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Lake Roosevelt Fisheries Evaluation Program

Meadow Creek vs. Lake Whatcom Stock Kokanee Salmon Investigations in Lake Roosevelt

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Lake Roosevelt Fisheries Evaluation Program

Meadow Creek vs. Lake Whatcom Stock Kokanee Salmon Investigations in Lake Roosevelt

Annual Report 2002

Contributions to Fisheries Management in Eastern Washington State Number 6

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Abstract

Lake Whatcom, Washington kokanee have been stocked in Lake Roosevelt since 1987 with the primary objective of creating a self-sustaining fishery. Success has been limited by low recruitment to the fishery, low adult returns to hatcheries, and a skewed sex ratio. It was hypothesized that a stock native to the upper Columbia River might perform better than the coastal Lake Whatcom stock. Kokanee from Meadow Creek, a tributary of Kootenay Lake, British Columbia were selected as an alternative stock. Post smolts from each stock were released from Sherman Creek Hatchery in late June 2000 and repeated in 2001. Stock performance was evaluated using three measures; 1) number of returns to Sherman Creek, the primary egg collection facility, 2) the number of returns to 86 tributaries sampled and, 3) the number of returns to the creel.

In two repeated experiments, neither Meadow Creek or Lake Whatcom kokanee appeared to be capable of providing a run of three-year old spawners to sustain stocking efforts. Less than 10 three-years olds from either stock were collected during the study period. Chi-square analysis indicated age two Meadow Creek kokanee returned to Sherman Creek and to other tributaries in significantly higher numbers when compared to the Lake Whatcom stock in both 2000 and 2001. However, preliminary data from the Spokane Tribe of Indians indicated that a large number of both stocks were precocial before they were stocked. The small number of hatchery three-year olds collected indicated that the current hatchery rearing and stocking methods will continue to produce a limited jacking run largely composed of precocious males and a small number of three-year olds.

No kokanee from the study were collected during standard lake wide creel surveys. Supplemental creel data, including fishing derbies, test fisheries, and angler diaries, indicated anglers harvested two-year-old hatchery kokanee a month after release. The majority of the two-year old kokanee harvested were from a direct stock at the Fort Spokane boat launch. Only Lake Whatcom kokanee were stocked from the boat launch, therefore stock performance was not evaluated, however the high success of the stocking location will likely increase harvest of hatchery kokanee in the future. Despite low numbers of the targeted three-year olds, Meadow Creek kokanee should be stocked when possible to promote fish native to the upper Columbia River.

Acknowledgements

We gratefully acknowledge the Spokane Tribe of Indians (STI) Lake Roosevelt Monitoring Program (Deanne Pavlik and Chuck Lee), and the Washington Department of Fish and Wildlife (WDFW; Casey Baldwin, Mitch Combs, Jason McLellan, and Heather Woller) for advice and coordination in all aspects of this project.

We thank the Spokane Tribal Hatchery personnel Tim Peone, Del Brown, James Andrews, and Jayne Abrahamson who assisted with the rearing and tagging of the kokanee. Additionally, we thank the Lake Roosevelt Fish Evaluation Project personnel: Andy Moss (STI), Monte Miller and Leroy Williams (Colville Tribe), and Jim Meskin (WDFW), for recovering hatchery kokanee. We also thank Laura Prey (WDFW, Rock Island Dam) for collecting and reading coded wire tags.

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Background

The construction of Grand Coulee Dam eradicated anadromous salmon and steelhead from the upper Columbia River and adjacent rivers and tributaries. To partially mitigate for the loss of anadromous fish, Lake Whatcom kokanee salmon (*Oncorhynchus nerka kennerlyi*) have been stocked in Lake Roosevelt since 1987. The primary purpose of the stocking was to develop a self-sustaining sport fishery and restore a migratory salmonid species to the Lake Roosevelt ecosystem for tribal sustenance and egg supply for the hatcheries. A long term tagging plan was initiated in 1990 to evaluate the success of releases and to determine the most successful strategies (Thatcher et al.1993, Tilson et al. 1994, 1995, 1996, 1997, Tilson and Scholz 1998, McLellan et al. 2001).

Initial returns of adult kokanee to the creel and egg collection sites were minimal largely due to entrainment caused by smolting fry. Consequently, in 1996, the Lake Roosevelt managers adopted the policy to stock residualized smolts (Tilson and Scholz 1998). Return numbers increased, but not to the level needed to achieve a self-sustaining run. In 1998 and 1999 a variety of tests were conducted in an attempt to improve the number of returns. Fish were released directly from the hatchery at different times of the year, morpholine imprinted and not, and from different times of the Lake Whatcom run. Kokanee were also released from net pens located in different areas of the reservoir,. Each year a “jack” run composed primarily of precocious males, approximately 0.2-0.5% of the total fish stocked, returned in the fall. While few three-year olds returned, the run of two-year olds indicated that those not imprinted and released from Sherman Creek in early June performed the best (McLellan et al. 2001).

Hatchery kokanee contributions to the fishery have been difficult to assess. Kokanee harvest in Lake Roosevelt increased an estimated 284 kokanee in 1981 (Harper et al. 1981) to 9,362 in 1988 and 11,906 in 1989 after hatchery stocking began in 1987 (Peone et al. 1991). Only a portion of the hatchery fish released in the reservoir during the first 10 years were marked, therefore it was impossible to determine if unmarked fish were of hatchery or wild origin. Beginning in 1997, all hatchery kokanee stocked in Lake Roosevelt were adipose fin clipped. In 1998, an estimated 10,188 kokanee were harvested of which 33% of the kokanee were of hatchery origin (McLellan et al. 2001; Spotts et al. 2002). Small sample sizes of kokanee observed in creel surveys have restricted our ability to determine the hatchery contribution to the fishery, as well as evaluate stock performance.

It was suggested that Lake Whatcom stock kokanee responded poorly to conditions in Lake Roosevelt and fisheries managers should obtain a stock of kokanee native to the upper Columbia River system. It was hypothesized that a locally adapted kokanee might perform better in Lake Roosevelt. Kokanee stocks found in the upper Columbia River basin that were considered as possible egg sources for supplementing Lake Roosevelt included; 1) Arrow Lakes, upper Columbia River, British Columbia, 2) Meadow Creek, a tributary to Kootenay Lake, British Columbia, and 3) Chain Lakes, Little Spokane River drainage. The kokanee population in the Arrow Lakes system was decreasing and eggs were not available. The spawning population in the Chain Lakes was small, approximately 50 spawning pairs, and therefore not considered. Consequently, Meadow Creek was chosen because the eggs were abundant and available.

The objective of the study was to test stock performance using three criteria. A significant difference in at least two of the three categories, with one stock consistently out performing the other, would indicate greater performance. The criteria were to determine if there was a significant difference between stocks that; (1) returned to Sherman Creek Hatchery, (2) returned to all tributaries sampled in the reservoir, and (3) recruited to the creel. A secondary objective was to present the results of kokanee performance from fish stocked at Little Falls Dam, Fort Spokane, and Meyers Falls. Additionally, hatchery kokanee collected during the Two Rivers Casino Derby, Winter Test Fishery, and Washington Department of Fish and Wildlife (WDFW) angler diaries, and a supplemental creel survey are presented to provide a comprehensive evaluation of kokanee collected by all participants of the Lake Roosevelt Fisheries Evaluation Program.

Methods

Description of the Study Area

Lake Roosevelt was formed when Grand Coulee Dam impounded the waters of the Columbia River in 1939 (Figure 1). At full pool the reservoir is 243 kilometers (km) long, inundates 334.9 km^2, and has a maximum depth of 122 meters(m) (Stober et al. 1981). At full pool, the lake's surface elevation is 430 m (1,290 ft) above mean sea level (MSL) and minimum operating pool is 403 m (1,208 ft) above MSL. The ten year mean drawdown was 15 m (49 ft) and generally occurs in April for flood control. Grand Coulee Dam was constructed primarily

for hydropower, flood control, and irrigation with secondary operations for recreation, fish, and wildlife.

Kokanee Pre- and Post-Release

Lake Whatcom stock kokanee (LKW) eyed eggs from the 1998, 1999, and 2000 brood stocks were obtained from the Lake Whatcom Hatchery (WDFW) in Bellingham, WA. Kokanee were collected from Meadow Creek, a tributary of Kootenay Lake, British Columbia by WDFW and British Columbia personnel in 1999 and 2000. The fertilized eggs were held at the Clearwater Hatchery in British Columbia until they were eyed, and then transported to the Spokane Tribal Hatchery for incubation and rearing (Combs 2001).

All fish were reared at the Spokane Tribal Hatchery in Wellpinit, WA. Fish were supplied with a combination of spring and well water ranging from 8-11ºC. Fish were feed trained on Biodiet® feed from Bioproducts, Inc. Once the fish were approximately 100 mm total length, they were adipose fin clipped and a portion coded wire tagged (CWT). Unique tag numbers were given to each lot of fish based on their stock origin (Meadow Creek or Lake Whatcom) and release location. Coded wire tags were injected into the rostrum using a model MK4 CWT machine (Northwest Marine Technology, Inc.). After marking, fish were returned to the hatchery raceways via a quality control device, which ensured 100% of the fish were marked.

Kokanee were transferred from the Spokane Tribal Hatchery to Sherman Creek Hatchery in March 2000-02. Meadow Creek and Lake Whatcom CWT kokanee were released from the Sherman Creek Hatchery on 28 June 2000, and 25 June 2001 (Table 1; Combs 2001, 2002, 2003). Three annual tag retention estimates by Tilson and Scholz (1998) were averaged (79%) and applied to the number of kokanee stocked each year to adjust for long-term tag retention (McLellan and Scholz 2002a).

Additional kokanee were released in 2000, 2001, and 2002 into Lake Roosevelt at Little Falls Dam on the Spokane River, Fort Spokane boat launch, Seven Bays net pens, Colville River net pens, and Meyers Falls on the Colville River (Appendix A).

