**Contributions to Fisheries Management in Eastern Washington State**
**Number 7, July 2004**

# Open water release strategies for kokanee in Lake Roosevelt, 2003

Prepared by:

Holly J. McLellan and Allan T. Scholz

Eastern Washington University
Fisheries Research Center
Department of Biology
Cheney, Washington 99004

And

Jason G. McLellan

Washington Department of Fish and Wildlife
8702 N. Division Street
Spokane, Washington 99218

Final Report Submitted to:
Spokane Tribe of Indians
PO Box 480
Wellpinit, WA 99040

BPA Project Number 1994-043-00
BPA Contract Number 00014804

## Abstract

Hatchery kokanee success on Lake Roosevelt is limited by low adult returns as a result of predation, early maturity, and sex ratios skewed towards males. Historically, kokanee have been released in areas dense with walleye, mainly below Little Falls Dam on the Spokane River and Sherman Creek Hatchery near Kettle Falls. We hypothesized adult kokanee returns would increase if kokanee were released at locations with lower walleye densities. Hatchery post-smolts were released at two boat launches (Fort Spokane and Gifford) that offered immediate refuge to deep water with large pelagic areas. The Fort Spokane release was compared to the Little Falls Dam release and the Gifford release was compared to the Sherman Creek release. The two direct release methods were also compared to each other.

Significantly more Fort Spokane released kokanee were recovered in the Spokane River and in all tributaries combined compared to kokanee released at Little Falls in both 2002 and 2003. Releasing kokanee at the Fort Spokane boat launch likely spatially isolated kokanee from walleye in the Spokane River. This release strategy did not provide a specific site for adults to return to; however, adults were easily captured at a few large tributaries near the release site. This release strategy was highly successful due to the increase in adults captured, as well as an increase in angler harvest, as indicated by the large numbers captured in the Two Rivers Casino Trout Derby.

There was no significant difference in the number of kokanee that were recovered at Sherman Creek between the Gifford and Sherman Creek releases. However, significantly more Gifford fish were captured reservoir wide. Moving kokanee below the high walleye density areas did not improve kokanee adult recoveries at Sherman Creek, but did increase overall numbers in the reservoir. Survival of Gifford fish may have been improved by spatial isolation from walleye, but homing was compromised.

In addition to the above studies, Meyer's Falls was evaluated as a new release location on the Colville River. The positive return results (0.40%) supported an increase in the number of fish stocked and future evaluation.

# Table of Contents

**ABSTRACT** ..... **2**

**TABLE OF CONTENTS** ..... **3**

**LIST OF TABLES** ..... **4**

**LIST OF FIGURES** ..... **5**

**INTRODUCTION** ..... **6**

**METHODS** ..... **8**

DESCRIPTION OF THE STUDY AREA ..... 8
KOKANEE PRE- AND POST-RELEASE ..... 10
EXPERIMENTAL DESIGN FOR RELEASE GROUPS ..... 11
SAMPLING PROCEDURES ..... 11
SUPPLEMENTAL EFFORTS ..... 12

**RESULTS** ..... **13**

KOKANEE BIOLOGICAL DATA ..... 13
EXPERIMENTAL RESULTS ..... 13
*Little Falls vs. Fort Spokane* ..... *13*
*Sherman Creek Hatchery vs. Gifford* ..... *14*
*Gifford vs. Fort Spokane* ..... *14*
*Meyer's Fall Evaluation* ..... *14*
SUPPLEMENTAL KOKANEE COLLECTION EFFORTS ..... 18
*LRFEP* ..... *18*
*Winter Test Fishery* ..... *18*
*Two Rivers Casino Trout Derby* ..... *18*
*Volunteer Angler Diaries* ..... *18*
*EWU Supplemental Creel* ..... *19*

**DISCUSSION** ..... **21**

**RECOMMENDATIONS** ..... **23**

FUTURE STOCKING STRATEGIES ..... 23
FUTURE RESEARCH ..... 23

**ACKNOWLEDGEMENTS** ..... **24**

**LITERATURE CITED** ..... **25**

**APPENDIX A- KOKANEE STOCKING RECORDS, 2001-2003** ..... **28**

**APPENDIX B- FISH SPECIES COLLECTED IN THE FALL, 2002-03.** ..... **29**

## List of Tables

Table 1. Number and fin clip of kokanee released for each experiment ..... 10

Table 2. Number of kokanee captured from Little Falls and Fort Spokane releases in 2002 and all site in 2003. ..... 15

