Integrated Status & Effectiveness Monitoring Program
Expansion of Existing Smolt Trapping Program and Steelhead Spawner Surveys
Draft Annual Report 2004

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This report covers the activities conducted by the Washington Department of Fish and Wildlife (WDFW) as part of a larger project (#2003-017-00), the objective of which is to develop monitoring and evaluation programs in the Wenatchee, John Day, and South Fork Salmon River. These programs are intended to be pilot subbasin-scale programs for status and trend monitoring for anadromous salmonids and their habitat and effectiveness monitoring for habitat restoration projects. Specifically, the WDFW was contracted to 1) estimate the total number of steelhead *Oncorhynchus mykiss* redds in selected streams within the Wenatchee subbasin by conducting index spawning ground counts, and 2) estimate the smolt production of spring Chinook *O. tshawytscha* salmon and steelhead for the Wenatchee subbasin. Status and trend monitoring of the steelhead and spring Chinook populations in the Wenatchee subbasin has been focused on supplementation programs and their efficacy in increasing the number of naturally spawning adults. An objective of this project was to increase not only the scope, but also the accuracy and precision of steelhead redd counts and smolt production estimates for the entire Wenatchee Subbasin.

The WDFW began limited steelhead spawning surveys, funded by Chelan County Public Utility District, in the Wenatchee Subbasin in 2000. Spawning ground surveys were conducted in streams selected for supplementation to determine the efficacy of a supplementation program in increasing the number of natural spawners. This project was intended to expand the scope of the surveys to include all tributaries in the Wenatchee subbasin with a significant steelhead spawning population and ensure surveys are conducted on a weekly basis.

The Wenatchee subbasin has an extensive smolt monitoring program that has been increasing since 1993 (Table 1). These programs are conducted in selected streams and focused on supplementation programs of target species. Chelan County Public Utility District (CCPUD) funds a smolt monitoring project on the Chiwawa River targeting spring Chinook and on upper Wenatchee River (0.5 km below Lake Wenatchee) targeting sockeye *O. nerka* salmon. More recently, the Washington State Salmon Recovery Funding Board (SRFB) and CCPUD funded a smolt monitoring program on the lower Wenatchee River (rkm 16) targeting spring Chinook, summer Chinook, and steelhead that began in 2000.

The limited scope of the upper Wenatchee smolt monitoring program (i.e., sockeye) prohibits estimating smolt production of other species (e.g. spring Chinook and steelhead) that spawn in the Little Wenatchee and White River watersheds (tributaries of Lake Wenatchee). Furthermore, the trap efficiency at both the upper and lower Wenatchee River locations has been determined to be inadequate to provide smolt production estimates of steelhead and spring Chinook with the desired level of precision. This project was intended to increase the trapping period of the upper Wenatchee smolt monitoring program to encompass the entire spring Chinook emigration period and provide an additional smolt trap and personnel (beginning in 2005) at each location to increase the capture efficiency and provide a higher level of precision.

Table 1. Current smolt trap locations within the Wenatchee subbasin.

Trap Location	Rkm	Year started	Funding Agency
Lower Wenatchee – 2 traps	16	2000 & 2005*	SRFB & CCPUD; BPA
Upper Wenatchee – 2 traps	90	1997 & 2005*	CCPUD; BPA
Chiwawa River	1	1993	CCPUD
Nason Creek	1	2001**	YN & BPA
Peshastin Creek	10	2004**	BPA

* Funded under this contact.

** Proposed under this project but different contracts.

Project Area

The Wenatchee subbasin is located in north central Washington and drains a portion of the east slope of the Cascade Mountains. The river flows in a generally southeasterly direction and flows into the Columbia River at rkm 781 (Andonaegui 2001). The subbasin covers approximately 3,550 km^2 with 383 km of major rivers and stream (Andonaegui 2001). The Little Wenatchee and White Rivers flow into Lake Wenatchee the source of the Wenatchee River. The Wenatchee River flows 90 km from Lake Wenatchee to the Columbia River. Other major tributaries of the Wenatchee River include the Chiwawa, Nason, Icicle, and Peshastin Creek.

The Wenatchee subbasin supports several runs of anadromous fish including spring Chinook, summer Chinook, sockeye, and summer steelhead. Coho *O. kisutch* salmon were recently reintroduced into the Wenatchee subbasin, but is still heavily dependent on hatchery releases. All anadromous fish must migrate through seven hydroelectric projects located in the Columbia River. Sockeye salmon only spawn in the White and Little Wenatchee rivers and summer Chinook only spawn in the mainstem Wenatchee River (Mosey and Murphy 2002). Both steelhead and spring Chinook spawn in all the major tributaries of the Wenatchee River including the mainstem (Mosey and Murphy 2002). Both spring Chinook and steelhead are listed as endangered under the Endangered Species Act. Sockeye and summer Chinook are currently healthy and support commercial, tribal, and sport fisheries depending on escapement levels.

Methods and Materials

Objective 1 – Conduct index spawning ground counts and estimate the total number of steelhead redds in selected streams within the Wenatchee Subbasin.

Steelhead spawning escapement of selected tributaries will be estimated using index area redds counts within known core-spawning areas as described in Hillman (2004) with weekly index-reach surveys and a single survey of larger reference reaches, which can be comprised of one or more index-reaches (Table 2). BPA support for this monitoring beyond 2004 is conditioned, in part, upon BPA receiving an acceptable plan that clearly identifies the monitoring and analytical framework, timeframes (i.e., expected schedules across years), and collaborative contributions for data collection and analyses by partner entities.

Comprehensive spawning ground surveys of index areas will be conducted weekly. All redds within an index area will be individually flagged, georeferenced by GPS, and numbered sequentially. A final survey will be conducted of the entire reach(s) at the end or after peak spawning if poor water conditions are expected. All redds in each reach will be counted. Marking redds is not required during the final survey. A different surveyor should survey within the index area and count only redds that are visible. An index expansion factor (*IF*) will be calculated by dividing the number of visible redds in the index by the total number of redds in the index area.

$$IF = n_{visible} / n_{total}$$

The reach total (*RT*) will be calculated by expanding the number of redds in the non-index area by the proportion of visible redds in the index (i.e., index expansion factor) and adding the total number of redds found in the index area.

$$RT = n_{non-index} / IF + N_{Index-total}$$

An estimate of the total number of redds (*TR*) in a selected stream will be calculated by summing the reach totals.

$$TR = \sum RT$$

Table 2. Wenatchee subbasin survey reach and index/reference areas – surveys conducted weekly from March through June.

Reach	Index/reference area
Wenatchee River	
Sleepy Hollow Br. to Lower Cashmere Br. (W2)	Monitor boat ramp to Cashmere boat ramp
Leavenworth Bridge to Icicle Road Bridge (W6)	Leavenworth boat ramp to Icicle River
Tumwater Dam to Tumwater Bridge (W8)	Swiftwater boat ramp to Tumwater Bridge
Chiwawa River to Lake Wenatchee (W10)	Chiwawa pump station to Lake Wenatchee
Peshastin Creek	
Mouth to Camas Creek (P1)	Kings Bridge to Mill Creek
Camas Creek to mouth of Scotty Creek (P2)	FR 7320 bridge to mouth of Shaser Cr.
Ingalls Creek	
Mouth to Trailhead rm 1.0 (D1)	Mouth to Trailhead rm 1.0
Trailhead to Wilderness Boundary rm 1.5 (D2)	Trailhead to Wilderness Boundary rm 1.5
Chiwawa River	
Mouth to Grouse Creek (C1)	Mouth to Road 310 Bridge
Grouse Creek to Rock Creek (C2)	Chikamin Creek to Log jam
Clear Creek	
Mouth to HWY 22 (V1)	Mouth to HWY 22
HWY 22 to Lower culvert rm 2.0 (V2)	HWY 22 to Lower culvert
Nason Creek	
Mouth to Kahler Creek Bridge (N1)	Mouth to Swamp Creek
HWY 2 Bridge to Lower R.R. Bridge (N3)	Highway 2 Bridge to Merrit Bridge
Lower R.R. Bridge to Whitepine Creek (N4)	Rayrock to Church camp
Icicle River	
Mouth to Hatchery (I1)	Mouth to Hatchery
Little Wenatchee River	
Mouth to Lost Creek (L2)	Fish Weir to Lost Creek
Lost Creek to Rainy Creek Bridge (L3)	Lost Creek to Rainy Creek Bridge
White River	
Sears Cr. Bridge to Napeequa River (H2)	Riprap bank to Napeequa River
Napeequa River to mouth of Panther Creek (H3)	Napeequa River to Grasshopper Meadows.
Napeequa River	
Mouth to rm 1.0 (Q1)	Mouth to rm 1.0

Objective 2 – Estimate the smolt production of spring Chinook salmon and steelhead for the Wenatchee Subbasin.

Smolt production will be estimated for spring Chinook salmon and steelhead from data collected at rotary smolt traps operated at two trapping locations (Figure 1). Population estimates will be generated at subbasin (i.e., Wenatchee) and watershed scales (i.e., White and Little Wenatchee rivers). These traps will be part of a comprehensive trapping program consisting of six traps located throughout the Wenatchee subbasin operated within the Project and/or by cooperating agencies funded outside of this Project.

Fish will be removed from the trap at a minimum every morning and placed in an anesthetic solution of MS-222. Fish will be identified to species and counted. Non-target species will be allowed to fully recover in fresh water prior to being released in an area of calm water downstream from the smolt trap. Target species will be held in separate live boxes for use during mark/recapture efficiency trials conducted in the evening.

Fork length will be measured to the nearest millimeter and weight to the nearest 0.1 g. A Fulton type condition factor ($W \times 10^5/FL^3$) will be calculated for all target species. The degree of smoltification (parr, transitional, or smolt) will be assessed by visual examination. Juvenile spring Chinook and steelhead will be classified as parr if parr marks are distinct, transitional if parr marks are not distinct, and smolts if parr marks were not visible and the fish exhibited a silvery appearance.

Mark/recapture efficiency trials will be conducted throughout the trapping season. The frequency of mark/recapture trials is dependent on the number of fish captured (no less than 100) and the river discharge. These trials will be conducted over the widest range of discharge possible (interval depends on trap location). Fish for the mark/recapture trials will be marked by clipping the tip of either the upper or lower lobe of the caudal fin. Fish will be placed in a live pen to recover for at least 8 h before being transported to the release site at least 1 km upstream of the trap. Marked fish will be distributed across the width of the river and along approximately 100 m of the bank in pools or in calm pockets of water around boulders. In the case of the upper Wenatchee River trap, marked fish will be transported and released into Lake Wenatchee. Fish will be released between 1800 h and 2000 h. All recaptures of marked fish typically occur within 48 h after each trial.

