APPENDIX D

Wenatchee Steelhead Spawning Ground Surveys, 2006

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To: Distribution List

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Subject: 2006 Wenatchee River Basin Steelhead Spawning Ground Surveys

Our objectives in conducting steelhead spawning ground surveys were to 1) determine spawn timing of naturally spawning steelhead within selected tributaries; 2) monitor changes in redd distribution within selected tributaries and 3) estimate the abundance of redds and naturally spawning steelhead (both hatchery and wild origin) within the Wenatchee River Basin. Furthermore, attempt to correlate observed changes in redd abundance with changes in hatchery practices (i.e., release time and location). Although total basin redd counts are not conducted, we also expect to establish a relationship between steelhead counts at Tumwater Dam (i.e., female and total) and index area redd counts.

Methods

Prior to 2004 the number of index areas has increased as more information became available. Beginning in 2004, survey methodology has remained similar. Direct comparisons of redd counts to years before 2004 may not be appropriate. Steelhead spawning ground surveys were conducted by foot or raft in index areas on the Wenatchee River and most major tributaries (Appendix A). Survey efforts were primarily concentrated in the upper Wenatchee basin because all hatchery fish were released upstream of Tumwater Dam. Peshastin Creek was included in our surveys because it was identified as a potential reference stream (i.e., no hatchery releases since 1998) for the Wenatchee Basin. Survey methodology involved surveying selected index areas, defined as likely spawning areas, as frequently as once a week. Redds were either individually flagged or in the case of localized spawning, mapped and numbered sequentially. All redds were also geo-referenced using handheld global positioning devices.

When the end of spawning within an index area was thought to be nearly complete, a different observer (i.e., naïve) surveyed the index area to determine the number of redds still visible at the end of spawning. At approximately the same time, non-index areas within a reach or stream were also surveyed. The total number of redds in non-index

areas was estimated by dividing the number of redds found in non-index areas by the proportion of redds still visible inside the index area. The reach total redd count was calculated by combining the number of redds in the index area and the estimated number of redds in the non-index. Murdoch and Peven (2005) provide a more detailed description of the methodology (Appendix F, Task 7-3).

Secondary sexual characteristics were used to calculate sex ratios for the entire run at Tumwater Dam. The sex ratio of the run was subsequently used as the value for the number fish per redd (i.e., assuming each female constructed one redd and male spawned with one female). Spawning escapement was estimated by multiplying the estimated total number of redds by the number of fish per redd. Linear regression analysis was used to examine the relationship between run escapement, index redd counts, and total redd counts upstream of Tumwater Dam.

Results

The number of steelhead migrating upstream of Tumwater Dam decreased 60.3% between 2005 and 2006 (Table 1). A greater number of male steelhead was observed at Tumwater Dam resulting in a fish per redd value of 2.05. The origin of fish could not be determined because most returning hatchery steelhead were not adipose fin clipped.

Table 1. Total number, gender, and sex ratio of steelhead migrating upstream of Tumwater Dam between 2001 and 2006. Sex ratio in 2001 was determined by the number of fish passed and collected during broodstock collection at Tumwater and Dryden dams. For 2002-2006, gender was determined by Tumwater Dam video data.

Year	Number of steelhead above Tumwater Dam			Male to female ratio (# of fish per redd)
	Total	Female	Male	
2001	820	394	426	1.92
2002	1,720	642	1,078	2.68
2003	1,810	1,133	677	1.60
2004	1,869	846	1,023	2.21
2005	2,650	1,644	1,006	1.61
2006	1,053	513	540	2.05

In 2006, river conditions were similar to that observed in 2003. High snow pack and warm weather conditions in April kept water conditions fluctuating considerably after the fourth week of April. Spawning ground surveys were not conducted beyond the third week of May due to poor river conditions. Steelhead began spawning during the third week of March in the Wenatchee River and progressed upstream as water temperatures increased. Spawning was observed in water temperatures ranging from 3.3–7.1 ^{o}C. Based on preliminary data, most spawning activity appeared to begin once a mean daily stream temperature reached ~4.2^{o}C. Peak spawning in the Wenatchee River occurred the

third week of April. Steelhead spawning also peaked in Nason Creek and the Chiwawa River the third week of April (Appendix B).

The estimated number of redds in the Wenatchee Basin decreased 65% between 2005 (*N* = 1,140) and 2006 (*N* = 395). High river discharge that occurred during and followed the peak of spawning decreased observer efficiency and may have resulted in underestimates of redd abundance. Although, the decrease in redds (65%) is similar to the observed decrease in spawners (60%). The proportion of redds in tributaries upstream of Tumwater Dam generally declined, but increased in tributaries downstream of Tumwater Dam.