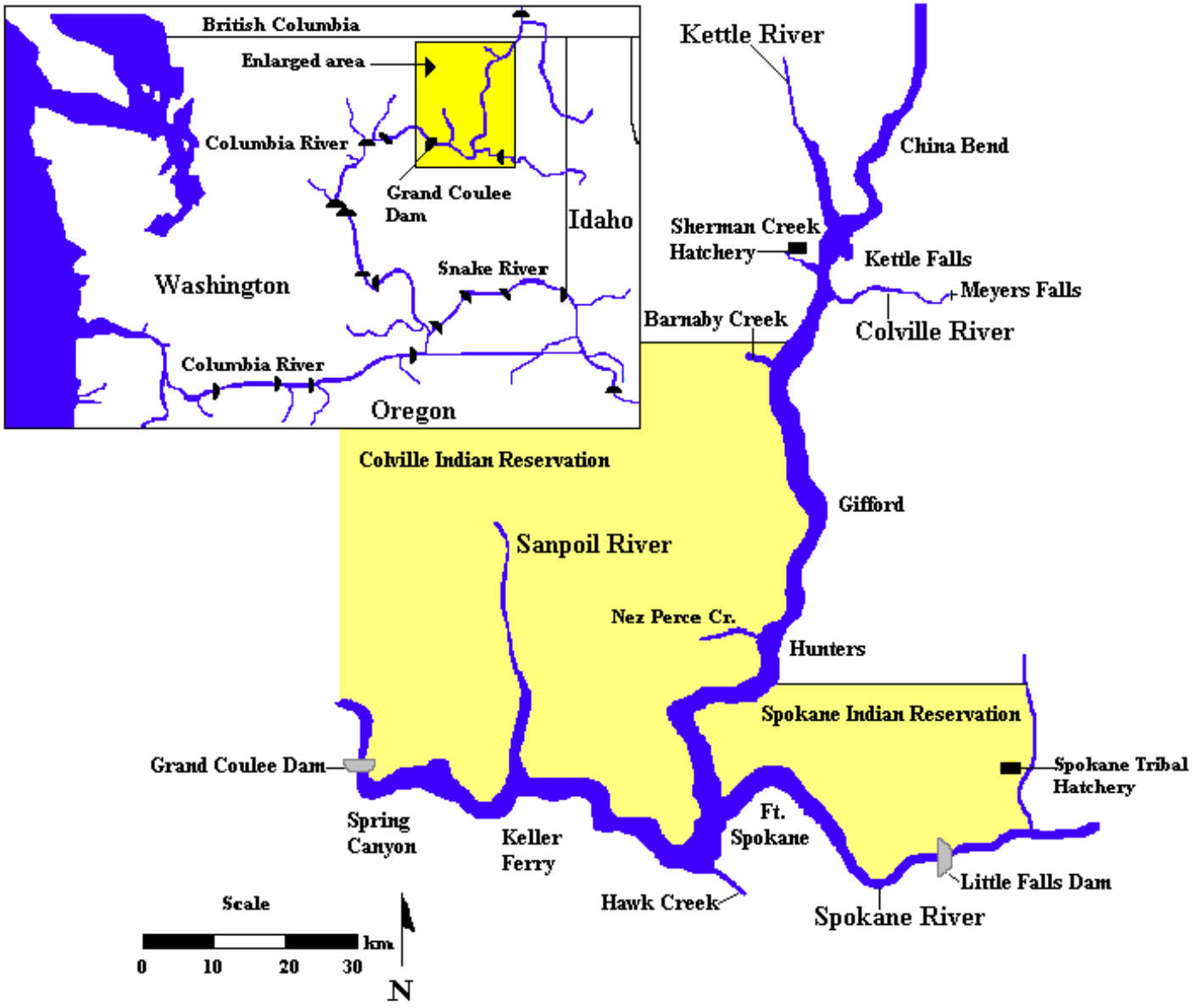

Figure 1. Map of Lake Roosevelt, Spokane Tribal Hatchery and Sherman Creek Hatchery.

Table 1. Meadow Creek and Lake Whatcom stock coded wire tagged (CWT) kokanee released from Sherman Creek, Lake Roosevelt, during 2000-01. All other kokanee released are summarized in Appendix A.

Date Released	Stock and Brood Year	CWT Code	Brood Year	No. Kokanee Released	Adjusted Tag Retention 1st year[1]	Adjusted Tag Retention 2nd year[1]
2000 Releases						
06/28/2000	Meadow Ck	62-03-35	1998	105,432	83,291	65,800
06/28/2000	Lake Whatcom	62-23-34	1998	94,518	74,669	58,989
2001 Releases						
06/25/2001	Meadow Ck	62-02-98/99	1999	101,993	80,574	63654
06/25/2001	Lake Whatcom	62-03-62/64	1999	113,350	89,547	70,742

[1]The number of kokanee released was multiplied by 0.79 to adjust for long-term tag retention. These numbers were used in statistical analysis.

Experimental Design for Coded Wire Tag Release Groups

Three hypotheses were tested to determine performance of both stocks of kokanee. The null hypothesis was tested using chi-square tests for independence. When sample sizes were low, less than 5-6, the Fisher exact test was employed to determine the probability of observing the contingency table by random chance (Zar 1999; Statview®; $\alpha = 0.05$). The hypotheses tested were:

Hypothesis 1 - Returns to Sherman Creek

1-H_o: There was no significant difference in the number of Meadow Creek stock kokanee and Lake Whatcom stock kokanee that returned to Sherman Creek.

Hypothesis 2 - Returns to tributaries throughout Lake Roosevelt

2-H_o: There was no significant difference in the number of Meadow Creek stock kokanee and Lake Whatcom stock kokanee collected at tributaries in the reservoir.

Hypothesis 3 - Returns to the creel

3-H_o: There was no significant difference in the number of Meadow Creek stock kokanee and Lake Whatcom stock that recruited to the creel.

A secondary objective was to evaluate and discuss the recoveries made of kokanee stocked at other locations, including Little Falls, Fort Spokane, and Meyers Falls. Additionally, hatchery kokanee collected through supplemental efforts between 2000 and 2002 were summarized.

Sampling Procedures

Spawning kokanee recovery began in August and lasted to the middle of November (8/17/00- 11/7/00; 8/15/01- 11/20/01; and 8/20/02-11/17/02). Kokanee collection in Lake Roosevelt was two tiered: (1) Weekly boat electrofishing surveys at Sherman Creek to collect kokanee returning to the primary egg collection location (3-5 amps, voltage low (50-500) with 50%, 120 pulses-per-second DC current). Backpack electrofishing in Sherman Creek was utilized when kokanee moved into the creek. A drift boat electrofisher was used to sample Meyers Falls and occasionally Sherman Creek in 2002 (2.5 GPP electrofishing unit, 1.5-2.0 amps, voltage low (50-500 with 40%), current 30 pps DC current). (2) Five, four, and three passes through the reservoir in 2000, 2001, and 2002 respectively. A pass consisted of electrofishing 5 to10 minute transects at each of the primary tributary mouth embayments to Lake Roosevelt Meyers Falls was added in 2002 as an additional site (embayments = 86;. Figure 2). The number of passes was reduced each year due to limited funding. Sites were sampled approximately every two to three weeks. During sampling, all fish species were collected to standardize catch data with previous surveys.

All kokanee collected were checked with a coded wire tag detector, measured to the nearest mm (total length), and a sub-sample was weighed (grams). Heads were removed from kokanee with a CWT, and placed in individually numbered bags for lab analysis. All CWT were extracted from the heads at the EWU Fisheries Research Center and examined with a dissecting microscope to determine the binary code or numerical code. For quality control, 50% of the tags were re-read.

Two-year old fish collected in 2000 and 2001 and three-year olds collected in 2001 and 2002 with coded wire tags were pooled to determine mean length at maturity of Meadow Creek and Lake Whatcom kokanee. The data was not normally distributed so a non-parametric test (Mann-Whitney) was used. Female to male ratio's for each stock were calculated. An age length key was established to assign ages to fish without specific marks (DeVries and Frie 1996), which was then used to create an age-length distribution of kokanee returning to Sherman Creek.

Lake Roosevelt creel surveys were a cooperative effort between the Spokane Tribe of Indians (STI), the Colville Confederated Tribes (CCT), and the WDFW. For specific methods refer to Cichosz et al. (1998). Creel clerks collected heads of all hatchery kokanee captured by anglers.

Supplemental Efforts

Kokanee harvest data were collected by STI during the Two Rivers Casino Trout Derby held in August 2000-2002. Data were also collected using volunteer angler diaries distributed by WDFW to fishing guides and anglers who primarily targeted kokanee and rainbow trout in the lower third of the reservoir in 2001. Supplemental creel data was also collected during test fisheries, which were conducted at the beginning of January of each year in the lower third of the reservoir. A supplemental boat launch creel was conducted at Keller Ferry on 27 June 2001.

Rock Island Dam Fish Passage Center monitored downstream fish passage between April 1st and August 31st of each year. During this time they collected Lake Roosevelt hatchery kokanee that were moving downstream. A concurrent CWT study was being conducted on the Lake Wenatchee sockeye, therefore only CWT kokanee/sockeye greater than 150 mm in 2000 and greater than 200 mm in 2001 and 2002 were sacrificed and returned to EWU as Lake Roosevelt kokanee (L. Praye, WDFW personal communication).

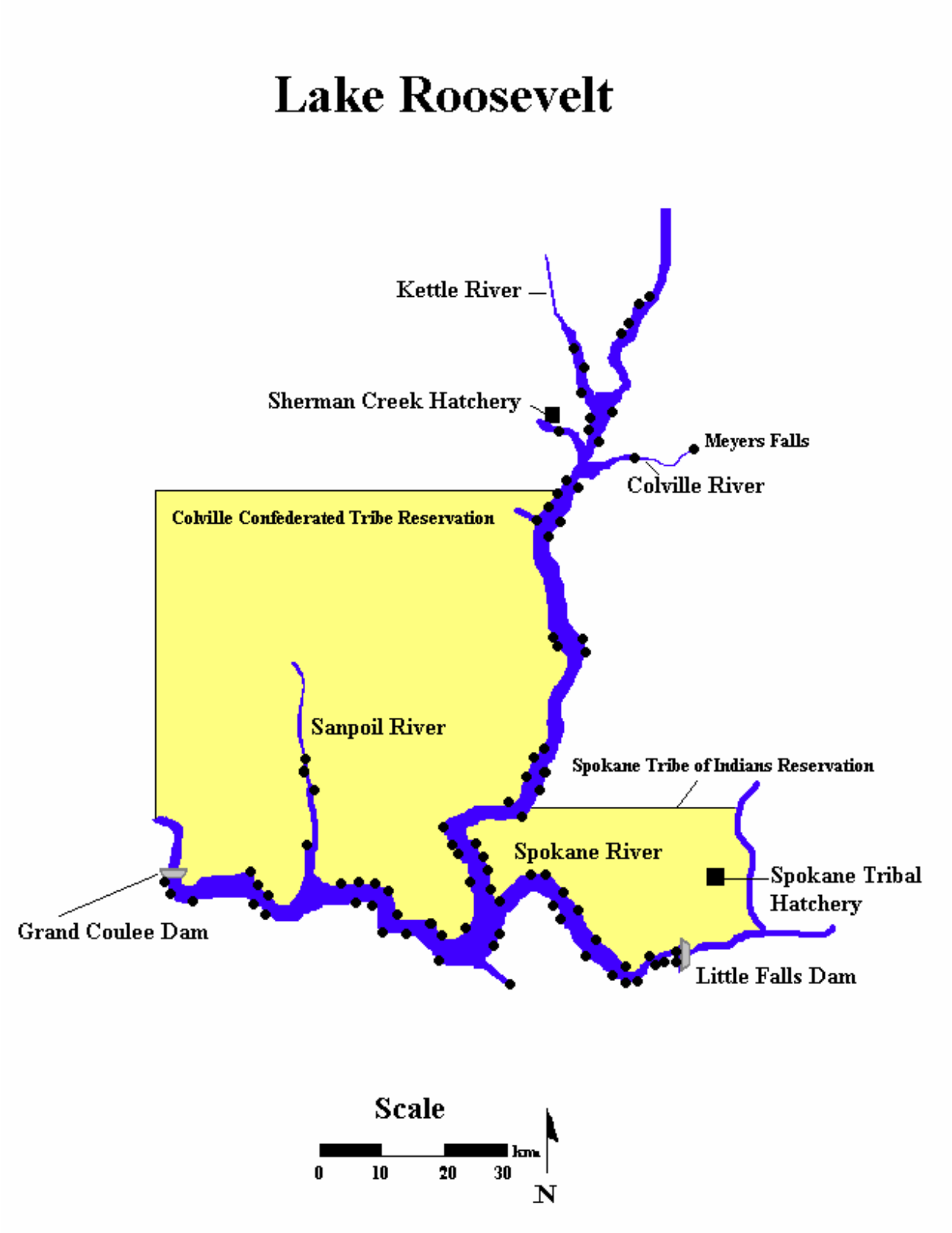

Figure 2. Map of Lake Roosevelt and 86 locations sampled for kokanee between 2000 and 2002.