The number of fish that could be marked and released may limit the frequency with which trap efficiency trials will be conducted. Emigration estimates will be calculated using estimated daily trap efficiency derived from the regression formula using trap efficiency (dependent variable) and discharge (independent variable).

Trap efficiency will be calculated using the following formula:

$$\text{Trap efficiency, } E_i = R_i / M_{I,}$$

where E_i is the trap efficiency during time period i; M_i is the number of marked fish released during time period i; and R_i is the number of marked fish recaptured during time period i.

The number of fish captured will be expanded by the estimated daily trap efficiency (e) to estimate the daily number of fish migrating past the trap (N_i) using the following formula:

$$\text{Estimated daily migration} = \hat{N}_i = C_i / \hat{e}_i$$

where N_i is the estimated number of fish passing the trap during time period i; C_i is the number of unmarked fish captured during time period i; and e_i is the estimated trap efficiency for time period i based on the regression equation.

The variance for the total daily number of fish migrating past the trap will be calculated using the following formulas:

Variance of daily migration estimate = $$\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \frac{\mathrm{MSE}\left(1 + \frac{1}{n} + \frac{\left(X_i - \overline{X}\right)^2}{\left(n-1\right)s_X^2}\right)}{\hat{e}_i^2}$$

where X_i is the discharge for time period i, and n is the sample size. If a relationship between discharge and trap efficiency was not present (i.e. $P < 0.05$; $r^2 \approx 0.5$), a pooled trap efficiency was used to estimate daily emigration:

Pooled trap efficiency = $$E_p = \sum R / \sum M$$

The daily emigration estimate will be calculated using the formula:

Daily emigration estimate = $$\hat{N}_i = C_i / E_p$$

The variance for daily emigration estimates using the pooled trap efficiency will be calculated using the formula:

Variance for daily emigration estimate = $$\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \frac{E_p(1 - E_p) / \sum M}{E_p^2}$$

The total emigration estimate and confidence interval will be calculated using the following formulas:

Total emigration estimate = $$\sum \hat{N}_i$$

95% confidence interval = $$1.96 \times \sqrt{\sum \mathrm{var}\left[\hat{N}_i\right]}$$

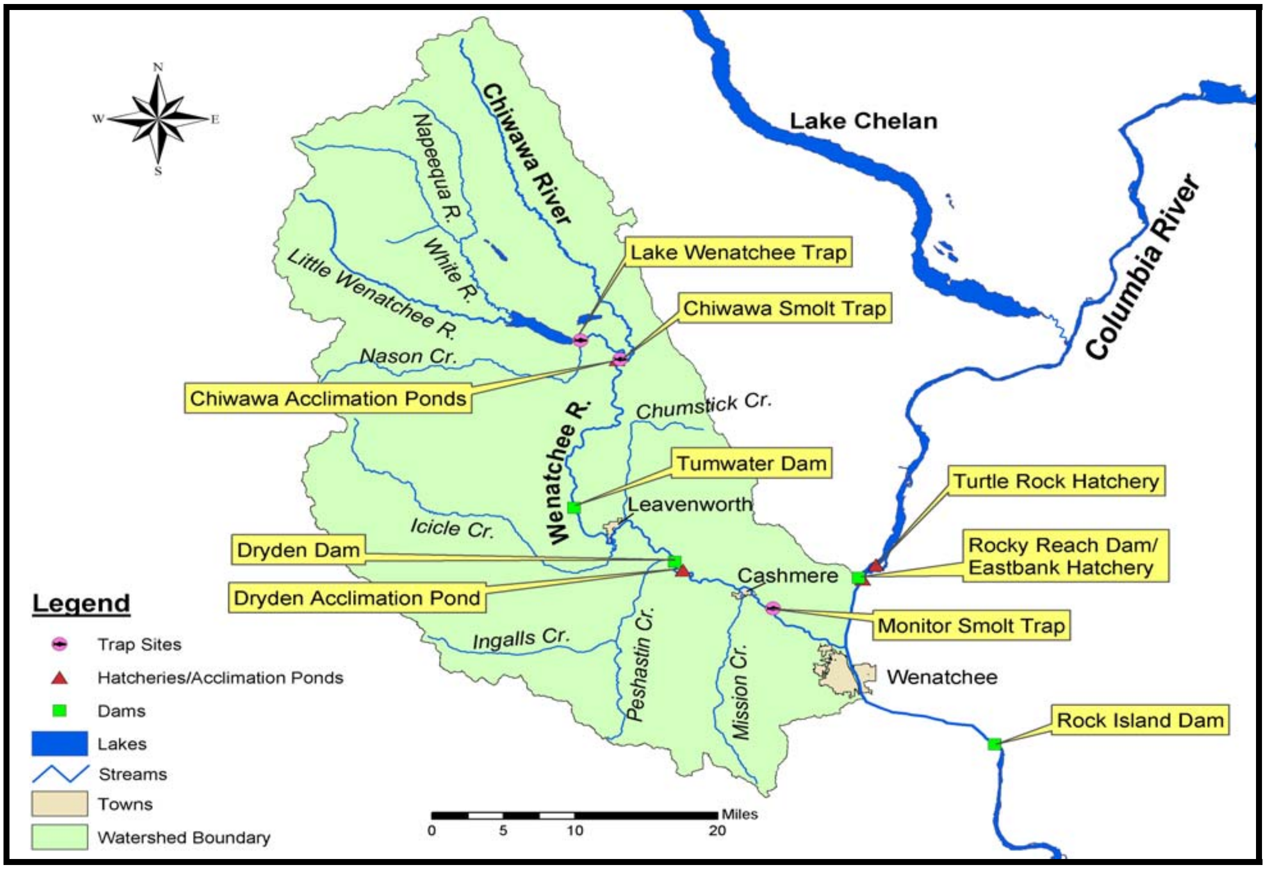

Figure 1. Location of the upper Wenatchee (Lake Wenatchee Trap) and lower Wenatchee River (Monitor Smolt Trap) smolt traps.

Results and Discussion

Objective 1 – Conduct index spawning ground counts and estimate the total number of steelhead redds in selected streams within the Wenatchee Subbasin.

In 2004, low snow pack and a moderate spring kept water conditions relatively consistent throughout the survey period. Spawning ground surveys were not conducted beyond the first week of June due to poor water clarity. Steelhead began spawning during the first week of March in the Wenatchee River and progressed upstream as water temperatures increased. Spawning was observed in water temperatures ranging from 3.8 – 9.7 ^{o}C. Based on preliminary data, spawning activity appeared to begin once a mean daily stream temperature reached 4 ^{o}C. Peak spawning in the Wenatchee River occurred the third week of April (Table 3). Steelhead spawning peaked in Nason Creek and the Chiwawa River during the fourth week of April.

Few steelhead redds were found in the Wenatchee River below Tumwater Dam (Figure 2). In contrast to previous years, only 36.6% of the steelhead redds found above Tumwater Dam were located in the Wenatchee River (54.3% in 2003, 62.6% in 2002, and 62.0% in 2001). Of those redds found in the Wenatchee River above Tumwater Dam, only 53.3% were located in the uppermost index area (W10), much lower than that observed in 2001 (86%), 2002 (95%), and 2003 (98.4%). Steelhead spawning in the Chiwawa River was similar to previous years and confined primarily to the lower portion of reach C1 (Figure 3). The majority of the steelhead (73.5%) were observed spawning in 1st and 2nd order tributaries rather than the mainstem Chiwawa River. A significantly higher proportion of redds were found in Nason Creek compared to 2003 (P<0.01). Furthermore, the distribution of redds in Nason Creek was significantly different (i.e., more redds found farther upstream) than observed in 2003 (P<0.01; Figure 4). A similar trend was also observed in Peshastin Creek (Figure 5).

The number of redds estimated above Tumwater Dam (N=365) was lower than expected based on Tumwater Dam steelhead counts (Table 4). Estimated male to female ratios of 1.2:1.0 for hatchery fish and 1.1:1.0 for wild fish were calculated from observations of fish handled during the course of broodstock collections at Dryden Dam right and left bank traps and at Tumwater Dam. In 2004, the number of steelhead above Tumwater Dam increased 24.5% over the 2003 escapement. However, the overall proportion of females was 10% lower than in 2003 (49.0% fewer wild and 27.6% more hatchery), which may account for the 16.3% decrease in the number redds above Tumwater Dam (Appendix A). Since comprehensive redd counts above Tumwater Dam began in 2002, the mean (SD) proportion of females accounted for using the index and total redd counts was 42 (6)% and 58 (2)%, respectively. Prespawn morality, undetected redds, and fall back are all possible explanations for the unaccounted female steelhead. Regression analysis of the redd count (index and total) and number of fish data (female and total) produced the best model using female steelhead and total redd counts (R^2 = 0.80, P < 0.05).

Additional effort was made to survey areas other than traditional spawning areas within Peshastin Creek, Nason Creek, and the Chiwawa River to determine if spawning may be present and/or to identify potential barriers to fish passage. The results of which indicate little to no evidence of adult steelhead activity above existing spawning areas. There was evidence of resident *O. mykiss* spawning in the upper most portions of the Peshastin River Basin. A continued effort is needed to further define the spawning distribution of steelhead with the Wenatchee River Basin.

Table 3. Summary of steelhead spawning ground surveys in the Wenatchee River Basin in 2004.

Reach	Survey week of index area													Total redd count	Estimated reach total
	7 Mar	14 Mar	21 Mar	28 Mar	4 Apr	11 Apr	18 Apr	25 Apr	2 May	9 May	16 May	23 May	30 May		
							Wenatchee River								
W2		0	0	1	0		0	0		0	0	0	0	1	1
W3													1	1	1
W4													0	0	0
W5													1	1	1
W6		0	0	0			0		0				0	0	0
W7													0	0	0
W8		0	0	2	1		1	1		0	0	0	0	5	5
W9				8	4		11	13		14	7	1	0	58	58
W10	5	8		1	4		36	2		11	3	0	0	70	72
Total	5	8	0	12	9	-	48	16	-	25	10	1	2	136	138
							Peshastin Creek								
P1		0		2	3		7	5		2	4	0		23	30
P2		0		0	1		0	0		1	3	0		5	13
Total	-	0	-	2	4	-	7	5	-	3	7	0	-	28	43
							Chiwawa River								
C1				0	1	0	3	5		3		0	1	13	16
C2										0		0	2	2	2
C3													0	0	0
C4													0	0	0
C5													0	0	0
Total	-	-	-	0	1	0	3	5	-	3	-	0	3	15	18

Table 3. Continued.