Table 3. Number (%) and chi-square test results for kokanee released from the Fort Spokane boat launch compared to fish released below Little Falls Dam collected in the reservoir and in the Spokane River, 2002 and 2003. ..... 16

Table 4. Number (%) and chi-square test results for kokanee released from the Gifford boat launch compared to fish released at Sherman Creek Hatchery collected in the reservoir and at Sherman Creek in 2003. Number of kokanee collected in the reservoir and chi-square results for kokanee released from Fort Spokane and Gifford. ..... 16

Table 5. Number (%) and chi-square test results for Meyers Falls released kokanee compared to Little Falls and Sherman Creek released kokanee recovered in the reservoir. As well as test results for kokanee released and collected at Meyers Fallscompared to kokanee released and collected at Little Falls and Sherman Creek. ..... 16

Table 6. Number of hatchery and wild kokanee collected for supplemental analysis through the Lake Roosevelt Fisheries Evaluation Program creel, Lake Roosevelt Test Fishery, Two Rivers Casino Trout Derby, WDFW angler diaries, and EWU supplemental creel, 2000-03. Note: Gifford and Meyers Falls releases only relevant in 2002-03. ..... 20

Table 7. Summary of kokanee stocked into Lake Roosevelt at Sherman Creek Hatchery, Kettle Falls net pens, Spokane River (Little Falls Dam), Fort Spokane boat launch, Seven Bays net pens, the Colville River net pens, and Meyers Falls, 2000-03. ..... 28

Table 8. 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). ..... 29

Table 9. Number of fish collected (n), relative abundance (R.A.), catch-per-unit-effort (CPUE), and size range (mm) of the fish collected via boat and drift boat electrofishing and at Lake Roosevelt 3 September to 4 November 2003 (effort = 13.09 hours). ..... 30

Table 10. Gillnetting data from Sherman Creek during 6 net nights, 2003. ..... 30

# List of Figures

Figure 1. Map of Franklin D Roosevelt Lake including kokanee hatcheries, direct release locations, and net pen release sites. ..... 9

Figure 2. Length frequency of female and male hatchery kokanee captured in Lake Roosevelt, 2002 (n= 108 females and 538 males) and 2003 (n = 240 female and 1,879 males). ..... 17

## Introduction

Kokanee salmon (*Oncorhynchus nerka kennerlyi*), the freshwater form of sockeye salmon, represent a major fishery in the Pacific Northwest (Rieman and Myers 1992, Modde et al. 1997, Taylor et al. 2000). Introduced kokanee stocks have developed self-sustaining populations (Martinez and Wiltzuis 1995), while others require annual hatchery supplementation (Wydoski and Bennett 1981, Rieman and Myers 1992). Kokanee are a pelagic, schooling fish that forage primarily on large zooplankton (Rieman and Maiolie 1995). Kokanee growth and maturity are density dependent and driven by the productivity of the rearing environment (Lewis, 1970, Rieman and Meyers 1992, Rieman and Maiolie 1995). In general, kokanee exhibit a 1:1 sex ratio, and mature between ages 3 and 4 (Gipson and Hubert 1993, Fraley 1984, Cochnauer 1984, Beauchamp et al. 1995).

Lake Whatcom kokanee salmon have been stocked in Lake Roosevelt since 1988 as partial mitigation for lost anadromous salmon and steelhead runs blocked by Grand Coulee Dam (Northwest Power Planning Council 1987). The goals of the hatchery kokanee program were to improve angler harvest of kokanee in Lake Roosevelt (harvest goal = 290,000 fish) and establish a self-sustaining run of kokanee that would provide eggs for continuous hatchery production (escapement goal = 10,000 age-3). Kokanee are currently released at two primary locations; Sherman Creek located in the northern section of the reservoir, and below Little Falls Dam located 42 km up the Spokane River from the confluence with the Columbia River.