Results

Hatchery Stock Results

Hypothesis 1- Sherman Creek Returns

Chi-square analysis indicated that two-year old Meadow Creek kokanee returned to Sherman Creek in significantly higher numbers when compared to the Lake Whatcom stock in 2000 ($\chi^2 = 736.6$, d.f. = 1; $p < 0.001$) and 2001 ($\chi^2 = 156.2$, d.f. = 1; $p < 0.001$). Chi-square analysis indicated there was no significant difference in the number of three-year olds that returned in 2001 ($\chi^2 = 0.007$, d.f. = 1; $p = 0.936$) and 2002 ($\chi^2 = 1.80$, d.f. = 1; $p = 0.180$). The Fisher exact test supported not rejecting the null hypothesis in both 2001 ($p > 0.999$) and 2002 ($p = 0.501$; Table 2). One 4 year old Lake Whatcom kokanee returned in 2002, which was not used in the analysis.

Hypothesis 2- Reservoir Wide Recoveries

Reservoir wide recoveries, including those at Sherman Creek, indicated similar results. Significantly more Meadow Creek kokanee were recovered compared to Lake Whatcom kokanee as two-year olds in 2000 ($\chi^2 = 735.3$, d.f. = 1; $p < 0.01$) and 2001($\chi^2 = 150.1$, d.f. = 1; $p < 0.01$; Table 3). There was no significant difference in the number of three-year olds collected in 2001 ($\chi^2 = 0.318$, d.f. = 1; $p = 0.5727$) and 2002($\chi^2 = 0.237$, d.f. = 1; $p = 0.627$). The Fisher exact test indicated similar results for 2001 and 2002 ($p = 0.615$, and $p > 0.999$) (Table 3).

Hypothesis 3- Recoveries from the Creel

No hatchery kokanee were collected in the STI creel surveys in 2000, two in 2001, and 18 in 2002 (STI unpublished data). None of the hatchery kokanee had coded wire tags, so stock could not be distinguished.

Table 2. Number of Lake Whatcom and Meadow Creek kokanee that returned to Sherman Creek 2000-02. Fish are listed by stock, age at capture, and year of capture.

Stock (age) Year	CWT #	Adjusted # stocked	Kokanee recovered	Recovery %	χ^2	p-value	Fisher exact p-value
Experiment 1							
Lake Whatcom (2) '00	62-03-34	74,669	197	0.26			
Meadow Creek (2) '00	62-03-35	83,291	1,337	1.61	736.6	< 0.01	< 0.001
Lake Whatcom (3) '01	62-03-34	58,989	6				
Meadow Creek (3) '01	62-03-35	65,800	7		0.007	0.9357	> 0.999
Experiment 2							
Lake Whatcom (2) '01	62-02-62&64	89,547	198	0.22			
Meadow Creek (2) '01	62-02-98&99	80,574	488	0.61	156.2	< 0.01	< 0.001
Lake Whatcom (3) '02	62-03-62&64	70,742	2				
Meadow Creek (3) '02	62-03-98&99	63,654	0		1.80	0.1798	0.501

Table 3. Number of Lake Whatcom and Meadow Creek kokanee collected at tributaries in the reservoir 2000-02. Fish are listed by stock, age at capture, and year of capture

Stock (Age) Year	CWT #	Adjusted # stocked	Kokanee recovered	Recovery %	χ^2	p- value	Fisher exact p-value
Experiment 1							
Lake Whatcom (2) '00	62-03-34	74,669	199	0.27			
Meadow Creek (2) '00	62-03-35	83,291	1,340	1.61	735.3	< 0.001	<0.001
Lake Whatcom (3) '01	62-03-34	58,989	6	0.01			
Meadow Creek (3) '01	62-03-35	65,800	9	0.01	0.318	0.573	0.615
Experiment 2							
Lake Whatcom (2) '01	62-02-62/64	89,547	209	0.18			
Meadow Creek (2) '01	62-02-98/99	80,574	496	0.49	150.1	< 0.001	< 0.001
Lake Whatcom (3) '02	62-02-62/64	70,742	2	0.00			
Meadow Creek (3) '02	62-02-98/99	63,653	0	0.00	0.237	0.627	> 0.999

Kokanee Biological Data

Two-year old fish collected in 2000-01 and three-year olds from 2001-02 with coded wire tags pooled to determine mean length at maturity for each age class of Meadow Creek and Lake Whatcom kokanee. Lake Whatcom two-year olds were significantly larger than Meadow Creek two-year olds ($p < 0.01$); however, there was no significant difference in mean length of three-year olds ($p = 0.78$; Table 4).

The female to male ratio for kokanee released from Sherman Creek Hatchery in 2000 indicated a more normal female to male (F:M) ratio for Meadow Creek kokanee for age 2 (1:9) and age 3 (5:3) compared to Lake Whatcom stock kokanee (1:62 age two and 1:5 age three).

The 2001 released fish were opposite where Lake Whatcom kokanee had a more normal ratio for age 2 (1:7) and age 3 (1:1) kokanee compared to Meadow Creek kokanee (age 2 1:12 and age 3 1:0; Table 5).

An age-length distribution of all the fish collected at Sherman Creek in 2001 (Figure 3) and in 2002 (Figure 4) indicated the majority of fish were two year olds.

The run timing of Lake Whatcom and Meadow Creek kokanee differed by 4 to 6 weeks. The peak of the Meadow Creek spawning run occurred during mid-September in 2000 (598 fish/hr) and 2001 (1,588 fish/hr; Figure 5). Lake Whatcom kokanee experienced variable peaking times, but primarily during October in 2000 (109 fish/hr) and 2001 (218 fish/hr; Figure 6). The data collected in 2003 was not used because only three fish from the experiment returned.

Table 4. Mean length of Meadow Creek and Lake Whatcom kokanee at ages two and three collected in Lake Roosevelt, 2000-02.

Stock and age	n	Mean length (±SD)	Mann-Whitney
Age 2			
Meadow Creek	1,865	274 (23)	
Lake Whatcom	582	293 (33)	p >0.01
Age 3			
Meadow Creek	9	445 (58)	
Lake Whatcom	12	448 (33)	p = 0.78

Table 5. Female to male ratio of coded wire tagged two and three-year old kokanee from each stock collected at Sherman Creek, 2000-02.

	Age 2			Age 3		
Year	Females	Males	F:M	Females	Males	F:M
2000						
Meadow Creek	130	1,151	1:9			
Lake Whatcom	3	185	1:62			
2001						
Meadow Creek	37	450	1:12	5	3	5:3
Lake Whatcom	25	172	1:7	1	5	1:5
2002						
Meadow Creek				1	0	1:0
Lake Whatcom				1	1	1:1

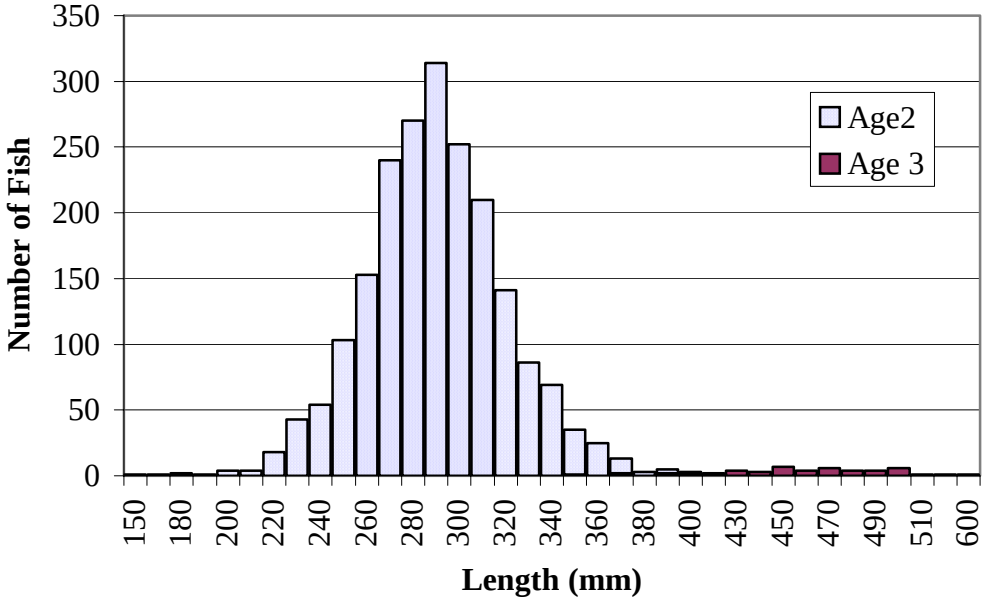

Figure 3. Age length distribution of hatchery kokanee collected in Lake Roosevelt, 2001 (age 2 = 2,043; age 3 = 50)

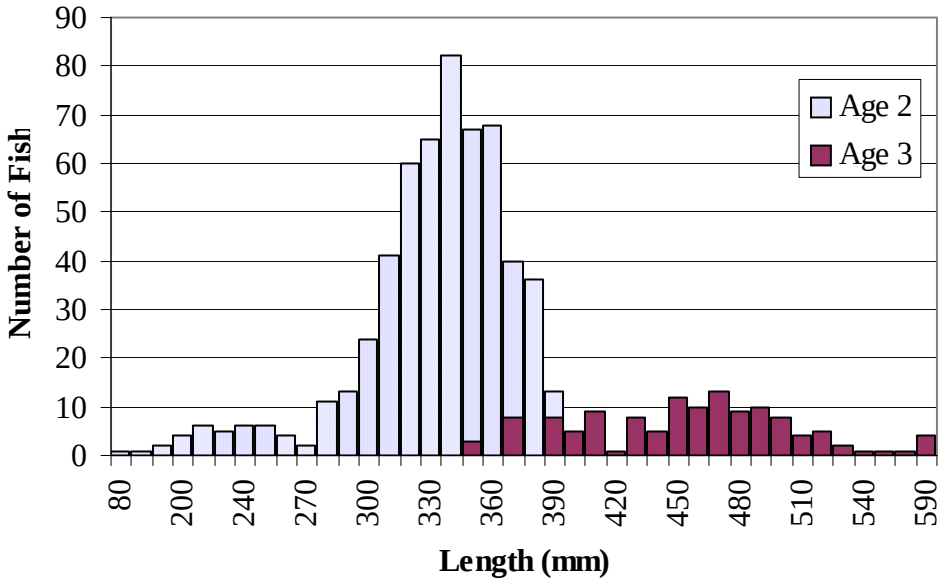

Figure 4. Age length distribution of hatchery kokanee collected in Lake Roosevelt, 2002 (age 2 = 564; age 3 = 127)