Reach	Survey week of index area													Total redd count	Estimated reach total
	7 Mar	14 Mar	21 Mar	28 Mar	4 Apr	11 Apr	18 Apr	25 Apr	2 May	9 May	16 May	23 May	30 May		
Clear Creek															
V1	0	0	0	0	1	2	1	4	10	6	2	2		28	28
V2							0	4	4	1	1	0		10	10
Total	0	0	0	0	1	2	1	8	14	7	3	2	-	38	38
Nason Creek															
N1		0	0	1	0	0	0	3	0	3		8		15	45
N2												7		7	20
N3		0	0	0	4	3	4	6	5	6		4		32	55
N4		0	0	0	0	0	0	5	0	2		0		7	28
Total	-	0	0	1	4	3	4	14	5	11	-	19	-	61	148
Little Wenatchee River															
L1					0	0		0	0	0			0	0	0
L2					0	0		0	0	0			0	0	0
Total	-	-	-	-	0	0	-	0	0	0	-	-	0	0	0
White River															
H2		0	0	0	0		0			0			0	0	0
H3		0	0	0	0		0			0			0	0	0
Total	-	0	0	0	0	-	0	-	-	0	-	-	0	0	0
Icicle River															
Total	-	0	1	3	-	-	18	-	1	-	-	-	-	23	23
Wenatchee River Basin															
Total	5	8	1	18	19	5	81	48	20	49	20	22	5	301	408

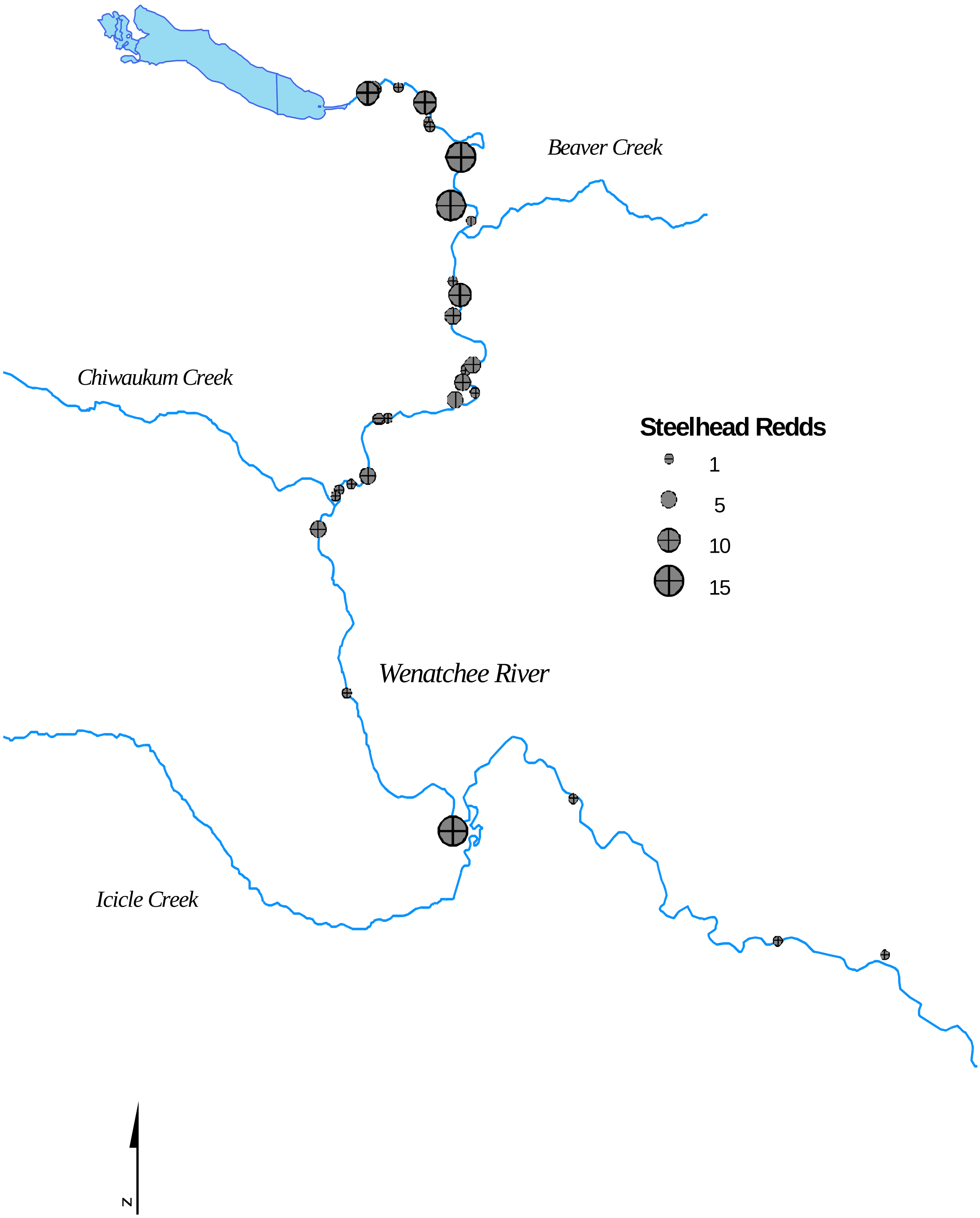

Figure 2. Steelhead spawning locations in the Wenatchee River and Icicle Creek in 2004.

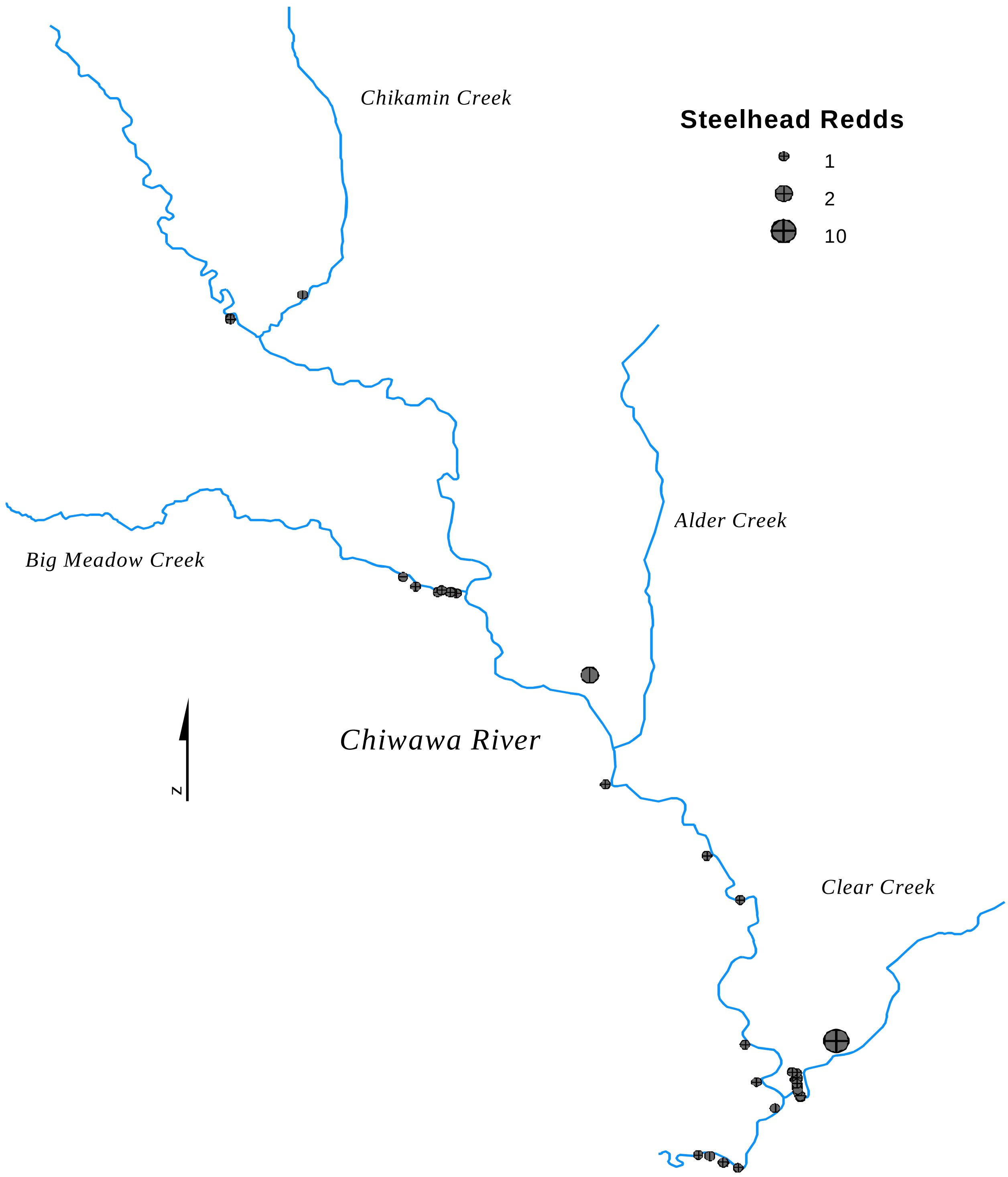

Figure 3. Steelhead spawning locations in the Chiwawa River Basin in 2004.

