effect.

Symptoms of OP-mediated AChE inhibition include behavioral symptom logy associated with continuous activation of muscarinic receptors at neuromuscular junctions, and may include tremors, muscle spasms, loss of coordination, lateral flexures (in fish), and paralysis (Karen et al., 1998). Acute toxicity can result in respiratory failure and death. Chronic effects include reduced reproductive success in bluegill (Giddings et al., 1994). Delayed neuropathy after OP exposure has been observed in humans, but has not been studied in fish. OP-induced AChE inhibition has been studied in brain, gill, liver, muscle, plasma and red blood cells of a wide variety of species. In teleosts, brain AChE activity appears to be the most robust endpoint of OP exposure (Straus & Chambers, 1995). Plasma and red blood cell AChE inhibition is commonly used as a non-lethal method of diagnosing OP exposure in humans, birds and mammals (USEPA, 2001).

AChE activity acts as a sensitive and specific biomarker of organophosphate and carbamate exposure when compared with control organisms. While there is considerable variability in compound toxicity and species sensitivity to individual OPs, the degree of observed inhibition is associated with exposure concentrations in a dose-response relationship, and toxic effects can be correlated to percent inhibition. Exposure duration, frequency of exposure, and life stage will affect the degree of inhibition and subsequent recovery (Walker, 1996). This study provides evidence that pesticide use in tree fruit orchards are affecting threatened steelhead in the Hood River.

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