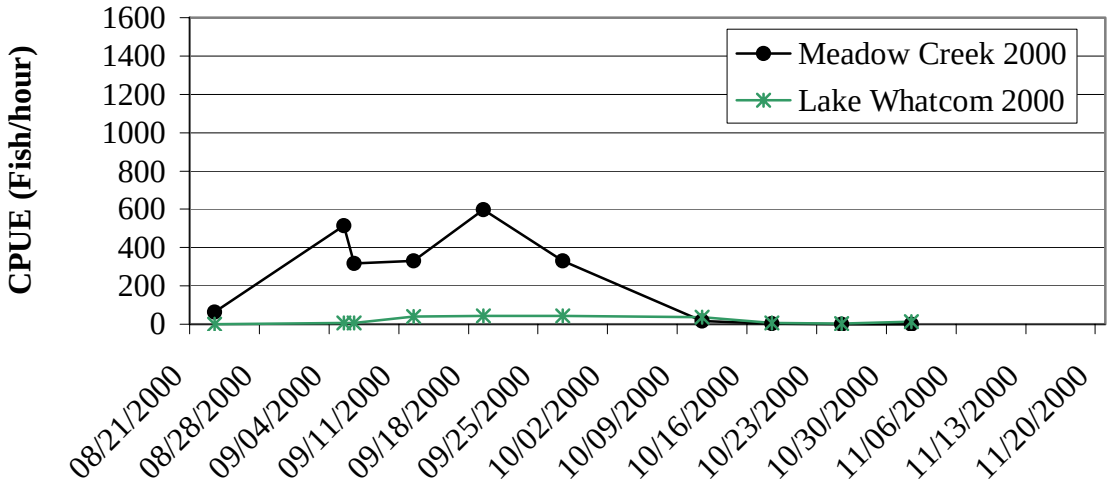

Figure 5. Meadow Creek stock and Lake Whatcom stock kokanee collected persampling date at Sherman Creek, 2000. (Graph excludes 10/4/2000 backpack shocking day).

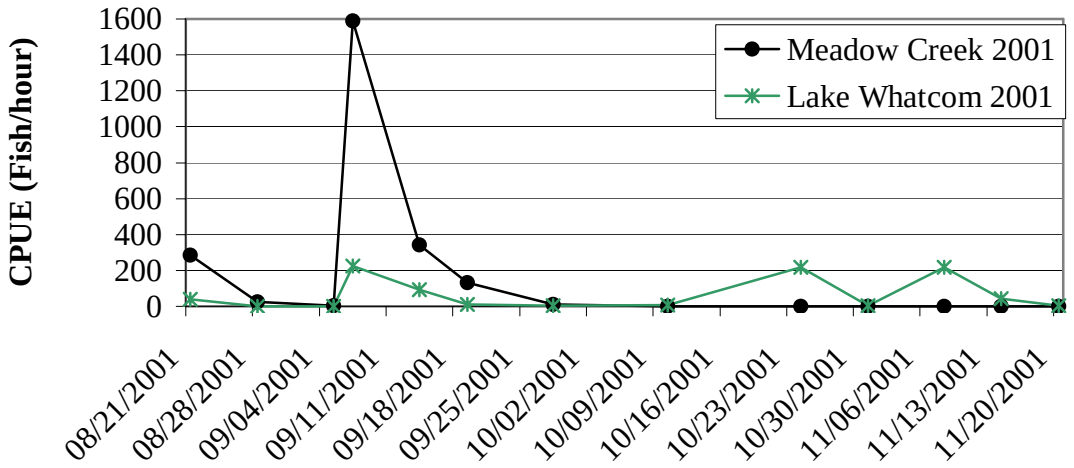

Figure 6. Meadow Creek stock and Lake Whatcom stock kokanee collected per sampling date at Sherman Creek, 2001.

Lake Roosevelt Kokanee Collections

A large number of kokanee were collected during the fall surveys that were not a direct part of the stock analysis study. The majority of these collections were a result of additional stocking efforts at Fort Spokane, Little Falls, and Meyers Falls between 2000 and 2002.

In 2000, kokanee were released from below Little Falls Dam (CWT group and an adipose fin clip group), Sherman Creek Hatchery (CWT group and an adipose fin clip group), and Kettle Falls net pens (adipose fin clip). Assuming the kokanee collected near a release location was from that release area, the majority of adipose fin clipped kokanee were released in the Sherman Creek and Kettle Falls area (98 %) compared to kokanee released from below Little Falls Dam (2.2 %; Table 6).

In 2001, kokanee were released from Sherman Creek Hatchery (left pectoral and adipose clip group and CWT group), Kettle Falls net pens (adipose clip), Meyer's Falls (right pectoral and adipose clip), Seven Bays net pens (adipose clip), Fort Spokane boat launch (CWT and adipose clip group), and Little Falls Dam (CWT and adipose group). Adipose only kokanee were collected throughout the reservoir, with the majority in the Hawk Creek (42 %) and Sherman Creek areas (44 %). Kokanee with left pectoral fin clips collected in 2001 were released from Sherman Creek and were primarily collected there. Right pectoral Meadow Creek kokanee released at Meyer's Falls were collected in the Kettle Falls area. Meyer's Falls was not sampled in 2001. Kokanee released at the Fort Spokane boat launch were primarily collected in the Seven Bays/Hawk Creek area (n = 93), but some were collected throughout the Spokane River (n = 127) and a small number in the Kettle Falls area (n = 9; Table 7). Few kokanee were collected from the Little Falls release (n = 5; Table 7).

In 2002, kokanee were released from Sherman Creek Hatchery (adipose clip), Colville River net pens (adipose clip), Meyer's Falls (right vent, left pectoral, and adipose clip), Seven Bays net pens (adipose clip), Fort Spokane (right pectoral and adipose clip), and Little Falls Dam (left pectoral and adipose clip). Similar to 2001, the adipose only kokanee were primarily captured near their release sites, at Kettle Falls or Seven Bays/Hawk Creek area (Table 6). Fish released from Fort Spokane were the most abundant collected in 2002 (n = 196). Few fish were collected from the Little Falls release (n = 11; Table 6).

Meyer's Falls was sampled three times in 2002. On 10 September 2002, nine Meadow Creek three-year olds, two wild kokanee (size range 403-589 mm TL), and one two-year old

Lake Whatcom kokanee were collected during 118 seconds of effort. Sampling was stopped because fish were requested for spawning, and the tanker truck for transporting was not available. On 23 September 2002, two age three Meadow Creek collected, four age two Lake Whatcom right pectoral and left ventral clipped, 1 right pectoral clip, and 1 adipose only were collected. On 30 October 2002, one adipose right pectoral clipped Lake Whatcom kokanee was collected. An organized plan to sample Meyers Falls after dark is planned for 2003 to capture more returning adults.

Wild kokanee do not have their adipose fin clipped. The wild fish are usually large in size and bright red during the spawning season, which resembles the appearance of Meadow Creek kokanee. Wild kokanee were typically captured each year in the reservoir at similar locations and sample sizes (Table 6). However, in 2002 ten wild kokanee were captured below Little Falls Dam, which appeared to be Lake Whatcom three year olds. Since they were below the dam and had appearances similar Lake Whatcom kokanee, they were probably entrained from Lake Coeur d' Alene and not the typical wild kokanee observed.

Table 6. Number of kokanee collected per section of the reservoir per fin mark 2000-02[1]. Refer to key for release location[2].

Location	# of sites per section	AD only			Left Pec		Right Pec		LPRV	Wild		
		00	01	02	01	02	01	02	02	00	01	02
Grand Coulee	8	0	4	0	0	0	0	1	0	0	0	0
Keller Ferry	6	0	5	2	0	1	0	7	0	0	0	0
Sanpoil	4	0	1	1	0	0	0	0	0	5	2	2
Hawk Creek/Seven Bays	10	7	361	81	2	7	0	196	3	13	8	6
Fort Spokane	9	0	2		0	0	0	0	0	0	0	0
Hunters	7	5	21	24	0	0	0	5	0	2	1	1
Gifford	4	2	8	1	0	0	0	0	0	2	0	0
Bradbury Beach	7	0	10	1	3	0	1	0	0	1	2	0
Kettle Falls	8	4	45	6	2	0	15	0	0	0	6	4
Sherman Creek Cove	1	1,033	338	263	306	2	15	4	3	1	4	3
Meyers Falls	1	--	--	12	--	0	--	2	5	--	--	2
Evans/China Bend	4	2	2	1	1	0	0	0	0	6	3	2
Porcupine Bay	12	8	63	0	0	0	0	0	0	1	6	0
Little Falls	5	9	3	10	0	1	0	13	0	0	0	10
Grand Total	**86**	**1,070**	**863**	**402**	**314**	**11**	**31**	**228**	**11**	**31**	**32**	**30**

[1] Coded wire tagged kokanee summarized in Table 7.

[2]Clip Key:

AD- 00: 2 year olds released from Sherman Creek Hatchery, Kettle Falls NP, or Little Falls Dam
01: 2 year olds released from Kettle Falls NP, Seven Bays NP, Little Falls, or
3 year olds from the previous years releases.
02: 2 year olds released from Sherman Creek Hatchery, Colville River NP, Seven Bays NP, or
3 year olds from the previous releases

ADRP 02: 2 year old Lake Whatcom fish released Fort Spokane or
3 year old Meadow Creek kokanee from Meyers Falls

ADLP 01: 2 year olds released from Sherman Creek Hatchery
02: 2 year olds releases from Little Falls or
3 year old Lake Whatcom fish from Sherman Creek

ADLVRP 02: 2 year old released from Meyers Falls

Table 7. All coded wire tagged release and capture data for kokanee collected in Lake Roosevelt, 2000-02.