Since inception, the hatchery kokanee program has been challenged with a combination of factors that have limited the success. Early maturation of age-2 fish, unusual sex ratios highly skewed toward males, entrainment, and predation by walleye (*Sander vitreus*) have been identified as factors that limit the success of the kokanee program by reduced adult returns to the creel and egg collection facilities (Baldwin et al. 2003, McLellan et al. 2004).

Hatchery kokanee are held through the post-smolt stage (age 1.5) and released in early June to reduce entrainment and predation. Unusual sex ratios and early maturity have been related to hatchery practices through a preliminary study that found that 73% of the kokanee sampled before release showed signs of maturity and were primarily males (Spokane Tribe of Indians (STI) unpublished data). These data indicate that as long as kokanee are raised to post smolts

(~160-180 mm) they will mature at age-2. Despite these hurdles, a large number of age-2 male kokanee should be returning to release locations.

In 2001, a direct release of yearling kokanee occurred at the Fort Spokane boat launch. These fish showed up in large numbers during the annual Two Rivers Casino Trout Derby. The Fort Spokane boat launch is located at the confluence of the Spokane and Columbia Rivers downstream of the historical Little Falls release site. The upper Spokane River area below Little Falls Dam has been identified as a large spawning area for walleye, the most abundant piscivore in Lake Roosevelt (McLellan and Scholz 2002, McLellan et al. 2002). The confluence likely provides a large, deep pelagic refuge from walleye. It was hypothesized that the kokanee released at Fort Spokane were avoiding heavy predation by walleye that had just completed spawning in the Spokane River.

Additionally, the area around Sherman Creek has been identified as an area dense with walleye on their summer home ranges (McLellan et al. 2002). Baldwin et al. (2003) found cumulative predation by walleye on hatchery kokanee to be between 9 and 15 % within 41 days after release near Sherman Creek in 1999 and 2000. It was hypothesized that releasing kokanee that had been imprinted to Sherman Creek water downriver, away from walleye concentrations in the upper reservoir, would increase returns to Sherman Creek. The Gifford boat launch, 33 km south of Sherman Creek Hatchery, would provide a large, deep pelagic refuge for kokanee attempting to escape predators.

Adult kokanee collections in Lake Roosevelt are limited to boat electrofishing and gill netting because return areas are below Little Falls Dam (19.5 m tall dam) and in relatively deep coves at tributary mouths. Typical kokanee populations migrate up creeks and spawn in shallow water where trapping is an effective tool for adult collections. The majority of tributaries that feed Lake Roosevelt are not conducive for adult kokanee spawning because of hydro-operations that alter tributaries during the winter months, habitat degradations, low water flows, and barriers. However, the Colville River is regulated by a small dam 8.3 km from the confluence at the base of Meyers Falls. Adult returns up the Colville River would mimic natural kokanee behavior and possibly increase the effectiveness of adult collections.

The objective of this study was to determine if moving kokanee away from heavy walleye densities would increase returns. We compared kokanee released below Little Falls Dam with kokanee released downriver at the Fort Spokane boat launch in 2002 and 2003. We also compared kokanee released from the Sherman Creek Hatchery with those released downriver at the Gifford boat launch in 2003. Finally, we evaluated kokanee returns to a new stocking area located up the Colville River at the base of Meyers Falls.

## 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 km long, inundates 33,490 hectares, and has a maximum depth of 122 m (Stober et al. 1981). At full pool, the lake's surface elevation is 393 m (1290 ft) above mean sea level (MSL). The ten year mean drawdown was 15 m and generally occurred in April for flood control.