Spawning in Nason Creek decreased from the 4-year mean of 29% to 20% in 2006 (Appendix C). While the overall number of redds in Nason Creek was lower than previous years, spawning continues to be primarily occurring in the middle two reaches (77%; Appendix D1). Steelhead redds observed in the Chiwawa River were also found in locations consistent with previous years (Appendix D2). The proportion of redds found in the Wenatchee River above Tumwater Dam increased from 40% in 2005 to 57% in 2006 (Appendix D3). While Peshastin Creek experienced an increase in the proportion of redds in the basin, the abundance of redds found in 2006 was 31% lower than 2005 (Appendix D4). Icicle Creek was the only spawning area that observed both an increase in the number and proportion of steelhead redds in the Wenatchee Basin.

Despite poor survey conditions towards the end of spawning, the proportion of redds found within the index areas upstream of Tumwater Dam (85%) was consistent with previous years (Table 2). Total run escapement explained a greater proportion of the variation in the estimated total number of redds than the number of female steelhead (Figure 1). Total run escapement also explained a greater proportion of the variation in total redd counts than index redd counts (Figure 2).

Table 2. Comparison of the number of redds found within index areas and the estimated number of redds in non-index areas upstream of Tumwater Dam.

Year	Index area	Non-index area	Estimated total	Within index area (%)
2001	118	19	137	86
2002	296	179	475	62
2003	353	88	441	80
2004	277	92	369	75
2005	828	136	964	86
2006	192	34	226	85

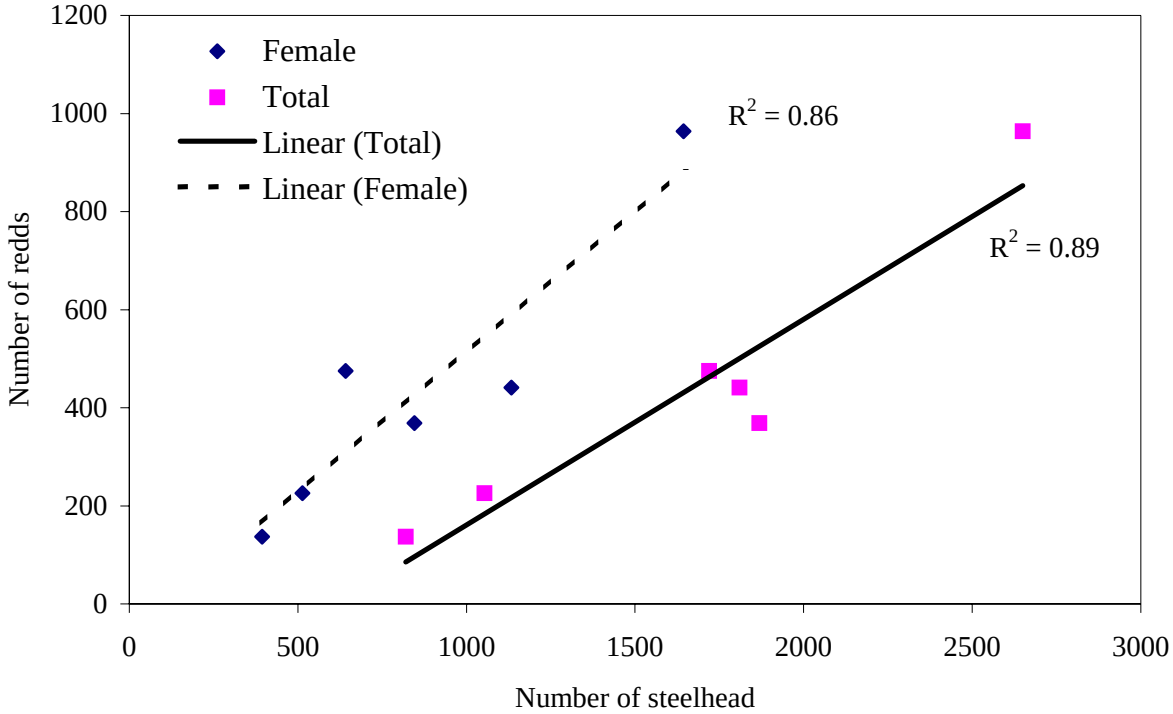


Figure 1. Relationship between steelhead run escapement (total and female) upstream of Tumwater Dam and total redd counts.