Site #	62-03-34-Sherman Ck			62-03-35: Sherman Ck		62-03-37: Spokane River		62-55-29: Sherman CK		62-03-36:Spokane River	62-51-44: Sherman Ck	62-02-67- Spokane River	62-02-98- Sherman Ck	62-02-99-Sherman Ck		62-03-62: Sherman Ck		62-03-64: Sherman Ck		62-03-65: Fort Spokane BL	
Release year	**2000**			**2000**		**2000**		**2000**		**2000**	**2000**	**2001**	**2001**	**2001**		**2001**		**2001**		**2001**	
Stock	**WHAL**			**MEAD**		**MEAD**		**WHAL**		**WHAL**	**WHAL**	**WHAL**	**MEAD**	**MEAD**		**WHAL**		**WHAL**		**WHAL**	
Age	**Age 2**	**Age 3**	**Age 4**	**Age 2**	**Age 3**	**Age 2**	**Age 3**	**Age 2**	**Age 3**	**Age 2**	**Age 2**	**Age 2**	**Age 2**	**Age 2**	**Age 3**	**Age 2**	**Age 3**	**Age 2**	**Age 3**	**Age 2**	**Age 3**
Capture Year	**2000**	**2001**	**2002**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2000**	**2001**	**2001**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**
Lincoln Ck Cove						1														1	
Hawk Ck				1	1	4			1	4								1		93	5
Nine Mile Ck													1								
Gerome Bay					1					1											
Hunters																				8	
Alder																				1	
Roper													2			1		1			
Colville River	1																			1	
Sherman Ck	197	5	1	1,337	6	1		32	1	2	35		214	274	1	94	1	104	1	8	
Kettle Falls Marina																2		2			
Fenders Ck	1												3			2		1			
Nancy Ck				1									1								
Deadman Ck-Kettle River													1								
Crown Ck																				1	
McCoys Marina						6	1			4										1	
Orazada Ck						1				2		4				1				31	
Blue Ck						2				2											
Spokane River Tribal BL										1											
Spring Creek						1															
Little Falls Dam						14				11		1								1	
Sanpoil River mouth				1																1	
Total	**199**	**5**	**1**	**1,340**	**8**	**30**	**1**	**32**	**2**	**27**	**35**	**5**	**222**	**274**	**1**	**100**	**1**	**109**	**1**	**147**	**5**

Kokanee collected in 2002 were assigned ages based on the various fin clips used as well as a few coded wire tags. All two-year olds collected in 2002 were of Lake Whatcom origin, because no Meadow Creek kokanee were released. Mean lengths of two-year olds with different fin clips were not pooled in 2002 because there was a significant difference in lengths between right pectoral clipped and adipose only fish (Mann Whitney $p<0.01$). However, all other combinations were not significantly different. Two-year old kokanee ranged from 323 to 354 mm and three-year olds ranged from 453 to 470 mm in total length (Table 8).

The female to male ratio for age two kokanee was similar for all three year when all data was pooled.. Age three fish appeared to have a more normal sex ratio ranging from 1:4 to 1:1 females to males. The wild population tended to have a normal sex ratio of approximately 1:1 (Table 9).

Total number, catch-per-unit-effort (CPUE) and relative abundance of all fish species captured was summarized in Appendix B, and the number of kokanee per sample site was summarized in Appendix C.

Table 8. Total length mm (± standard deviation) at age of kokanee collected in Lake Roosevelt, 2002.

	Age				
Fin Clip	**1**	**2**	**3**	**4**	**Wild**
Ad only	80 (0) n=1	323 (40) n=325	460 (38) n=76		
Coded wire tag			453 (35) n=8	360 (0) n=1	
Right pectoral		353 (25) n=222	470 (0) n=1		
Left pectoral		354 (38) n=8	450 (10) n=3		
Lt pec/ Rt vent		324 (54) n=11			
Wild					452 (114) n=30
Grand Mean TL	**80 (0) n=1**	**335 (38) n=566**	**459 (37) n=88**	**360 (0) n=1**	**452 (114) n=30**

Clip Code:

AD only	2 year old fish released from Sherman Creek Hatchery; Colville River net pens, or Seven Bays net pens
	3 year old released from Spokane River, Seven Bays net pens, Kettle Falls net pens.
Code wire tag	3 year old coded wire tagged fish
Right pectoral	2 year old Whatcom fish released Fort Spokane or
	3 year old Meadow Creek kokanee from Meyers Falls.
Left pectoral	2 year old Whatcom Little Falls release or
	3 year old Whatcom fish from Sherman Creek
Left pec/Rt vent	2 year old released at Meyers Falls
Wild	Kokanee with adipose fin intact

Table 9. Female to male ratio using all hatchery kokanee collected with known and assigned ages, 2000-02.

	Age 2			Age 3			Wild		
Year	**Females**	**Males**	**F:M**	**Females**	**Males**	**F:M**	**Females**	**Males**	**F:M**
2000	245	2,359	1:10	2	8	1:4	17	10	2:1
2001	158	1,700	1:11	17	28	1:2	8	14	1:2
2002	49	478	1:10	46	42	1:1	12	13	1:1

Supplemental Kokanee Collection Efforts

Winter Test Fishery

During the annual kokanee test fishery in January the percent of hatchery kokanee varied between 2.2 to 18.2% of the catch over the past four years (Table 10).

Two Rivers Casino Trout Derby

Origin (hatchery or wild) was not documented during the first Two Rivers Casino Trout Derby in 2000, but 20 kokanee were captured, (0.7 kokanee/boat). During the 2001 derby, anglers captured 193 kokanee (2.4 kokanee/boat), of which 88 (46%) were hatchery fish. All coded wire tagged fish (n = 47; 53% of the hatchery fish) were two-year old Lake Whatcom fish (62-03-65), stocked at the Fort Spokane boat launch. During the 2002 derby, anglers captured 80 kokanee (0.9 kokanee/boat), of which 50 (63%) were hatchery origin. Of those, 58% (n=29) were right pectoral clipped, indicating the Fort Spokane boat launch release (Table 10; STI unpublished data). .

Volunteer Angler Diaries

Anglers recorded data in diaries supplied by WDFW from 15 June to 27 November 2001. Anglers recorded capturing 204 kokanee of which 18% (n=37) were of hatchery origin (C. Baldwin, WDFW, unpublished data). Hatchery kokanee captured by anglers were not checked for CWTs. However, one angler kept heads of which three CWTs were collected and all were three-year old Meadow Creek kokanee (62-03-35) released from Sherman Creek Hatchery (406-432 mm or 16-17 inches TL; Table 10).

EWU Supplemental Creel

On 27 June 2001 EWU performed a supplementary creel at Spring Canyon from 2:00-6:00 p.m. Weather conditions were very poor, with 20-30 mph winds and a hailstorm, yet five wild and one hatchery (17%) kokanee were observed (no coded wire tag; Table 10).

Recoveries below Grand Coulee Dam

Rock Island Dam Fish Passage Center operates between April and August and only collects kokanee over 200 mm to protect endangered Wenatchee sockeye salmon migrating past the dam. The size restriction and timing of operation limits their ability to capture Lake Roosevelt kokanee. Despite the limitations, the data they collect has value.

No Meadow Creek or Lake Whatcom stock age two fish collected at the fish passage center in 2000. Two kokanee were collected at the Rock Island Dam fish passage center during 2001. Both kokanee were Lake Whatcom stock (62-03-64), with one captured in May and one in June. Six kokanee were collected in 2002, two Fort Spokane releases (62-03-65), two Sherman Creek releases (62-03-64), and two adipose fin clipped only (Table 10).

Table 10. Number of coded wire tagged (CWT), adipose clipped, right pectoral clipped, and wild kokanee collected in the Spokane Tribe creel surveys, Lake Roosevelt Test Fishery, Two Rivers Casino Trout Derby, WDFW angler diaries, and EWU supplemental creel, 2000-02.

Event and Year	CWT	AD clipped	Right Pectoral	Wild	Unknown	Total	% hatchery
Spokane Tribe Creel[1]							
2000	0	0	--	0	0	0	0
2001	0	2	0	--	0	--	--
2002	0	18	0	11	0	29	62.0
Winter Test Fishery[1]							
2000	0	1	--	45	0	46	2.2
2001	0	9	0	58	0	67	13.4
2002	0	2	0	34	0	36	2.8
2003	0	2	0	9	0	11	18.2
Two Rivers Casino Derby							
2000 (30 boats)	--	--	--	--	20	20	--
2001 (82 boats)	54	34	0	99	6	193	45.6
2002 (85 boats)	0	21	29	30	0	80	62.3
Volunteer Anger Diaries[2]							
2001	2	37	0	167	0	204	19.1
EWU sup. Creel							
2001	0	1	0	5	0	6	16.7
Rock Island Dam							
2000	0	0	--	0	0	0	0
2001	2	0	0	0	0	0	100
2002	4	2	0	0	0	0	100

[1]Spokane Tribe (D. Pavlik, unpublished data)- - data not applicable
[2] WDFW (C. Baldwin, unpublished data)

Discussion

The purpose of testing new stocks of kokanee in Lake Roosevelt was to determine if a native stock performed better than the coastal Lake Whatcom stock that had performed poorly in the past. Meadow Creek returns as two-year olds were significantly larger compared to Lake Whatcom in both years. Age three returns of both stocks were not significantly different, but sample sizes were small. Three-year old kokanee have been the primary goal of Lake Roosevelt fisheries managers because two-year old kokanee (jacks) are only in the fishery for three months. Additionally, returning jacks are primarily males, which are not conducive for establishing a self-sustaining fishery.

Three-year old returns remained low with the native stock; however, we still recommend using Meadow Creek kokanee whenever possible. Two-year old returns indicated Meadow Creek kokanee stayed in the reservoir and returned to egg collection facilities significantly better than Lake Whatcom stock, which is progress towards a sustainable fishery. Meadow Creek kokanee are also indigenous to the upper Columbia system, and stocking them instead of coastal strains should be a priority for ecological reasons. Kokanee that entrain through Grand Coulee Dam have the potential to mix with endangered runs of sockeye salmon in Columbia River tributaries.

The Spokane Tribe of Indians is responsible for coordinating the creel surveys at Lake Roosevelt and analyzing the data. The creel surveys have been plagued with problems making some parts of the creel un-usable between 2000-02. The lack of kokanee observed in the creel prompted fisheries managers to look elsewhere for creel information, including the Two Rivers Casino Trout Derby, Winter Test Fishery, Angler Diaries, and supplemental creel.

The two Rivers Casino Trout Derby held in August revealed that age two kokanee did recruit to the creel, with 46% of the kokanee being hatchery origin in 2001 and 62% in 2002. The majority of the fish were from the Fort Spokane release. Meadow Creek kokanee were not stocked with the Lake Whatcom kokanee from the Fort Spokane boat launch, therefore stock performance could not be evaluated. However, the results indicated two-year old kokanee can recruit to the creel, and releasing kokanee from the Fort Spokane boat launch was successful.

The other supplemental creel efforts were primarily focused in the southern part of the reservoir, and indicated that the majority of the harvest were wild kokanee. The angler diaries indicated only 18% of the fish were hatchery origin (C. Baldwin, WDFW, unpublished data). A

supplemental creel indicated that 17% of the fish were hatchery origin. The test fishery varied between 2.2 and 18.2% (C. Lee, STI unpublished data). While these estimates were lower than the derby result, the fact remains that hatchery kokanee, even as two year olds, were recruiting to the fishery.

Data from the Two Rivers Casino Trout Derby suggest that kokanee possibly perform better from the Fort Spokane release site compared to Little Falls and Sherman Creek releases because they escape walleye predation (*Stizostedion vitreum*). Walleye spawn in the Spokane River below Little Falls Dam in the spring then migrate out into other areas of the reservoir (Beckman et al. 1985, Hall et al.1985, Peone et al. 1990, Griffith and Scholz 1991, McLellan et al. 1998, McLellan et al. 2002, and McLellan and Scholz 2002). A large number of walleye migrate out of the Spokane River north to the Kettle Falls area, about the same time kokanee are released from the Sherman Creek Hatchery (McLellan et al. 2002).