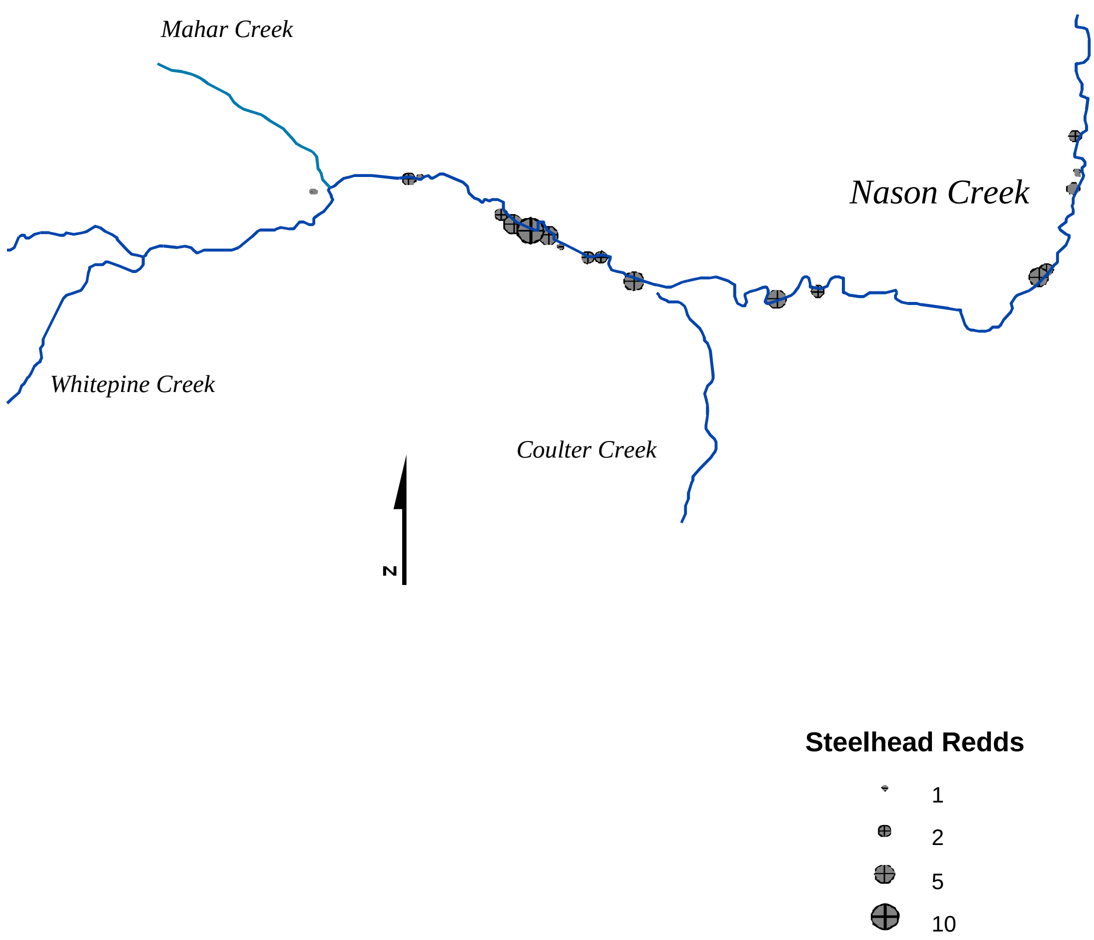

Figure 4. Steelhead spawning locations in the Nason Creek Basin in 2004.

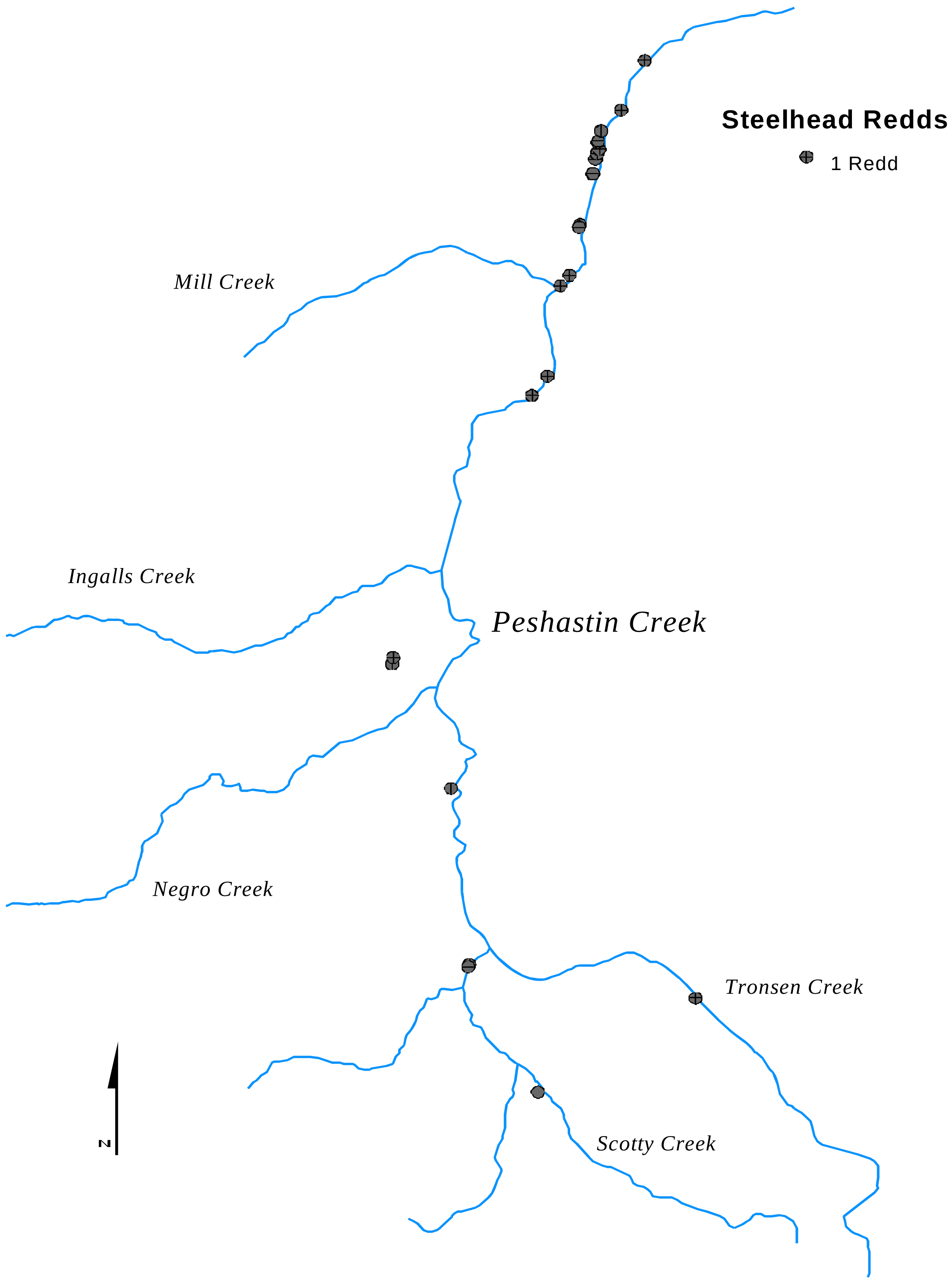

Figure 5. Steelhead spawning locations in the Peshastin Creek Basin in 2004.

Table 4. Summary of steelhead migrating above Tumwater Dam and subsequent estimated number of redds.

Year	Number of steelhead above Tumwater Dam*			Total redd count of index areas above Tumwater Dam	Estimated total number of redds above Tumwater Dam
	Total	Wild females	Hatchery females		
2001	817	137	313	118	137
2002	1,773	579	258	296	475
2003	1,414	404	328	353	441
2004	1,873	206	453	277	369

* Period of counting occurs from July through April.

Objective 2 – Estimate the smolt production of spring Chinook salmon and steelhead for the Wenatchee Subbasin.

Upper Wenatchee Smolt Trap

The upper Wenatchee River smolt trap (1.5 m diameter) was located approximately 0.5 km below the outlet of Lake Wenatchee. The trap operated nightly between 3 March and 18 November 2004. We captured 355 yearling spring Chinook smolts (Figure 6) and 55 juvenile steelhead (Figure 7) during the sampling period. One steelhead fry was also captured during trapping. Due to the low numbers of spring Chinook and steelhead captured, wild sockeye smolts were used as a surrogate for mark/recapture efficiency trials. We conducted 11 mark/recapture efficiency trials during the sampling period and released 10,949 marked sockeye into Lake Wenatchee, of which 72 were recaptured (Table 5). A delay in migration and subsequent recapture of the marked fish from Lake Wenatchee negatively affected the relationship between discharge and trap efficiency (i.e., unequal probability of recapture). Therefore, the pooled trap efficiency (0.7%) was used to calculate the spring Chinook and steelhead smolt production estimate. The smolt production estimate (95% C.I.) for spring Chinook and steelhead was 50,857 (± 1,957) and 143 (± 32), respectively (Appendix B).

Spring Chinook egg deposition was calculated based on the total number of redds counted in the White, Napeequa, Panther, and Little Wenatchee rivers (N=84) in 2002, multiplied by an average fecundity of 4,600 eggs derived from broodstock (M. Tonseth, WDFW, personal communication). The egg-to-smolt survival rate for spring Chinook was calculated at 13.2%, which is within the range of spring Chinook egg-to-smolt survival rates calculated for the Chiwawa River Basin. The average number of smolt per redd was calculated at 605. Individual length and weight measurements were recorded from a sample of the daily catch. Mean fork length (SD) of spring Chinook and steelhead was 100.7 (7.9) mm and 95.0 (33.4) mm, respectively (Table 5).

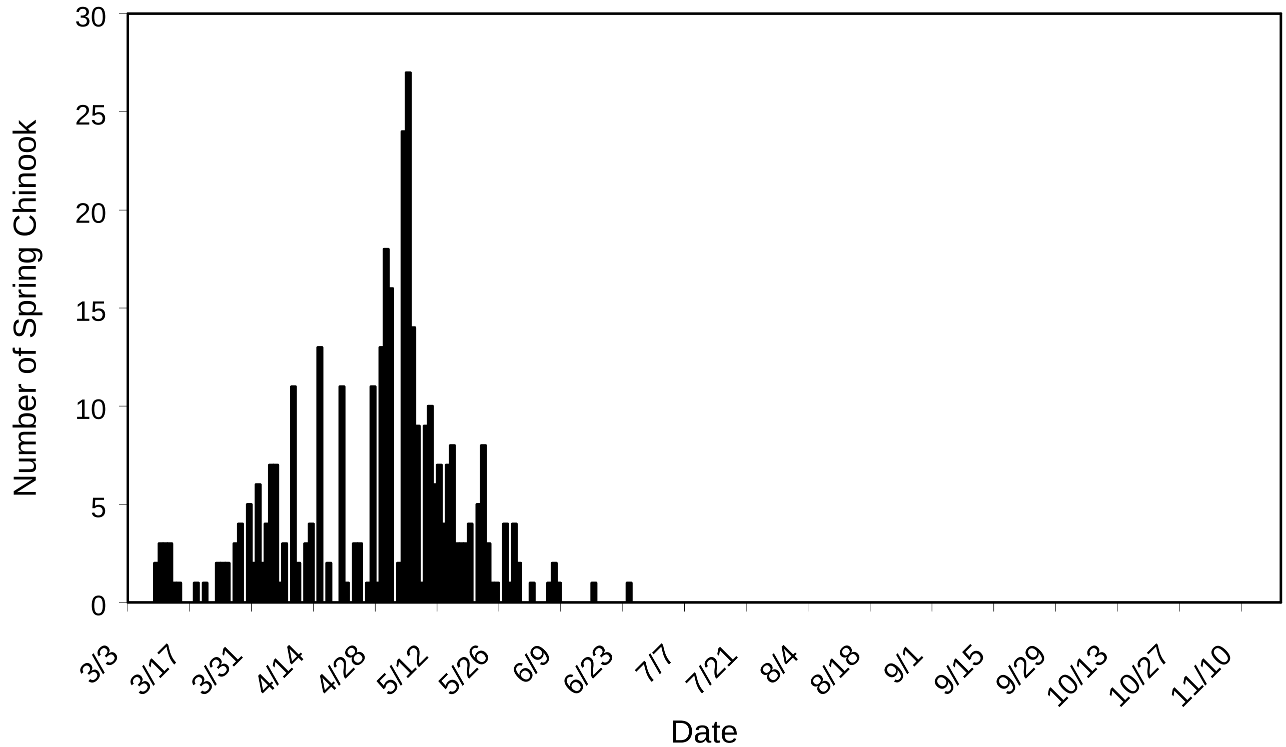

Figure 6. Daily capture of wild spring Chinook at the upper Wenatchee River trap in 2004.