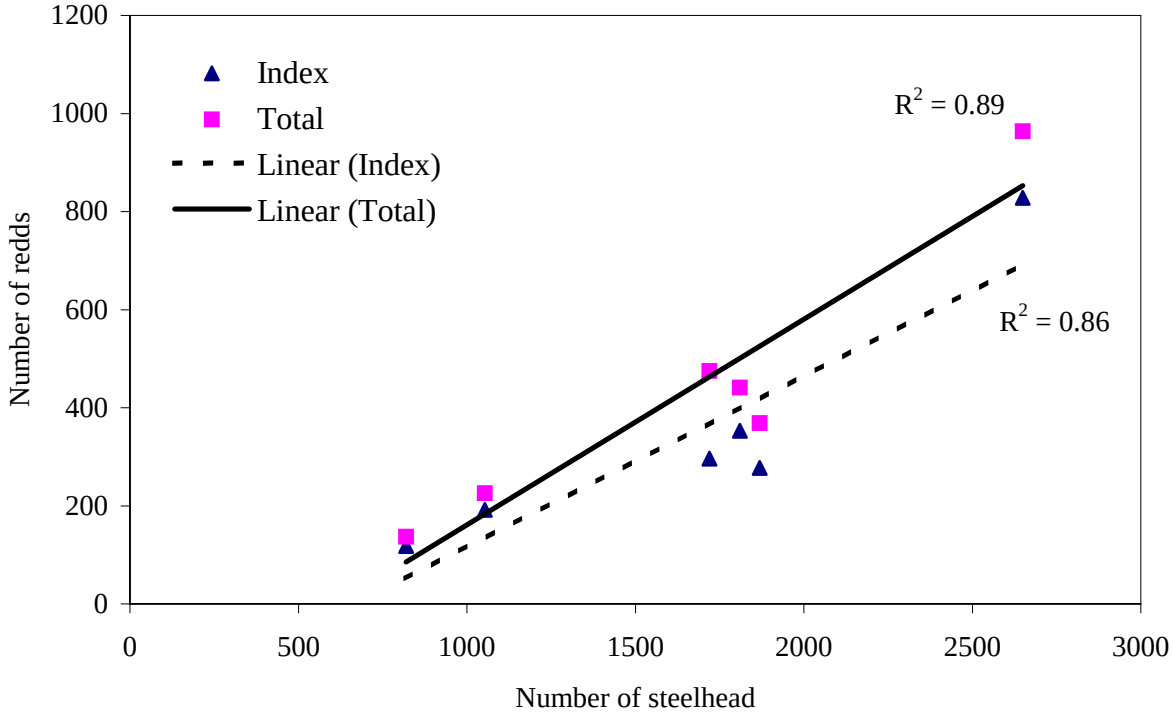


Figure 2. Relationship between steelhead run escapement upstream of Tumwater Dam and total and index areas redd counts.

In 2006, only 44% of the steelhead migrating above Tumwater Dam were accounted for on spawning ground surveys compared to the 4-year average (2002-2005) of 54% (Table 3). Difficult survey conditions (i.e., numerous freshets) likely resulted in lower observer efficiency other factors that may have influenced spawning escapement (i.e., fall back and prespawn mortality) are unknown.

Table 3. Comparison of run and spawning escapement estimates for steelhead upstream of Tumwater Dam.

Year	Run Escapement	Spawning escapement estimates	
		Number of spawners (# redds x # fish/redd)	Proportion of run escapement
2001	820	263	32
2002	1,720	1,273	74
2003	1,810	706	39
2004	1,869	815	44
2005	2,650	1,552	59
2006	1,053	463	44

Discussion

The decrease in steelhead redd abundance in the Wenatchee Basin was attributed to a lower run escapement, which may have been affected by changes in smolt-to-adult survival, harvest rates, or hatchery stray rates. Based on the last six years of effort, we have made some general conclusions regarding steelhead spawning ground surveys in the Wenatchee Basin:

1) The current steelhead spawning ground methodology used in the Wenatchee River basin is feasible and can be conducted with reasonable accuracy based on the relationship between run and spawning escapement.

2) Redd estimates likely underestimate the total number of redds because all available spawning habitat (i.e., numerous low order streams) is not surveyed.

3) All hatchery steelhead should be externally marked (i.e., adipose fin clips) in order to assess the efficacy of hatchery releases and determine both the temporal and spatial distribution of hatchery steelhead in the Wenatchee Basin.