Predation by walleye on hatchery kokanee in Lake Roosevelt has been evaluated by the WDFW (Baldwin et al., in press). Results from the 1999 predation study indicated 15.1% (10.8-21.5% confidence interval (C.I.)) of the kokanee released from Sherman Creek were consumed within 41 days of the release. Additionally, lake wide modeling indicated that predation on kokanee was as high as 43% (21%-64%; 95% C.I.; Baldwin and Polacek 2003). In 2000, the number of kokanee lost dropped to 22,883 (16,919-31,278 C.I.), or 6.3% (4.7-8.6%) of Sherman Creek raceway and net pen releases (Baldwin et al., in press). By directly stocking kokanee from the Fort Spokane boat launch, they may be avoiding spatial and temporal overlap with walleye concentrations found in the Spokane River. Consequently, a direct release of Sherman Creek kokanee into deep water south of where the walleye congregate may also offer refuge for these fish.

Despite the new information on hatchery kokanee harvest, the planting of alternative stocks has not increased the number of three-year old returns to Sherman Creek Hatchery. The large number of returning precocial kokanee historically observed with the Lake Whatcom stock, also occurred with the Meadow Creek stock. The high rate of precocity found in Lake Roosevelt was thought in part to be associated with the productivity of the lake. Lewis (1970) found maturity of kokanee to be related to productivity in lakes, the faster they grew the sooner they matured. Lake Roosevelt is classified as oligotrophic, but in certain locations has an abundant zooplankton food source (Cichosz et al. 1998, 1999). The confluence of Spokane River and the

Columbia River had a mean annual zooplankton biomass of 6,710 µg/m^3 and Porcupine Bay had mean annual biomass of 25,498 µg/m^3 with large *Daphnia* species ranging from 0.18-3.03 mm in length (Cichosz et al. 1999). While Lake Roosevelt kokanee mature at two years of age, they were larger than older mature kokanee in other areas (Table 11).

A preliminary study comparing the precocity of Lake Whatcom and Meadow Creek kokanee found that both showed signs of sexual maturity before they left the hatcheries. Combining both stocks, 73% of the fish sampled in 2001 were precocial before stocking (C. Lee, STI, unpublished data). While phenotypic sex in salmonids is generally believed to be under genetic control, Craig et al. (1996) was able to alter the sex ratio of sockeye and kokanee salmon with warm water temperatures during embryonic development. An experimental group of eggs in Heath tray baskets were moved from ambient well water (8.3 – 9.7 ºC) to heated well water (10.4 – 12.0 ºC) for approximately 1 month and then moved back to ambient water. Sex ratios of the experimental group ranged from 61.8 to 83.9% females, with the control groups maintaining a 1:1 sex ratio (Craig et al. 1996). They determined that the sex was irreversibly determined during some common point during early development and sex in kokanee and sockeye salmon is thermolabile (Craig et al. 1996).

The Spokane Tribe of Indians are currently investigating precocity by hatchery kokanee raised in the Spokane Tribal Hatchery compared to WDFW Ford Hatchery who raise their fish with cooler spring water. Preliminary results showed no early maturity in the fish sampled at the Ford Hatchery (n = 237; C. Lee, STI unpublished data). These results indicated that at some point during early develop at the Spokane Tribal Hatchery water temperatures could be playing a role with the early maturity of hatchery kokanee.

In addition to the hatchery kokanee, Lake Roosevelt has a unique wild kokanee population. The majority of kokanee caught by anglers appear to be of wild origin (see results section). The wild kokanee grow to large sizes in Lake Roosevelt, up to 533 mm in length (21 inches) and 1,589 grams in weight (3.5 lbs.; STI, unpublished data). Little is known about life history of the wild fish, such as when and where they migrate into Lake Roosevelt, or if, when, or where they spawn. Preliminary microsatellite DNA analysis indicated that the wild kokanee are related to an up river (Canada) stock of fish (Richard LeCaire, Colville Tribe of Indians, personal communication). Mimicking the wild kokanee recruitment may provide the best opportunity to improve the current hatchery kokanee program.

Table 11. Comparison of spawning kokanee total lengths (mm) at age two and age three for selected lakes and reservoirs.

Location	Year	Age 2	Age 3	Citation
Lake Roosevelt, WA (WHAL)	2002	335	448	Current study
Lake Roosevelt, WA (MEAD)	2002	--	445	Current study
Lake Roosevelt, WA (WHAL)	2001	279	438	McLellan and Scholz 2002
Lake Roosevelt, WA (MEAD)	2001	298	443	McLellan and Scholz 2002
Lake Roosevelt, WA (WHAL)	2000	279	--	McLellan and Scholz 2001
Lake Roosevelt, WA (MEAD)	2000	271	--	McLellan and Scholz 2001
Harvey Ck, Sullivan Lk, WA	2002		288	McLellan 2003
Dworshak Reservoir, ID	1999	219-336	--	Maiolie et al. 2001
Dworshak Reservoir, ID	1988	261	310	Rieman and Myers 1992
Flathead Lake, MT	1996	269-405	--	Hansen et al. 1996
Redfish Lake, ID	1990	150	190	Rieman and Myers 1992
Coeur d' Alene Lake, ID	1985	192	225	Rieman and Myers 1992
Coeur d' Alene Lake, ID	1983	182	220	Rieman and Myers 1992
Spirit Lake, ID	1988	240	270	Rieman and Myers 1992
Pend Oreille Lake, ID	1988	205	242	Rieman and Myers 1992
Priest Lake, ID	1985	245	290	Rieman and Myers 1992

WHAL = Lake Whatcom stock
MEAD = Meadow Creek stock

Recommendations

Hatchery Managers

1. Use Meadow Creek, British Columbia stock or another kokanee native to the upper Columbia River whenever possible instead of the coastal Lake Whatcom stock.
2. Experiment with reducing precocity with temperature and feed manipulations at the Spokane Tribal Hatchery.

Stocking Strategies for 2003

1. Release kokanee post-smolts at the Fort Spokane boat launch to provide a put-and-take fishery. A distinguishing mark is necessary to evaluate performance through the creel and trout derby.
2. Release kokanee post-smolts from Meyers Falls with a distinguishing mark. This could potentially serve as an egg collection site.
3. Release kokanee near Bradbury Beach mid-water and from the Sherman Creek Hatchery to determine if a mid-water release south of the hatchery in deep water increases survival by avoiding heavy walleye predation.

Future Research

1. Improve the creel survey to include kokanee harvest.
2. Determine if Meyers Falls is conducive as an egg collection site, focusing on determining limiting factors such as temperature, flow, and habitat.
3. Determine the life history of the wild kokanee in Lake Roosevelt including: origin (natural reproduction in Lake Roosevelt, or entrainment), size, age, and time of entrainment at various upper reservoir locations.
4. Continue DNA analysis to determine if Lake Roosevelt has a distinct kokanee population.

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Appendix A- Kokanee Stocking Records, 2000-2002

Table 12. Summary of Lake Whatcom (WHAL) and Meadow Creek (MEAD) kokanee stocked into Lake Roosevelt from Sherman Creek Hatchery, Kettle Falls net pens, Spokane River (Little Falls Dam), Fort Spokane boat launch, Seven Bays net pens, and the Colville River, and Meyers Falls, 2000-02.

Date	Spc:Stk:BY:BO	Release Location	Run Time	Kokanee Released	Release fish/lb.	Total Length (mm)	CWT Code
2000 LAKE ROOSEVELT PLANTS							
06/28/2000	KO:WHAL:98:H	Sherman Creek	early	94,518	9.6	168	62-23-34
06/28/2000	KO:MEAD:98:W	Sherman Creek		105,432	9.6	168	62-03-35
07/25/2000	KO:WHAL:98:H*	Sherman Creek	middle	5,829	8.9	173	62-55-29
07/25/2000	KO:WHAL:98:H*	Sherman Creek	middle	3,557	8.9	173	62-51-44
07/25/2000	KO:WHAL:98:H	Sherman Creek	middle	72,602	8.9	173	AD CLIPPED
06/14/2000	KO:WHAL:98:H	Kettle Falls NP	middle	197,975	19.6	133	AD CLIPPED
06/28/2000	KO:WHAL:98:H	Sherman Creek	middle	95,680	9.6	168	AD CLIPPED
6/20-29/00	KO:WHAL:98:H	Spokane River	early	51,075	10	167	62-03-36
6/20-29/00	KO:MEAD:98:W	Spokane River	middle	55,675	10	167	62-03-37
06/12/2000	KO:WHAL:98:H	Spokane River	middle	15,770	14	150	AD CLIPPED
05/19/2000	KO:WHAL:98:H	Spokane River	middle	41,600	18	137	AD CLIPPED
05/30/2000	KO:WHAL:98:H	Spokane River	middle	21,600	3.5	237	AD CLIPPED
06/12/2000	KO:WHAL:98:H	Spokane River	middle	30,000	15	146	AD CLIPPED
TOTAL				**791,313**			
2001 LAKE ROOSEVELT PLANTS							
04/25/2001	KO:WHAL:99:H	Spokane River	middle	46,560	16	143	AD CLIPPED
05/14/2001	KO:MEAD:99:W	Meyers Falls		21,648	7	188	AD RIGHT PEC
06/01/2001	KO:MEAD:99:W	Spokane River		24,533	7	188	62-03-67
06/06/2001	KO:MEAD:99:W	Spokane River		27,875	7	188	62-03-67
6/11&12/2001	KO:WHAL:99:H	Fort Spokane BL	middle	57,477	8	180	62-03-65
06/04/2001	KO:MEAD:99:W	Seven Bays NP		98,217	11.5	159	AD CLIPPED
05/27/2001	KO:MEAD:99:W	Kettle Falls NP		334,324	18	137	AD CLIPPED
06/25/2001	KO:MEAD:99:W	Kettle Falls NP		49,699	18	137	AD CLIPPED
06/25/2001	KO:MEAD:99:W	Sherman Creek		62,928	7.6	184	62-02-98
06/25/2001	KO:MEAD:99:W	Sherman Creek		39,065	10	167	62-02-99
06/25/2001	KO:WHAL:99:H	Sherman Creek	middle	35,251	7.6	184	62-03-64
06/25/2001	KO:WHAL:99:H	Sherman Creek	middle	26,037	10	167	62-03-64
06/25/2001	KO:WHAL:99:H	Sherman Creek	middle	52,062	10	167	62-03-62
06/25/2001	KO:WHAL:99:H	Sherman Creek	middle	92,558	7	188	AD LEFT PEC
TOTAL				**968,234**			
2002 LAKE ROOSEVELT PLANTS							
05/15/2002	KO:WHAL:00:H	Fort Spokane		12,448	8	180	AD RIGHT PEC
05/15/2002	KO:WHAL:00:H	Fort Spokane		12,280	8	180	AD RIGHT PEC
05/16/2002	KO:WHAL:00:H	Little Falls Dam		12,456	8	180	AD LEFT PEC
05/16/2002	KO:WHAL:00:H	Little Falls Dam		12,656	8	180	AD LEFT PEC
05/29/2002	KO:WHAL:00:H	Meyers Falls		17,000	8	180	AD RIGHT VENT LEFT PEC
05/26/2002	KO:WHAL:00:H	Colville River NP		247,484	18	137	AD CLIPPED
05/18/2002	KO:WHAL:00:H	Seven Bays NP		109584	16	143	AD CLIPPED
06/26/2002	KO:WHAL:00:H	Sherman Creek		230038	10	167	AD CLIPPED
TOTAL				**653,946**			

Appendix B- Fish species collected in the fall, 2000-02.