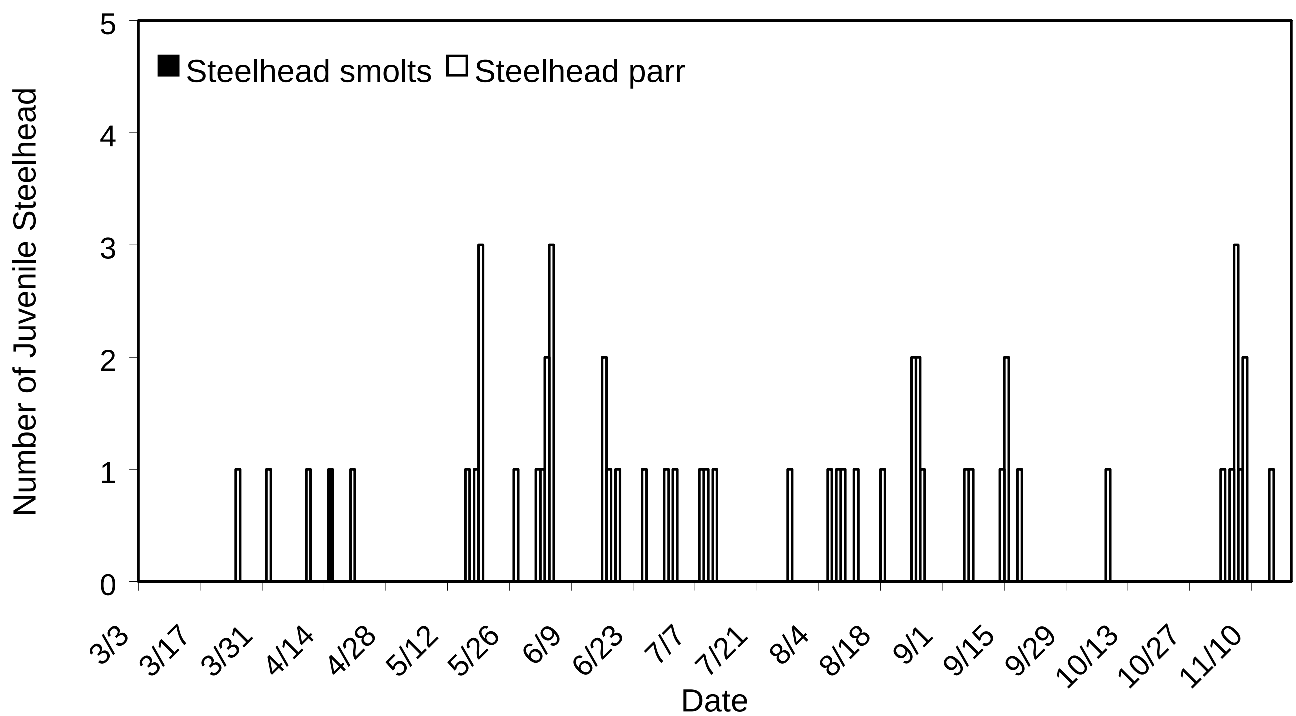

Figure 7. Daily capture of wild juvenile steelhead at the upper Wenatchee smolt trap in 2004.

Table 5. Mark/recapture efficiency trials conducted at the upper Wenatchee River smolt trap, 2004.

Date	Number of fish marked	Number of recaptured fish	Percent efficiency
6 Apr	1,000	4	0.4
9 Apr	1,000	1	0.1
12 Apr	1,000	2	0.2
15 Apr	1,000	2	0.2
17 Apr	1,000	7	0.7
19 Apr	1,000	1	0.1
21 Apr	1,000	4	0.4
23 Apr	1,000	3	0.3
26 Apr	1,000	17	1.7
29 Apr	1,000	21	2.1
4 May	949	10	1.0
Total	10,949	72	0.7

Table 6. Mean fork lengths (mm), weights (g), and body condition factor of spring Chinook and juvenile steelhead captured in the Lake Wenatchee smolt trap during 2004.

	Spring Chinook			Steelhead		
	Mean	SD	*N*	Mean	SD	*N*
Fork length	100.7	7.9	*320*	95.0	33.4	*53*
Weight	10.4	2.6	*320*	11.3	12.5	*53*
K factor	1.01	0.08	*320*	0.94	0.09	*53*

Lower Wenatchee River Smolt Trap

The lower Wenatchee River smolt trap (2.4 m diameter) was located at the West Monitor Bridge (rkm 9.6). The trap operated nightly between 12 February and 29 July. We captured 1,061 wild spring Chinook (Figure 8) and 360 juvenile steelhead (Figure 9). A total of 131 steelhead fry were also captured. Low daily numbers of spring Chinook and steelhead captured precluded their use for mark/recapture trials. Hatchery Chinook and hatchery coho were used as surrogates for mark/recaptures trials, which were conducted at various levels of river discharge or if the trap position had changed. We conducted ten mark/recapture efficiency trials during the sampling period and released 4,776 marked hatchery Chinook and coho into the Wenatchee River, of which 45 were recaptured (Table 7). Smolt production estimates were calculated using separate regression models (independent variable = river discharge) for each of the two trap positions. In some cases, efficiency trials from previous years (i.e., 2001-2003) were used in the regression model to increase sample size. Hatchery coho and hatchery Chinook will be used as surrogates in trap efficiency trials until the

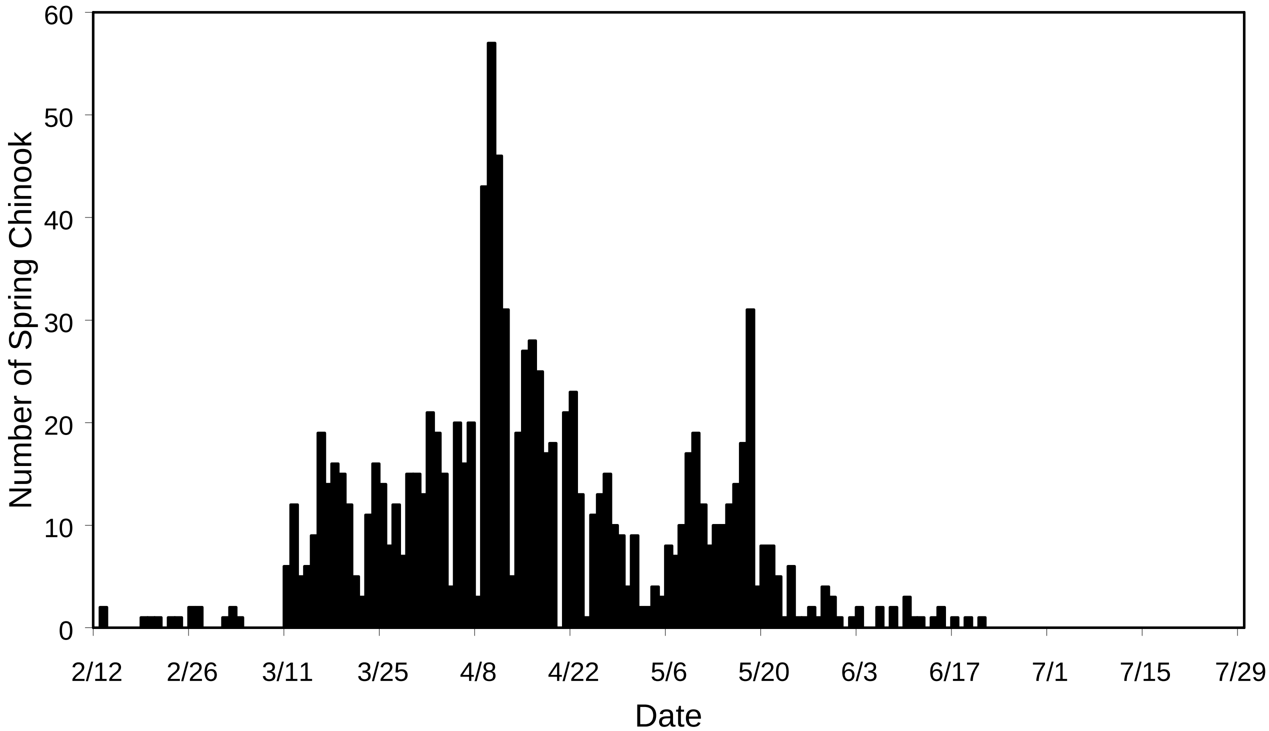

Figure 8. Daily capture of wild spring Chinook at the lower Wenatchee River trap in 2004.