4) A high proportion of steelhead spawn in the 8 km reach of the Wenatchee River immediately below Lake Wenatchee. Quantitative habitat assessments may provide information regarding the carrying capacity within this reach.

5) Of those steelhead found spawning in the Chiwawa River, almost all utilize the lowest 12 km of the mainstem or small tributaries located in that reach. Further

investigation is needed to assess the effects of low water temperatures (<5°C) in the upper watershed that may be a limiting factor preventing steelhead from utilizing high quality spawning habitat.

6) Radio tagging or PIT tagging adult steelhead (particularly females) at Tumwater Dam may provide insight to the difference observed between run and spawning escapement estimates (e.g., fallback and prespawn mortality rates).

7) Radio tagging or PIT tagging adult steelhead (hatchery and wild) at Tumwater Dam may also allow for comparisons of spatial and temporal spawning distribution as well as hatchery/wild interactions (e.g. do hatchery fish mate with wild fish).

References

Murdoch, A. R. and C. M. Peven. 2005. Conceptual approach to monitoring and evaluating the Chelan county Public Utility District hatchery programs. Chelan County PUD, Wenatchee, WA.

Appendix A. Wenatchee River Basin 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
Tumwater Bridge to Plain (W9)	Tumwater Bridge to Plain
Plain to Lake Wenatchee (W10)	Chiwawa pump station to Lake Wenatchee
Peshastin Creek	
Mouth to Camas Creek (P1)	Kings Bridge to Camas Creek
Camas Creek to mouth of Scotty Creek (P2A)	Ingalls Creek to Ruby Creek
Camas Creek to mouth of Scotty Creek (P2)	FR7320 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 62 Bridge rm 6.4
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

Appendix B. Summary of steelhead spawning ground index surveys in the Wenatchee River basin in 2006.

Reach	Survey Week of Index Area													Reach Total	Expanded # of redds
	5 Mar	12 Mar	19 Mar	26 Mar	2 Apr	9 Apr	16 Apr	23 Apr	30 April	7 May	14 May	21 May	28 May		
Wenatchee River															
W1							2							2	6
W2	0	0	1	1			3							5	7
W3							5							5	15
W4							0							0	0
W5								1						1	1
W6				1	0	0	1	4		1	0			7	28
W7															
W8	0	0	0	2	1	3	4	2						12	12
W9	0	0	1	3	0	11	25	3		0	0			43	43
W10	0	0	2	5	5	8	7	10		37	5			79	79
Total	0	0	4	12	6	22	47	20		38	5			154	191
Peshastin Creek															
P1				0			10	3		7				20	53
P2				0			1	1		7				9	14
Total				0			11	4		14				29	67
Chiwawa River															
C1			0	0	0	0	4	3	1	0	0	0		8	8
C2															
Total			0	0	0	0	4	3	1	0	0	0		8	8

Appendix B. Continued.