Table 13. Summary of the total number of fish collected (n), relative abundance (R.A.), catch-per-unit-effort (CPUE), and size range (mm) of the fish collected by EWU via boat electrofishing at Lake Roosevelt between 17 August and 17 November 2000 (effort = 71.2 hours).

Family	Species	n	R.A. %	CPUE (fish/hr)	Size range
Cyprinidae	Chiselmouth	1	0.02	0.01	113
	Carp	35	0.68	0.49	42-747
	Peamouth	5	0.1	0.07	60-138
	Northern pikeminnow	61	1.18	0.86	33-599
	Longnose dace	1	0.02	0.01	35
	Speckled dace	1	0.02	0.01	
	Redside shiner	29	0.56	0.41	41-79
	Tench	7	0.14	0.1	148-470
Catostomidae	Longnose sucker	8	0.15	0.11	80-437
	Bridgelip sucker	7	0.14	0.1	191-360
	Largescale sucker	397	7.69	5.58	43-682
Ictaluridae	Yellow bullhead	1	0.02	0.01	180
Salmonidae	Cutthroat	1	0.02	0.01	411
	Lake Whitefish	4	0.08	0.06	493-523
	Rainbow trout	502	9.72	7.05	30-588
	Kokanee	2807	54.35	39.42	167-562
	Chinook	6	0.12	0.08	425-752
	Mountain whitefish	27	0.52	0.38	109-418
	Brown trout	31	0.6	0.44	113-567
	Bull trout	2	0.04	0.03	417-800
	Bull trout/E. brook hybrid	1	0.02	0.01	383
	Eastern brook trout	47	0.91	0.66	73-409
Gadidae	Burbot	37	0.72	0.52	95-601
Cottidae	Sculpin spp.	107	2.07	1.5	18-143
Centrarchidae	Pumpkinseed	3	0.06	0.04	93-103
	Smallmouth bass	187	3.62	2.63	24-297
	Largemouth bass	26	0.5	0.37	33-380
	Black crappie	41	0.79	0.58	36-206
Percidae	Yellow perch	478	9.25	6.71	49-210
	Walleye	178	3.45	2.5	66-536
Grand Total		**5,165**	**100**	**72.54**	

Table 14. Summary of the total number of fish collected (n), relative abundance (R.A.), catch-per-unit-effort (CPUE), and size range (mm) of the fish collected by EWU via boat electrofishing at Lake Roosevelt between 15 August and 20 November 2001 (effort = 64.35 hours).

Family	Species	n	RA %	CPUE (fish/hr)	Size range
Cyprinidae	Carp	80	1.6	1.24	32-815
	Peamouth	2	0.04	0.03	130-284
	Northern pikeminnow	63	1.26	0.98	38-600
	Speckled dace	1	0.02	0.02	50
	Redside shiner	2	0.04	0.03	104-109
Catostomidae	Longnose sucker	4	0.08	0.06	161-431
	Bridgelip sucker	4	0.08	0.06	75-512
	Largescale sucker	483	9.65	7.51	29-635
Ictaluridae	Yellow bullhead	1	0.02	0.02	123
Salmonidae	Cutthroat (westslope)	1	0.02	0.02	232
	Lake Whitefish	5	0.1	0.08	172-585
	Rainbow trout	326	6.51	5.07	47-547
	Kokanee	2126	42.47	33.04	89-600
	Chinook	1	0.02	0.02	645
	Mountain whitefish	17	0.34	0.26	99-349
	Brown trout	18	0.36	0.28	95-676
	Bull trout	1	0.02	0.02	512
	Eastern brook trout	59	1.18	0.92	73-430
Gadidae	Burbot	13	0.26	0.2	96-602
Cottidae	Sculpin spp.	112	2.24	1.74	30-138
Centrarchidae	Smallmouth bass	527	10.53	8.19	38-365
	Largemouth bass	17	0.34	0.26	57-422
	Black crappie	242	4.83	3.76	37-251
Percidae	Yellow perch	789	15.76	12.26	39-197
	Walleye	112	2.24	1.74	70-485
Grand Total		**5,006**	**100**	**77.79**	

Table 15. Summary of the total number of fish collected (n), relative abundance (R.A.), catch-per-unit-effort (CPUE), and size range (mm) of the fish collected by EWU via boat electrofishing and drift boat electrofishing at Lake Roosevelt 20 August and 13 November 2002 (effort = 48.81 hours).

Family	Species	n	R.A. %	CPUE (fish/hr)	Size range
Cyprinidae	Chiselmouth	1	0.04	0.02	45
	Carp	62	2.22	1.27	46-851
	Peamouth	7	0.25	0.14	50-145
	Northern pikeminnow	49	1.75	1.00	22-610
	Longnose dace	1	0.04	0.02	46
	Speckled dace	1	0.04	0.02	43
	Redside shiner	26	0.93	0.53	65-70
	Tench	4	0.14	0.08	120-449
Catostomidae	Longnose sucker	1	0.04	0.02	523
	Bridgelip sucker	10	0.36	0.20	46-400
	Largescale sucker	239	8.54	4.90	20-598
Salmonidae	Cutthroat	1	0.04	0.02	235
	Lake Whitefish	1	0.04	0.02	221
	Rainbow trout	219	7.83	4.49	57-590
	Kokanee	691	24.70	14.16	76-589
	Chinook	5	0.18	0.10	326-777
	Mountain whitefish	40	1.43	0.82	95-415
	Brown trout	73	2.61	1.50	200-620
	Bull trout	1	0.04	0.02	291
	Eastern brook trout	37	1.32	0.76	117-376
Gadidae	Burbot	14	0.50	0.29	200-620
Cottidae	Sculpin spp.	49	1.75	1.00	29-107
Centrarchidae	Pumpkinseed	3	0.11	0.06	69-92
	Smallmouth bass	374	13.37	7.66	41-393
	Largemouth bass	20	0.71	0.41	45-219
	Black crappie	59	2.11	1.21	42-280
Percidae	Yellow perch	687	24.55	14.07	40-232
	Walleye	123	4.40	2.52	66-650
		2,798	**100.00**	**57.32**	

Appendix C – Number of kokanee collected per site, 2000-02.

Table 16. Kokanee collected per site sampled during 2000. AD- = fin clipped only, AD+ = fin clipped and coded wire tag, NO- = no clips or coded wire tag (wild fish). BP = backpack shocked.

Location	Site Number	Days Fished	Effort (min)	AD-	AD+	NO-	Total
Grand Coulee							
Crescent Bay	E1	5	46				0
Eden Harbor	E2	5	40				0
Spring Canyon	E3	5	56				0
Qui Qui Creek	E4	5	39				0
Swawilla Basin	E5	5	41				0
Cayuse Bay	E6	5	50				0
Wynhoff Cove	E7	5	30				0
Coffman Canyon	E8	5	35				0
Keller Ferry							
Bay at RM 14 (Flats)	E11	1	10				0
Keller Boat Launch Bay	55	1	8				0
Covington Cove	E13	1	10				0
Hellgate Canyon	70	2	15				0
Penix Canyon	E14	5	43				0
Spiegel Canyon	E15	5	38				0
Whitestone Creek	E16	5	38				0
Burbot Creek	E17	5	43				0
Sanpoil							
Manila Creek	SP14	3	25				0
John Tom Creek	SPE3	3	23				0
Silver Creek	SPE4	1	10				0
Sanpoil River Mouth	SPE5	4	80		1	5	6
Hawk Creek/Seven Bays							
Lundstrom Bay	E18	4	30				0
Moonshine Bay	E19	4	33				0
Halverson Canyon	E20	4	33				0
Sterling Point Creek A	E21	4	28				0
Sterling Point Creek B	E22	4	33				0
Lincoln Creek Cove	E23	5	53		1		1
Hawk Creek	HE2	6	290	7	11	13	31
Sunday Bay	E24	5	43				0
George Creek	E25	5	45				0
Friday Bay	E26	4	30				0
Fort Spokane							
Spokane River	S2/S4	4	29				0
Columbia River	137	4	28				0
Louie Creek	E28	4	30				0
Abraham Creek	E29	4	31				0
Denison Canyon	E31	4	31				0
Three mile Creek	E30	4	48				0
Castle Rock Creek	E33	4	41				0
Six Mile Creek	E34	4	50				0
Nine Mile Creek	E35	4	40				0
Hunters							
Wilmont Cove	E36	4	60	1	1		2
Gerome Bay	E37	4	40		1	1	2
Alder Creek	E39	4	50	1			1
Managhan Creek	E40	4	22				0
Hunters Creek	E41	4	50	3		1	4
Falls Creek	E42	4	38				0
Nez Perce Creek	E43	4	58				0
Gifford							

Table 16 continued

Location	Site Number	Days Fished	Effort (min)	AD-	AD+	NO-	Total
Cloverleaf	E46	5	45				0
East Strange Creek	E47	5	50		1	1	2
West Stranger Creek	E44/E45	5	55				0
Hall Creek	E48	5	62	2		1	3
Bradbury Beach							
Cheweka Creek	281	5	32				0
Barnaby Creek	282	5	43				0
Quilisacut Creek	289	5	30				0
La Fleur Creek	294	5	26			1	1
Martin Creek	302	5	23				0
Roper Creek	E49	5	74		1		1
Rickey Creek	E50	5	43				0
Kettle Falls							
Colville River	E51	9	190	1	2		3
Sherman Creek Cove	E52	10	297	996	1,568	1	2,565
Sherman Creek (BP)	Creek	4	41	37	56		93
Kettle Marina	E53	5	45	1			1
Across Kettle Marina	E54	5	45				0
Fenders Creek	E55	5	50	2	3		5
Nancy Creek	E56	5	48		2		2
Napoleon Bridge	K16	5	65				0
Deadman Creek	K8	5	52				0
Kettle Bridge	K1/K3	5	55				0
Evans/China Bend							
15-mile Creek	E60	5	30			1	1
Flat Creek	E61	5	45				0
Crow Creek	406	5	45	2		5	7
Rattlesnake Creek	408	5	40				0
Porcupine Bay							
McCoy Springs	SE2	5	38.3	5	10		15
Orazada Creek	SE3	4	38.3	1	3	1	5
Hollies Creeks	SE4	5	43				0
Sand Creek	SE5	5	40				0
Porcupine Creek	S37	5	32				0
Blue Creek	SE7	5	60	2	4		6
Pitney Creek	SE8	5	35				0
Springs	S57	5	46.7		1		1
Cayuse Cove	SE10	5	55				0
Harker Canyon	SE11	5	56.7				0
Mill Canyon	SE12	5	45				0
Little Falls							
South pumphouse	S86	5	45				0
Boat Launch	S88	5	50.5		1		1
Above Spring Creek	S93	1	20				0
Spring Creek	SE13	5	70				0
Powerhouse	S94	5	65	3	19		22
Spillway	SE14	5	100	6	6		12
Grand Total			**4,316**	**1,066**	**1,692**	**31**	**2,789**

Table 17. Kokanee collected per site sampled during 2001. AD- = fin clipped only, AD+ = fin clipped and coded wire tag, ADLP- = adipose and left pectoral fin clip, ADRP- = adipose and right pectoral fin clip, and NO- = no clips (wild fish).