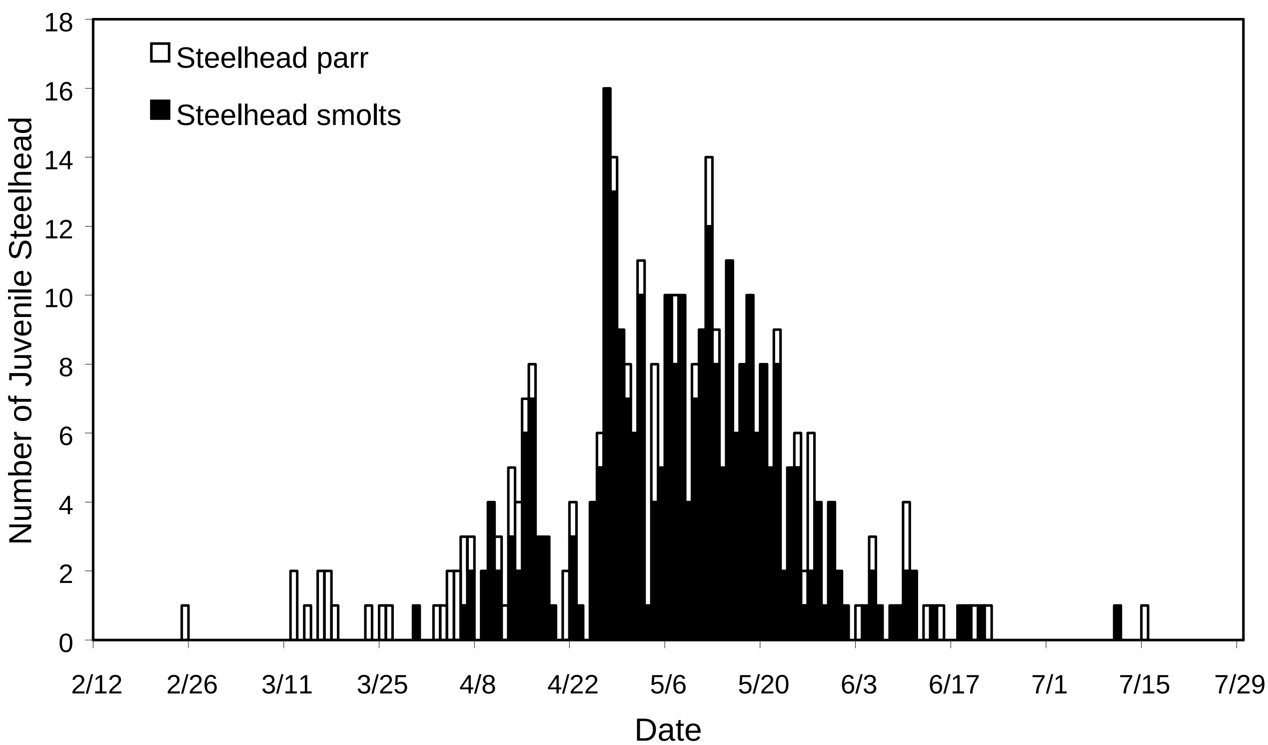

Figure 9. Daily capture of wild juvenile steelhead at the lower Wenatchee smolt trap in 2004.

relative abundance of wild spring Chinook and steelhead increases or trap efficiency significantly increases (e.g., a second trap) to perform species-specific efficiency trials.

Table 7. Mark/recapture efficiency trials conducted at the lower Wenatchee River smolt trap, 2004.

Date	Position	Number of fish marked	Number of recaptured fish	Percent efficiency
5 Apr	Out	662	9	1.4
8 Apr	Out	344	8	2.3
21 Apr	Out	500	9	1.8
27 Apr	In	506	7	1.4
1 May	In	371	4	1.1
7 May	In	539	0	0.0
11 May	In	334	1	0.3
19 May	In	528	2	0.4
21 May	In	626	5	0.8
1 Jun	In	366	0	0.0
Total		4,776	45	0.9

The smolt production estimate for wild spring Chinook and steelhead was 198,012 and 42,733, respectively (Appendix C). Egg deposition for spring Chinook was calculated based on the number of redds (N = 1,139) counted in the Wenatchee River basin multiplied by an average fecundity of 4,600 eggs based on broodstock collected (M. Tonseth, WDFW, personal communication). An egg-to-smolt survival rate for spring Chinook was calculated at 3.8%, which is lower than the range of spring Chinook egg-to-smolt survival rates calculated for the Chiwawa River Basin. The average number of smolts per redd was calculated at 173 smolts. Egg to smolt survival rates of steelhead were not calculated because the number of redds is unknown.

Due to the low trap efficiencies in 2004, confidence interval for these smolt production estimates were not reported (i.e., greater than the estimate). In 2005, an additional smolt trap will be deployed at this location and the resultant increase in trap efficiency should provide more accurate and precise smolt production estimates.

Individual length and weight measurements were recorded from a sample of the daily catch. Mean fork length (SD) of spring Chinook and steelhead was 96.8 (10.3) mm and 158.7 (33.4) mm, respectively (Table 8).

Table 8. Mean fork lengths (mm), weights (g), and body condition factor of spring Chinook and juvenile steelhead captured in the Lower Wenatchee smolt trap during 2004.

	Spring Chinook			Steelhead		
	Mean	SD	*N*	Mean	SD	*N*
Fork length	96.8	10.3	*1,026*	158.7	33.4	*360*
Weight	10.1	3.4	*1,026*	45.0	22.8	*360*
K factor	1.08	0.12	*1,026*	1.02	0.11	*360*

Summary and Conclusions

Objective 1 – Conduct index spawning ground counts and estimate the total number of steelhead redds in selected streams within the Wenatchee Subbasin.

Based on our efforts this year, we have made some general conclusions and recommendations regarding steelhead spawning ground surveys in the Wenatchee Basin:

1) Current steelhead spawning ground methodology in the Wenatchee River basin is feasible and can be conducted with reasonable accuracy provided surveys are conducted when river conditions are appropriate.

2) Hatchery steelhead may disperse throughout the basin and spawn in streams in which no releases have occurred. Hatchery rearing and release methodology may influence both subsequent stray rates and/or dispersal patterns. The origin of spawning adult steelhead should be determined whenever feasible.

3) A high proportion of steelhead spawn in the 8 km reach of the Wenatchee River immediately below Lake Wenatchee. Although this reach contains more suitable spawning substrate than other reaches of the Wenatchee River, implications regarding early life stage survival should be investigated further (i.e. tributary versus mainstem spawners).

4) Of those steelhead found spawning in the Chiwawa River, almost all utilized the lowest 12 km of the mainstem or small tributaries located in that reach. Low temperatures (<5^{o}C) in the upper watershed may be a limiting factor and prevent steelhead from utilizing high quality spawning habitat.

5) Steelhead in Nason Creek utilized more of the available spawning habitat than steelhead in the Chiwawa River. However, the lack of suitable 1st and 2nd order tributaries in the Nason Creek Basin force all fish to spawn in the main river. Additional surveys should be conducted to confirm this hypothesis.

6) Continued expansion of survey areas will determine the extent of spawning distribution and allow for refinement of survey methods. A methodology for

estimating steelhead redds outside of the survey area is necessary to develop a subbasin estimate (i.e., this project different contract with USFS).

7) Expanded temperature monitoring above, below, and within existing steelhead spawning areas may provide insight into steelhead distribution and help explain underutilization of quality spawning habitat.

8) Radio tagging adult steelhead (particularly females) at Tumwater Dam may provide critical insight to the consistent proportion of unaccounted female steelhead over Tumwater Dam. Information would also assist with calculating fallback rates, prespawn mortality rates and determining spatial and temporal spawning distribution of hatchery and wild fish within the upper Wenatchee Basin.

Objective 2 – Estimate the smolt production of spring Chinook salmon and steelhead for the Wenatchee Subbasin.

Based on our efforts this year, we have made some general conclusions and recommendations regarding smolt production estimates in the Wenatchee Basin:

1) In order to develop smolt productions with more precision, trap efficiency must be increased at the lower and upper Wenatchee smolt trap locations.

2) Species-specific mark/recapture efficiency trials are necessary to avoid bias in the smolt production estimate. Efficacy of using surrogates should be investigated further to determine potential bias.

3) Large variation in river discharge requires that mark/recapture efficiency trials be conducted systematically at all levels of river discharge.

4) To make valid comparisons of production estimates within the Wenatchee subbasin, identical trapping methodologies and statistical analysis should be used.

5) Egg deposition estimates should be derived from total ground redd counts when feasible. Other methodologies may positively bias egg-to-smolt survival estimates.

References

Andonaegui, C. 2001. Salmon, Steelhead, and Bull Trout Habitat Limiting Factors For the Wenatchee Subbasin (Water Resource Inventory Are 45) and Portions of WRIA 40 with Chelan County (Squilchuck, Stemilt and Colockum drainages). WA State Conservation Commission, Olympia, WA.

Hillman, T.W. 2004. Monitoring strategy for the Upper Columbia Basin: Draft report February 1, 2004. Prepared for Upper Columbia Regional Technical Team, Wenatchee, Washington.

Mosey, T. and L.J. Murphy. 2002. Spring and Summer Chinook Spawning Ground Surveys on the Wenatchee River Basin, 2001. Chelan County Public Utility District, Wenatchee, WA.

Project 2002-017-00: Integrated Status & Effectiveness Monitoring Program
March 1, 2004 through February 28, 2005

Category		Qty.	Unit Cost	Budget Amount	Actual Spent
PERSONNEL SALARIES				**$47,175**	**$36,598**
		Months	$/Month		
Task 1.	Scientific Technician 2	4	$2,775	$11,100	8964
Task 2.	Scientific Technician 2	13	$2,775	$36,075	27634
BENEFITS				**$15,747**	**$13,967**
Task 1.	State OASI, Retirement, and Medicare	na	9.05% of salary	$1,005	$798
Task 2.	State OASI, Retirement, and Medicare	na	9.05% of salary	$3,265	$2,474
Task 1.	Health & Ind. Insurance (Jan - June, 2004)	4	$608.29/Month	$2,433	$2,433
Task 2.	Health & Ind. Insurance (July - Dec., 2004)	13	$695.70/Month	$9,044	$8,262
PERSONNEL SERVICES OVERHEAD (on SAL. & BENEFITS)				**$251**	**161**
Task 1.	Personnel Service Overhead	na	0.40%	$58	39
Task 2.	Personnel Service Overhead	na	0.40%	$194	122
SUPPLIES/EQUIPMENT		**Qty.**	**Unit Cost**	**$29,300**	**$28,251**
Task 1.	Misc. Equipment (waders, boots,)	na	na	$1,000	$117
Task 1.	GPS and software	5	$500	$2,500	$1,383
Task 2.	Pontoon Boats	2	$700	$1,400	$2,560
Task 2.	Smolt trap cone (8' diameter)	1	$8,200	$8,200	$7,595
Task 2.	Smolt trap cone (5' diameter)	2	$6,300	$12,600	$12,000
Task 2.	Smolt trap live box	2	$1,800	$3,600	$4,596
INDIRECT COSTS		**Qty.**	**Unit Cost**	**$25,692**	**$26,934**
Task 1.	Indirect (Jan. - June, 2004)		25%	$3,899	$4,051
Task 2.	Indirect (July - Dec., 2004)		29.30%	$21,793	$22,883
SUBCONTRACTS		**Qty.**	**Unit Cost**	**$40,000**	**$39,606**
Smolt trap construction by Chelan County PUD		2	$20,000	$40,000	$39,606
BUDGET TOTAL				**$158,165**	**$145,517**

Appendix A. Steelhead spawning surveys in the Wenatchee River basin, 2001 – 2004. Redd counts are estimated values derived from index and non-index area counts.