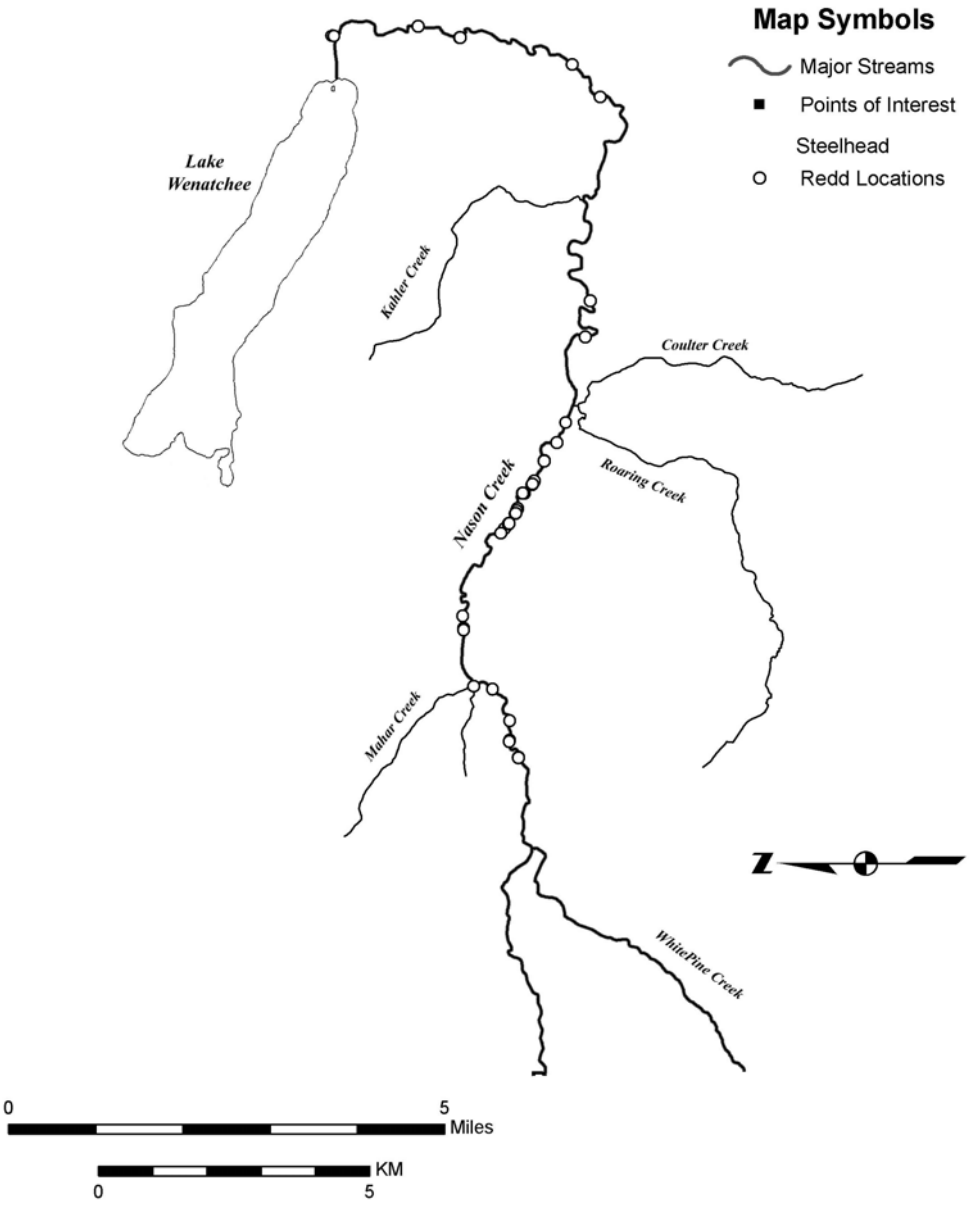
Reach	Survey Week of Index Area													Reach Total	Expanded # of redds
	5 Mar	12 Mar	19 Mar	26 Mar	2 Apr	9 Apr	16 Apr	23 Apr	30 April	7 May	14 May	21 May	28 May		
Clear Creek															
V1	0	0	0	0	0	1	0	5		1	0			7	7
V2				0	0	0	0	0	0	0	0	0		0	0
Total	0	0	0	0	0	1	0	5	0	1	0	0		7	7
Nason Creek															
N1	0	0	1	0	0	1	1	1		0			1	5	8
N2													2	2	27
N3	0	0	0	0	0	1	8	11		9			3	32	32
N4	0	0	0	0	0	3	3	1		0			0	7	7
Total	0	0	1	0	0	5	12	13		9			6	46	74
White River															
H2		0	0	0	0	0	0	0		0	0			0	0
H3		0	0	0	0	0	0	0		0	0			0	0
Total		0	0	0	0	0	0	0		0	0			0	0
Icicle River															
Total				2	0	5	26	5		3	0			41	41
Wenatchee River Basin															
Total	0	0	5	14	6	33	100	50	1	65	5	0	6	285	388

Appendix C. Steelhead spawning surveys in the Wenatchee River basin, 2001 – 2006. Redd counts are expanded values derived from sample rates within index areas.