Location	Site Number	Days Fished	Effort (min)	AD-	AD+	ADLP-	ADRP-	NO-	Total
Grand Coulee									
Crescent Bay	E1	4	35						0
Eden Harbor	E2	4	40	3					3
Spring Canyon	E3	4	45	1					1
Qui Qui Creek	E4	4	40						0
Swawilla Basin	E5	4	33						0
Cayuse Bay	E6	4	46						0
Wynhoff Cove	E7	4	40						0
Coffman Canyon	E8	4	33						0
Keller Ferry									
Bay at RM 14 (Flats)	E11	3	24						0
Keller Boat Launch Bay	55	5	34						0
Covington Cove	E13	5	45						0
Hellgate Canyon	70	4	41						0
Penix Canyon	E14	4	45						0
Spiegel Canyon	E15	4	39						0
Whitestone Creek	E16	4	45	2					2
Burbot Creek	E17	4	46	3					3
Sanpoil									
Manila Creek	SP14	4	40						0
John Tom Creek	SPE3	4	28						0
Silver Creek	SPE4	4	38						0
Sanpoil River Mouth	SPE5	4	43	1	1			2	4
Hawk Creek/Seven Bays									
Lundstrom Bay	E18	4	43						0
Moonshine Bay	E19	4	42						0
Halverson Canyon	E20	4	36	3					3
Sterling Point Creek A	E21	4	35						0
Sterling Point Creek B	E22	4	40	1					1
Lincoln Creek Cove	E23	4	49	20	1				21
Hawk Creek	HE2	6	75	118	97	2		8	223
Hawk Creek (backpack)	HE2	2	32	219	5				224
Sunday Bay	E24	4	40						0
George Creek	E25	4	40						0
Friday Bay	E26	4	40						0
Fort Spokane									
Spokane River	S2/S4	3	28						0
Columbia River	137	4	32						0
Louie Creek	E28	4	33						0
Abraham Creek	E29	4	37						0
Denison Canyon	E31	4	28						0
Three mile Creek	E30	4	40						0
Castle Rock Creek	E33	4	40						0
Six Mile Creek	E34	4	38						0
Nine Mile Creek	E35	4	40	2	1				3
Hunters									
Wilmont Cove	E36	4	60	1					1
Gerome Bay	E37	4	41	16	2			1	19
Alder Creek	E39	4	40		1				1

Table 17 Continued

Location	Site Number	Days Fished	Effort (min)	AD-	AD+	ADLP-	ADRP-	NO-	Total
Managhan Creek	E40	4	28						0
Hunters Creek	E41	4	40	2	8				10
Falls Creek	E42	4	40						0
Nez Perce Creek	E43	3	32	2					2
Gifford									
Cloverleaf	E46	4	27						0
East Strange Creek	E47	4	35						0
West Stranger Creek	E44/E45	4	40	2					2
Hall Creek	E48	4	50	6					6
Bradbury Beach									
Cheweka Creek	281	4	32	2				1	3
Barnaby Creek	282	4	35			1			1
Quilisacut Creek	289	4	33						0
La Fleur Creek	294	4	33				1		1
Martin Creek	302	4	35						0
Roper Creek	E49	4	44	8	4	2		1	15
Rickey Creek	E50	4	37						0
Kettle Falls									
Colville River	E51	10	154	26	3	1	13	2	45
Sherman Creek Cove	E52	20	237	314	711	236	15	4	1,280
Sherman Creek (BP)	Creek	4	38	24		70			94
Kettle Marina	E53	5	75	8	4	1	1	2	16
Across Kettle Marina	E54	4	40	1					1
Fenders Creek	E55	4	39	7	6			2	15
Nancy Creek	E56	4	38	1	2		1		4
Napoleon Bridge	K16	4	50						0
Deadman Creek	K8	4	40	2	1				3
Kettle Bridge	K1/K3	4	40						0
Evans/China Bend									
15-mile Creek	E60	4	35						0
Flat Creek	E61	4	40	1				2	3
Crow Creek	406	4	43		1	1		1	3
Rattlesnake Creek	408	4	37	1					1
Porcupine Bay									
McCoy Springs	SE2	6	50	9	2			2	13
Orazada Creek	SE3	3	30	53	36			4	93
Hollies Creeks	SE4	5	40						0
Sand Creek	SE5	4	30						0
Porcupine Creek	S37	4	30						0
Blue Creek	SE7	4	40						0
Pitney Creek	SE8	4	25	1					1
Springs	S57	4	40						0
Cayuse Cove	SE10	4	35						0
Harker Canyon	SE11	4	40						0
Mill Canyon	SE12	4	30						0
Little Falls									
South Pumphouse	S86	3	30						0
Boat Launch	S88	5	48	1					1
Spring Creek	SE13	4	65						0
Powerhouse	S94	3	45	1	1				2
Spillway	SE14	3	80	1	1				2
Grand Total			**3,816**	**863**	**886**	**314**	**31**	**32**	**2,126**

Table 18. Kokanee collected per site sampled during 2002. AD- = fin clipped only, AD+ = fin clipped and coded wire tag, ADLP- = adipose and left pectoral fin clip, ADRP- = adipose and right pectoral fin clip, and NO- = no clips (wild fish).

Location	Site Number	Days Fished	Effort (min)	AD-	AD+	ADLP-	ADRP-	ADRV-	ADLPRV-	NO-	Total
Grand Coulee											
Crescent Bay	E1	3	30								
Eden Harbor	E2	3	30								
Spring Canyon	E3	2	20								
Qui Qui Creek	E4	3	30				1				1
Swawilla Basin	E5	3	25								
Cayuse Bay	E6	3	23								
Wynhoff Cove	E7	3	25								
Coffman Canyon	E8	3	20								
Keller Ferry											
Covington Cove	E13	3	23				1				1
Hellgate Canyon	70	3	26								
Penix Canyon	E14	3	30								
Spiegel Canyon	E15	3	30								
Whitestone Creek	E16	3	26	1			3				4
Burbot Creek	E17	3	30	1		1	3				5
Sanpoil											
Manila Creek	SP14	3	18								
John Tom Creek	SPE3	3	18								
Silver Creek	SPE4	2	8								
Sanpoil River Mouth	SPE5	3	53	1						2	3
Hawk Creek/Seven Bays											
Lundstrom Bay	E18	3	23								
Moonshine Bay	E19	3	20								
Halverson Canyon	E20	3	23								
Sterling Point Creek A	E21	3	25								
Sterling Point Creek B	E22	3	25								
Lincoln Creek Cove	E23	3	30				1				1
Hawk Creek	HE2	4	73	81	6	7	195		3	6	298
Sunday Bay	E24	3	30								
George Creek	E25	3	23								
Friday Bay	E26	3	28								
Fort Spokane											
Spokane River	S2/S4	3	25								
Columbia River	137	3	21								
Louie Creek	E28	3	22								
Abraham Creek	E29	3	27								
Denison Canyon	E31	3	23								
Three mile Creek	E30	3	42								
Castle Rock Creek	E33	3	35								
Six Mile Creek	E34	3	30								
Nine Mile Creek	E35	3	30								
Hunters											
Wilmont Cove	E36	3	38.5								
Gerome Bay	E37	3	30	2			5				7
Alder Creek	E39	3	37.5	9							9
Managhan Creek	E40	3	15	3							3
Hunters Creek	E41	3	30								
Falls Creek	E42	3	23	3							3
Nez Perce Creek	E43	3	30	7						1	8

Table 18 continued

Location	Site	Days	Effort	AD-	AD+	ADLP-	ADRP-	ADRV-	ADLPRV-	NO-	Total
Gifford											
Cloverleaf	E46	3	18								
East Strange Creek	E47	3	30								
West Stranger Creek	E44/E45	3	22	1							1
Hall Creek	E48	3	30								
Bradbury Beach											
Cheweka Creek	281	3	15								
Barnaby Creek	282	3	28	1							1
Quilisacut Creek	289	3	18								
La Fleur Creek	294	3	15								
Martin Creek	302	3	15								
Roper Creek	E49	3	37								
Rickey Creek	E50	3	27								
Kettle Falls											
Meyers Falls	MF	3	21.06	12			2		5	2	21
Colville River	E51	6	96	6						2	8
Sherman Creek Cove	E52	11	308.45	263	3	2	3	1	3	3	278
Kettle Marina	E53	3	35								
Across Kettle Marina	E54	3	28								
Fenders Creek	E55	3	26							2	2
Nancy Creek	E56	3	28								
Napoleon Bridge	K16	3	28								
Deadman Creek	K8	3	28								
Kettle Bridge	K1/K3	3	30								
Evans/China Bend											
15-mile Creek	E60	3	23								
Flat Creek	E61	3	30								
Crow Creek	406	3	28	1						2	3
Rattlesnake Creek	408	3	25								
Porcupine Bay											
McCoy Springs	SE2	3	30								
Orazada Creek	SE3	3	28								
Hollies Creeks	SE4	3	28								
Sand Creek	SE5	3	20								
Porcupine Creek	S37	3	23								
Blue Creek	SE7	3	30								
Pitney Creek	SE8	3	23								
Springs	S57	3	28								
Narrows Springs	SE9	3	20								
Cayuse Cove	SE10	3	27								
Harker Canyon	SE11	3	30								
Mill Canyon	SE12	3	28								
Little Falls											
Pumphouse	S86	3	28								
Boat Launch	S88	3	28								
Spring Creek	SE13	3	40	10		1	12			8	31
Powerhouse	S94	3	35								
Spillway	SE14	3	80				1			2	3
Grand Total			2739.51	402	9	11	227	1	11	30	691

Appendix D – Summary of kokanee collected by other agencies, 2000-01.

Table 19. Summary of kokanee collected by the Spokane Tribe, Colville Tribe, and Washington Department of Fish and Wildlife (WDFW) during 2000 and 2001.

	AD+	AD-	ADRP-	NO-	Unknown	Total
2000						
Spokane Tribe (EF and GN)	13	12	--	31	0	56
Spokane Tribe Creel	0	0	--	0	0	0
Colville Tribe (EF)	2	0	--	2	0	4
WDFW (GN)	21	30[1]	--	45	1	97
2001						
Spokane Tribe (EF and GN)	?	?	?	?	?	?
Spokane Tribe Creel	0	2	0	?	0	?
Colville Tribe (EF)	6	86[2]	0	18	0	107
WDFW (GN)	8	25	2	18	2	55

[1]22 hatchery kokanee were not checked for coded wire tags
[2]18 hatchery kokanee were not checked for coded wire tags