Basin/subbasin	2001	2002	2003	2004
		Chiwawa River Basin		
Chiwawa River	25	27	26	18
Rock Creek	--	1	0	0
Chikamin	--	0	0	1
Meadow Creek	--	5	1	9
Twin Creek	--	4	0	--
Goose Creek	--	0	--	--
Alder Creek	--	0	5	2
Deep Creek	--	0	--	--
Clear Creek	--	43	32	38
Subtotal	25	80	64	68
		Nason Creek Basin		
Nason Creek	27	80	121	148
White Pine Creek	--	--	--	0
Un-named Creek	--	--	--	3
Subtotal	27	80	121	151
		White River Basin		
White River	--	0	1	0
Panther Creek	--	--	0	0
Napeequa river	--	0	2	0
Subtotal		0	3	0
		Little Wenatchee River		
Mainstem	--	1	5	0
		Icicle Creek		
Mainstem	19	27	16	23
		Peshastin Creek Basin		
Peshastin Creek	--	--	15	43
Ingalls Creek	--	--	0	0
Ruby Creek	--	--	0	0
Tronsen Creek	--	--	0	1
Scotty Creek	--	--	0	1
Shaser Creek	--	--	0	0
Schafer	--	--	--	0
Subtotal			15	45
		Wenatchee River		
Beaver Creek	--	0	0	15*
Chiwakum Creek	--	--	0	0
Mainstem	116	315	248	138
Subtotal				153
Wenatchee Basin Total	187	503	472	440

*Redds were enumerated by USFS

Appendix B. Actual daily and estimated captures and emigration estimates for wild spring Chinook and steelhead smolts, Upper Wenatchee River trap 2004.

Date	Mean discharge (m^3/s)	Spring Chinook			Steelhead		
		Catch		Daily migration	Catch		Daily migration
		Actual	Estimated		Actual	Estimated	
4-Mar	16.5	0			0		0
5-Mar	17.0	0		0	0		0
6-Mar	23.0	0		0	0		0
7-Mar	24.6	0		0	0		0
8-Mar	25.1	0		0	0		0
9-Mar	33.4	2		0	0		0
10-Mar	41.1	3		286	0		0
11-Mar	42.5	3		429	0		0
12-Mar	76.7	3		429	0		0
13-Mar	93.5	1		429	0		0
14-Mar	42.5	1		143	0		0
15-Mar	113.0	0		143	0		0
16-Mar	105.6	0		0	0		0
17-Mar	113.3	0		0	0		0
18-Mar	109.9	1		0	0		0
19-Mar	104.5	0		143	0		0
20-Mar	88.1	1		0	0		0
21-Mar	90.6	0		143	0		0
22-Mar	19.1	0		0	0		0
23-Mar	51.5	2		0	0		0
24-Mar	49.0	2		286	0		0
25-Mar	45.3	2		286	0		0
26-Mar	39.6	0		286	0		0
27-Mar	42.5	3		0	0		0
28-Mar	43.2	4		429	0		0
29-Mar	43.3	0		571	0		0
30-Mar	45.0	5		0	0		0
31-Mar	48.1	2		714	0		0
1-Apr	39.5	6		286	0		0
2-Apr	44.9	2		857	0		0
3-Apr	42.5	4		286	0		0
4-Apr	47.9	7		571	0		0
5-Apr	50.4	7		1000	0		0
6-Apr	55.8	1		1000	0		0
7-Apr	56.6	3		143	0		0
8-Apr	54.1	0		429	0		0
9-Apr	53.8	11		0	0		0
10-Apr	53.8	2		1571	0		0
11-Apr	52.4	0		286	0		0
12-Apr	52.4	3		0	0		0
13-Apr	113.0	4		429	0		0
14-Apr	122.1	0		571	0		0
15-Apr	121.8	13		0	1		143
16-Apr	113.6	0		1857	0		0
17-Apr	109.0	2		0	0		0
18-Apr	99.1	0		286	0		0
19-Apr	98.3	0		0	0		0
20-Apr	113.0	11		0	0		0
21-Apr	125.3	1		1571	0		0
22-Apr	132.8	0		143	0		0
23-Apr	127.4	3		0	0		0

Continued Appendix B.

24-Apr	83.5	3		429	0		0
25-Apr	83.5	0		429	0		0
26-Apr	81.8	1		0	0		0
27-Apr	81.8	11		143	0		0
28-Apr	83.8	1		1571	0		0
29-Apr	82.1	13		143	0		0
30-Apr	100.8	18		1857	0		0
1-May	62.6	16		2571	0		0
2-May	69.4	0		2286	0		0
3-May	66.0	2		0	0		0
4-May	59.5	24		286	0		0
5-May	65.1	27		3429	0		0
6-May	71.9	14		3857	0		0
7-May	71.6	9		2000	0		0
8-May	87.8	1		1286	0		0
9-May	17.6	9		143	0		0
10-May	16.5	10		1286	0		0
11-May	17.6	6		1429	0		0
12-May	71.4	7		857	0		0
13-May	79.3	4		1000	0		0
14-May	63.4	7		571	0		0
15-May	62.3	8		1000	0		0
16-May	62.3	3		1143	0		0
17-May	95.7	3		429	0		0
18-May	88.1	3		429	0		0
19-May	81.6	4		429	0		0
20-May	81.2	0		571	0		0
21-May	86.4	5		0	0		0
22-May	84.1	8		714	0		0
23-May	77.3	3		1143	0		0
24-May	84.7	1		429	0		0
25-May	84.7	1		143	0		0
26-May	85.2	0		143	0		0
27-May	91.5	4		0	0		0
28-May	99.1	1		571	0		0
29-May	93.5	4		143	0		0
30-May	111.9	2		571	0		0
31-May	127.2	0		286	0		0
1-Jun	115.8	0		0	0		0
2-Jun	93.5	1		0	0		0
3-Jun	85.2	0		143	0		0
4-Jun	84.4	0		0	0		0
5-Jun	98.8	0		0	0		0
6-Jun	99.1	1		0	0		0
7-Jun	90.6	2		143	0		0
8-Jun	107.6	1		286	0		0
9-Jun	107.6		1	143		0	0
10-Jun	104.2	0		143	0		0
11-Jun	90.6	0		0	0		0
12-Jun	85.0	0		0	0		0
13-Jun	87.8	0		0	0		0
14-Jun	93.5	0		0	0		0
15-Jun	82.1	0		0	0		0
16-Jun	73.9	1		0	0		0
17-Jun	77.6	0		143	0		0
18-Jun	61.2	0		0	0		0
19-Jun	73.6	0		0	0		0

Continued Appendix B.

20-Jun	66.6	0	0	0	0
21-Jun	65.1	0	0	0	0
22-Jun	69.4	0	0	0	0
23-Jun	73.6	0	0	0	0
24-Jun	71.6	1	0	0	0
25-Jun	71.4	0	143	0	0
26-Jun	70.8	0	0	0	0
27-Jun	89.2	0	0	0	0
28-Jun	78.2	0	0	0	0
29-Jun	69.4	0	0	0	0
30-Jun	63.2	0	0	0	0
1-Jul	57.2	0	0	0	0
2-Jul	56.4	0	0	0	0
3-Jul	53.5	0	0	0	0
4-Jul	48.1	0	0	0	0
5-Jul	46.7	0	0	0	0
6-Jul	46.7	0	0	0	0
7-Jul	40.8	0	0	0	0
8-Jul	47.0	0	0	0	0
9-Jul	46.7	0	0	0	0
10-Jul	33.4	0	0	0	0
11-Jul	29.7	0	0	0	0
12-Jul	28.3	0	0	0	0
13-Jul	28.3	0	0	0	0
14-Jul	23.5	0	0	0	0
15-Jul	23.4	0	0	0	0
16-Jul	10.0	0	0	0	0
17-Jul	33.4	0	0	0	0
18-Jul	33.4	0	0	0	0
19-Jul	32.9	0	0	0	0
20-Jul	33.1	0	0	0	0
21-Jul	33.7	0	0	0	0
22-Jul	21.1	0	0	0	0
23-Jul	19.9	0	0	0	0
24-Jul	29.2	0	0	0	0
25-Jul	28.2	0	0	0	0
26-Jul	28.2	0	0	0	0
27-Jul	28.6	0	0	0	0
28-Jul	28.6	0	0	0	0
29-Jul	28.6	0	0	0	0
30-Jul	14.6	0	0	0	0
31-Jul	16.9	0	0	0	0
1-Aug	16.7	0	0	0	0
2-Aug	16.9	0	0	0	0
3-Aug	16.9	0	0	0	0
4-Aug	16.7	0	0	0	0
5-Aug	13.7	0	0	0	0
6-Aug	13.3	0	0	0	0
7-Aug	14.2	0	0	0	0
8-Aug	13.9	0	0	0	0
9-Aug	7.1	0	0	0	0
10Aug	13.9	0	0	0	0
11-Aug	13.5	0	0	0	0
12-Aug	13.3	0	0	0	0
13-Aug	13.0	0	0	0	0
14-Aug	13.0	0	0	0	0
15-Aug	13.0	0	0	0	0

Continued Appendix B.

16-Aug	12.8	0	0	0	0
17-Aug	12.7	0	0	0	0
18-Aug	13.5	0	0	0	0
19-Aug	12.9	0	0	0	0
20-Aug	13.3	0	0	0	0
21-Aug	13.0	0	0	0	0
22-Aug	12.7	0	0	0	0
23-Aug	12.3	0	0	0	0
24-Aug	13.7	0	0	0	0
25-Aug	12.5	0	0	0	0
26-Aug	19.0	0	0	0	0
27-Aug	23.2	0	0	0	0
28-Aug	22.7	0	0	0	0
29-Aug	21.2	0	0	0	0
30-Aug	17.8	0	0	0	0
31-Aug	17.0	0	0	0	0
1-Sep	15.3	0	0	0	0
2-Sep	13.9	0	0	0	0
3-Sep	13.4	0	0	0	0
4-Sep	14.2	0	0	0	0
5-Sep	12.8	0	0	0	0
6-Sep	11.9	0	0	0	0
7-Sep	10.9	0	0	0	0
8-Sep	10.8	0	0	0	0
9-Sep	10.2	0	0	0	0
10-Sep	9.9	0	0	0	0
11-Sep	9.8	0	0	0	0
12-Sep	9.8	0	0	0	0
13-Sep	9.9	0	0	0	0
14-Sep	9.9	0	0	0	0
15-Sep	21.2	0	0	0	0
16-Sep	24.1	0	0	0	0
17-Sep	46.7	0	0	0	0
18-Sep	46.2	0	0	0	0
19-Sep	45.9	0	0	0	0
20-Sep	45.9	0	0	0	0
21-Sep	39.4	0	0	0	0
22-Sep	29.7	0	0	0	0
23-Sep	24.9	0	0	0	0
24-Sep	21.8	0	0	0	0
25-Sep	19.8	0	0	0	0
26-Sep	18.4	0	0	0	0
27-Sep	17.8	0	0	0	0
28-Sep	16.7	0	0	0	0
29-Sep	14.4	0	0	0	0
30-Sep	15.0	0	0	0	0
1-Oct	13.9	0	0	0	0
2-Oct	13.3	0	0	0	0
3-Oct	12.7	0	0	0	0
4-Oct	12.5	0	0	0	0
5-Oct	11.8	0	0	0	0
6-Oct	12.3	0	0	0	0
7-Oct	13.4	0	0	0	0
8-Oct	12.7	0	0	0	0
9-Oct	14.2	0	0	0	0
10-Oct	14.2	0	0	0	0
11-Oct	11.9	0	0	0	0

Continued Appendix B.