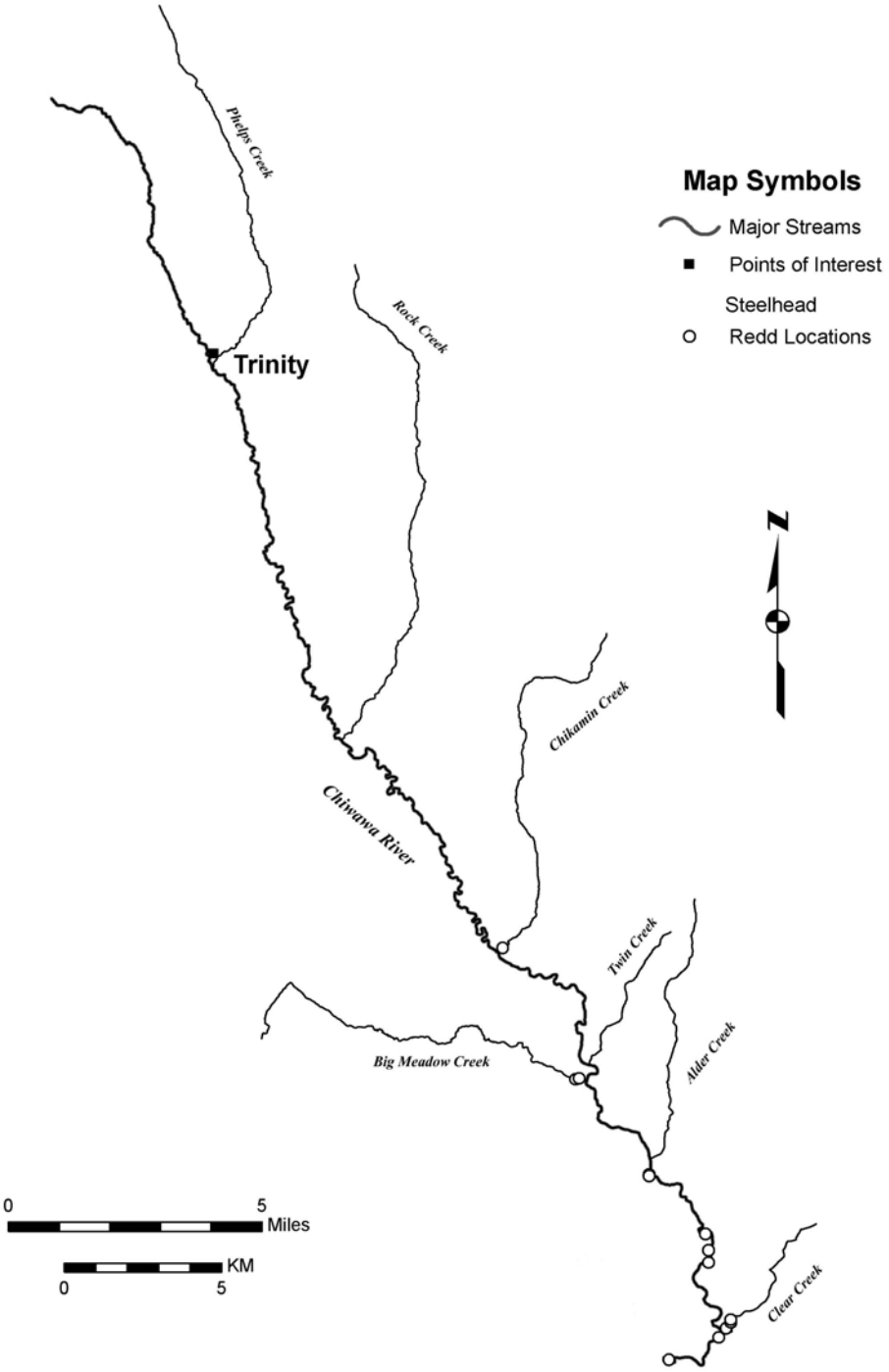
Basin/subbasin	2001	2002	2003	2004	2005	2006
Chiwawa River Basin						
Chiwawa River	25	27	26	17	118	8
Rock Creek	--	1	0	0	0	0
Chikamin creek	--	0	0	1	2	1
Meadow Creek	--	5	1	5	16	3
Twin Creek	--	4	0	--	0	--
Goose Creek	--	0	--	--	--	--
Alder Creek	--	0	5	2	14	0
Deep Creek	--	0	--	--	--	--
Clear Creek	--	43	32	37	12	7
Subtotal	25	80	64	62	162	19
Nason Creek Basin						
Nason Creek	27	80	121	124	410	74
White Pine Creek	--	--	--	0	0	0
Un-named Creek	--	--	--	3	0	3
Roaring Creek	--	--	--	--	2	0
Subtotal	27	80	121	127	412	77
White River Basin						
White River	--	0	1	0	2	0
Panther Creek	--	--	0	0	0	0
Napeequa River	--	0	2	0	0	0
Subtotal		0	3	0	2	0
Little Wenatchee River						
Mainstem	--	1	5	0	0	--
Icicle Creek						
Mainstem	19	27	16	23	8	41
Peshastin Creek Basin						
Peshastin Creek	--	--	15	32	91	67
Mill Creek	--	--	--	--	1	0
Ingalls Creek	--	--	0	0	0	0
Ruby Creek	--	--	0	0	0	--
Tronsen Creek	--	--	0	2	5	0
Scotty Creek	--	--	0	0	0	0
Shaser Creek	--	--	0	0	0	0
Schafer Creek	--	--	--	0	0	0
Subtotal	--	--	15	34	97	67
Wenatchee River						
Mainstem	116	315	248	136	456	191
Beaver Creek	--	0	0	* 15	3	0
Chiwaukum Creek	--	--	0	--	0	0
Subtotal	116	315	248	151	459	191
Wenatchee Basin Total	**187**	**503**	**472**	**397**	**1,140**	**395**

*Redds were enumerated by USFS

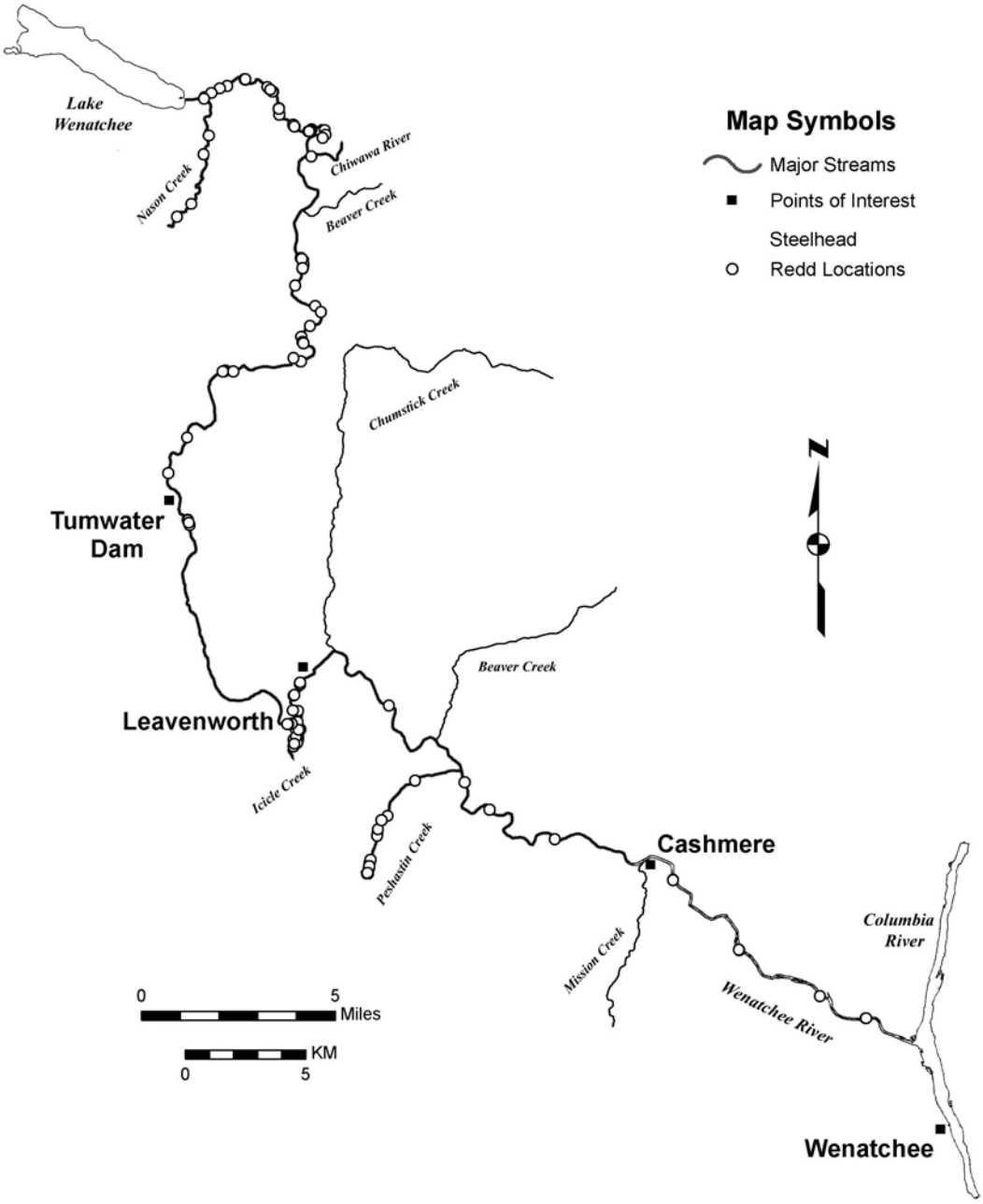
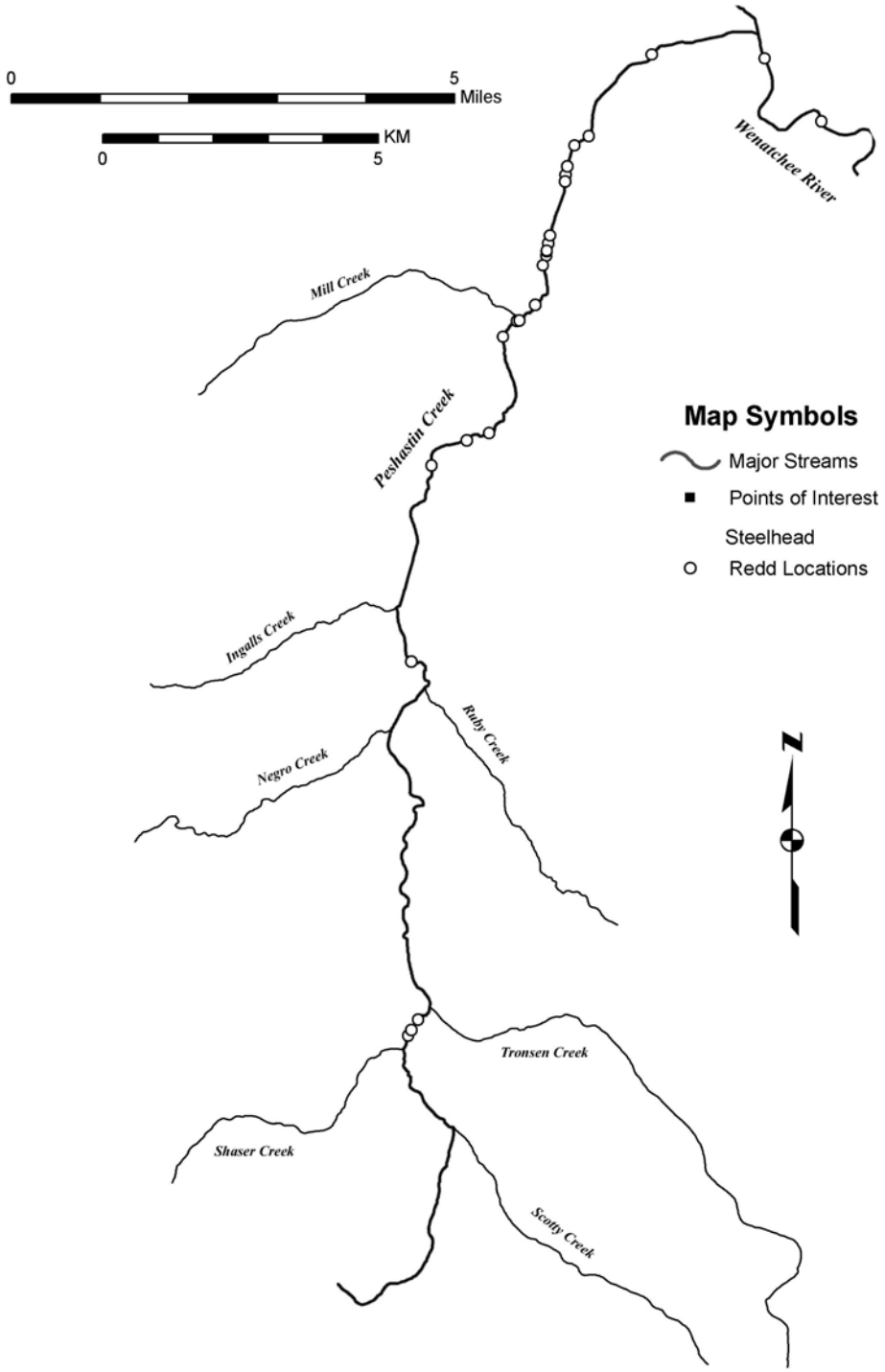
Appendix D1. Steelhead spawning distribution in the Nason Creek Basin in 2006.



Appendix D2. Steelhead spawning distribution in the Chiwawa River Basin in 2006.



Appendix D3. Steelhead spawning distribution in the Wenatchee River in 2006.



Appendix D4. Steelhead spawning distribution in the Peshastin Creek Basin in 2006.