12-Oct	13.3	0		0	0		0
13-Oct	12.5	0		0	0		0
14-Oct	12.3	0		0	0		0
15-Oct	13.6	0		0	0		0
16-Oct	18.3	0		0	0		0
17-Oct	21.2	0		0	0		0
18-Oct	21.2	0		0	0		0
19-Oct	19.5	0		0	0		0
20-Oct	19.3	0		0	0		0
21-Oct	19.1	0		0	0		0
22-Oct	18.4	0		0	0		0
23-Oct	11.3	0		0	0		0
24-Oct	20.1	0		0	0		0
25-Oct	19.3	0		0	0		0
26-Oct	18.4	0		0	0		0
27-Oct	21.0	0		0	0		0
28-Oct	5.7	0		0	0		0
29-Oct	53.8	0		0	0		0
30-Oct	47.9	0		0	0		0
31-Oct	42.5	0		0	0		0
1-Nov	37.4	0		0	0		0
2-Nov	42.2	0		0	0		0
3-Nov	13.1	0		0	0		0
4-Nov	39.9	0		0	0		0
5-Nov	37.4	0		0	0		0
6-Nov	36.0	0		0	0		0
7-Nov	33.4	0		0	0		0
8-Nov	31.2	0		0	0		0
9-Nov	29.7	0		0	0		0
10-Nov	26.9	0		0	0		0
11-Nov	28.3	0		0	0		0
12-Nov	26.6	0		0	0		0
13-Nov	24.6	0		0	0		0
14-Nov	48.1	0		0	0		0
15-Nov	51.0	0		0	0		0
16-Nov	55.8	0		0	0		0
17-Nov	16.5	0		0	0		0
18-Nov	17.0	0		0	0		0
Totals		**355**	**1**	**50,857**	**1**	**0**	**143**

Appendix C. Actual daily and estimated captures and emigration estimates for wild spring Chinook and steelhead smolts lower Wenatchee River trap 2004.

Date	Discharge (m^3/s)	Spring Chinook			Steelhead		
		Catch		Daily migration	Catch		Daily migration
		Actual	Estimated		Actual	Estimated	
12-Feb	40.0	0		0	0		0
13-Feb	39.6	2		1288	0		0
14-Feb	39.9	0		0	0		0
15-Feb	38.9	0		0	0		0
16-Feb	39.1	0		0	0		0
17-Feb	38.9	0		0	0		0
18-Feb	38.5	0		0	0		0
19-Feb	37.9	1		644	0		0
20-Feb	37.3	1		644	0		0
21-Feb	36.5	1		644	0		0
22-Feb	35.9	0		0	0		0
23-Feb	35.9	1		644	0		0
24-Feb	36.8	1		644	0		0
25-Feb	38.0	0		0	0		0
26-Feb	37.6	2		1288	0		0
27-Feb	37.4	2		1288	0		0
28-Feb	37.2	0		0	0		0
29-Feb	37.2	0		0	0		0
1-Mar	37.2	0		0	0		0
2-Mar	37.3	1		644	0		0
3-Mar	37.3	2		1288	0		0
4-Mar	37.2	1		644	0		0
5-Mar	37.8	0		0	0		0
6-Mar	39.2	0		0	0		0
7-Mar	38.4	0		0	0		0
8-Mar	41.6	0		0	0		0
9-Mar	62.0	0		0	0		0
10-Mar	86.3	0		0	0		0
11-Mar	93.5	6		3462	0		0
12-Mar	92.0	12		7730	0		0
13-Mar	94.1	5		2674	0		0
14-Mar	92.6	6		4509	0		0
15-Mar	92.7	9		5729	0		0
16-Mar	93.7	19		10695	0		0
17-Mar	95.7	14		6309	0		0
18-Mar	100.9	16		4754	0		0
19-Mar	104.7	15		3561	0		0
20-Mar	102.3	12		3264	0		0
21-Mar	95.9	5		2204	0		0
22-Mar	91.5	3		1933	0		0
23-Mar	94.6	11		5532	0		0
24-Mar	106.9	16		3419	0		0
25-Mar	115.1	14		2154	0		0
26-Mar	117.5	8		1139	0		0
27-Mar	115.0	12		1857	0		0
28-Mar	110.7	7		1266	0		0
29-Mar	106.8	15		3214	0		0
30-Mar	105.2	15		3468	1		231
31-Mar	108.3	13		2601	0		0
1-Apr	106.9	21		4481	0		0

Continued Appendix C.

2-Apr	102.4	19	5141	0	0
3-Apr	99.3	15	4963	0	0
4-Apr	101.1	4	1173	0	0
5-Apr	109.3	20	3830	0	0
6-Apr	120.9	16	2058	1	129
7-Apr	130.4	20	2028	2	203
8-Apr	151.4	3	207	0	0
9-Apr	160.3	43	2614	2	122
10-Apr	163.7	57	3318	4	233
11-Apr	169.3	46	2533	2	110
12-Apr	180.8	31	5335	0	0
13-Apr	204.4	5	861	3	516
14-Apr	225.9	19	3270	2	344
15-Apr	214.8	27	4647	6	1033
16-Apr	192.4	28	4819	7	1205
17-Apr	172.2	25	1377	3	165
18-Apr	156.9	17	1084	3	191
19-Apr	145.6	18	1363	1	76
20-Apr	135.7	20	1816	2	182
21-Apr	130.3	21	2136	0	0
22-Apr	125.0	23	2650	3	346
23-Apr	119.9	13	1723	1	133
24-Apr	124.6	1	116	2	233
25-Apr	123.6	11	1316	4	479
26-Apr	123.7	13	1549	5	596
27-Apr	139.6	15	1261	16	1345
28-Apr	178.8	10	1721	13	2237
29-Apr	181.0	9	1549	9	1549
30-Apr	174.8	4	688	7	1205
1-May	183.2	9	1549	6	1033
2-May	213.9	2	344	10	1721
3-May	261.4	2	344	1	172
4-May	272.0	4	688	4	688
5-May	265.8	3	516	5	861
6-May	245.0	8	1377	10	1721
7-May	214.6	7	1205	8	1377
8-May	204.4	10	1721	10	1721
9-May	210.6	17	2926	4	688
10-May	201.4	19	3270	7	1205
11-May	188.8	12	2065	9	1549
12-May	174.2	8	1377	12	2065
13-May	166.0	10	1721	8	1377
14-May	160.5	10	1721	5	861
15-May	158.6	12	747	11	685
16-May	160.0	14	855	6	367
17-May	161.5	18	1078	8	479
18-May	168.9	31	1707	10	551
19-May	183.9	4	688	6	1033
20-May	220.3	8	1377	8	1377
21-May	235.3	8	1377	5	861
22-May	247.0	5	861	8	1377
23-May	236.5	1	172	2	344
24-May	219.3	6	1033	5	861
25-May	196.1	1	172	5	861
26-May	182.9	1	172	1	172
27-May	220.2	2	344	2	344

Continued Appendix C.

28-May	244.7	1	172	4	688
29-May	221.2	4	688	1	172
30-May	187.1	3	516	4	688
31-May	180.8	1	172	2	344
1-Jun	172.8	0	0	1	172
2-Jun	157.2	1	172	0	0
3-Jun	150.3	2	211	0	0
4-Jun	159.5	0	0	1	61
5-Jun	196.7	0	0	2	344
6-Jun	222.3	2	344	1	172
7-Jun	201.2	0	0	0	0
8-Jun	174.1	2	516	1	172
9-Jun	155.8	0	0	1	65
10-Jun	161.1	3	241	2	120
11-Jun	180.9	1	55	2	110
12-Jun	162.4	1	59	0	0
13-Jun	142.2	0	80	0	0
14-Jun	143.9	1	78	1	78
15-Jun	139.0	2	170	0	0
16-Jun	123.2	0	0	0	0
17-Jun	114.4	1	158	0	0
18-Jun	120.2	0	0	1	131
19-Jun	132.5	1	97	1	97
20-Jun	131.7	0	0	0	0
21-Jun	127.6	1	108	1	108
22-Jun	134.1	0	0	0	0
23-Jun	160.4	0	0	0	0
24-Jun	150.6	0	0	0	0
25-Jun	154.5	0	0	0	0
26-Jun	160.1	0	0	0	0
27-Jun	149.2	0	0	0	0
28-Jun	130.1	0	0	0	0
29-Jun	113.0	0	0	0	0
30-Jun	103.7	0	0	0	0
1-Jul	101.2	0	0	0	0
2-Jul	95.2	0	0	0	0
3-Jul	87.6	0	0	0	0
4-Jul	82.9	0	0	0	0
5-Jul	77.2	0	0	0	0
6-Jul	71.7	0	0	0	0
7-Jul	69.7	0	0	0	0
8-Jul	67.9	0	0	0	0
9-Jul	59.9	0	0	0	0
10-Jul	53.8	0	0	0	0
11-Jul	49.4	0	0	0	0
12-Jul	45.4	0	0	0	0
13-Jul	43.4	0	0	0	0
14-Jul	42.8	0	0	0	0
15-Jul	42.5	0	0	0	0
16-Jul	43.1	0	0	0	0
17-Jul	43.8	0	0	0	0
18-Jul	42.2	0	0	0	0
19-Jul	42.1	0	0	0	0
20-Jul	43.2	0	0	0	0
21-Jul	40.9	0	0	0	0
22-Jul	37.7	0	0	0	0
23-Jul	34.9	0	0	0	0

Continued Appendix C.

24-Jul	35.4	0	0	0		0
25-Jul	32.9	0	0	0		0
26-Jul	32.0	0	0	0		0
27-Jul	31.2	0	0	0		0
28-Jul	29.2	0	0	0		0
29-Jul	28.6	0	0	0		0
Totals		**1,061**	**198,012**	**299**	**0**	**42,733**