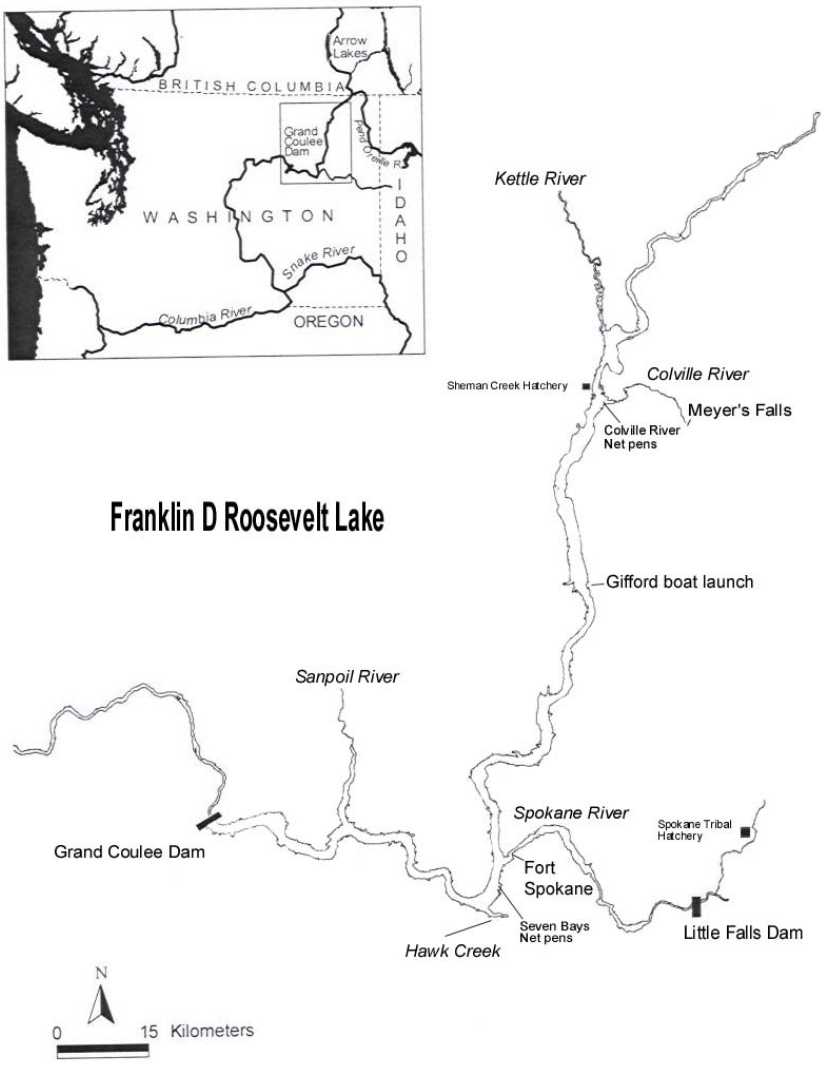


Figure 1. Map of Franklin D Roosevelt Lake including kokanee hatcheries, direct release locations, and net pen release sites.

### Kokanee Pre- and Post-Release

Lake Whatcom stock kokanee (LKW) eyed eggs from the 2000 and 2001 brood years were obtained from the Lake Whatcom Hatchery (WDFW) in Bellingham, Washington. All fish were reared at the Spokane Tribal Hatchery in Wellpinit, Washington. 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 ventral or pectoral fin clipped depending on their experimental release location.

Kokanee were trucked from the Spokane Tribal Hatchery and released below Little Falls Dam (16 May 2002 and 5 May 2003) and Fort Spokane boat launch (15 May 2002 and 6 May 2003). Kokanee were trucked to Meyers Falls and released into the plunge pool (6 May 2003) (Table 1).

Kokanee were transferred from the Spokane Tribal Hatchery to Sherman Creek Hatchery in March 2002, just before the second imprinting period. Kokanee were trucked from the Sherman Creek Hatchery and released from the Gifford boat launch, and the control group was released from Sherman Creek Hatchery (9 June 2003) (Table 1; Combs and Lovrak 2004).

Additional kokanee were released in 2002 and 2003 into Lake Roosevelt from net pens at the Colville River, Seven Bays, Lincoln, and at Grand Coulee Dam (Appendix A).

Table 1. Number and fin clip of kokanee released for each experiment

| Date Released | Location | Fin Clip | No. Released | #/lb | Length (mm) |
|---|---|---|---|---|---|
| **2002 Releases** | | | | | |
| May 16 | Little Falls | Left pectoral | 24,728 | 8.0 | 180 |
| May 15 | Fort Spokane | Right pectoral | 25,112 | 8.0 | 180 |
| **2003 Releases** | | | | | |
| May 5 | Little Falls | Left pectoral | 24,900 | 12.0 | 157 |
| May 14-21 | Fort Spokane | Right pectoral | 211,461 | 10.9 | 162 |
| June 9 | Sherman Creek | Left/right ventral | 24,821 | 10.8 | 163 |
| June 9 | Gifford Boat launch | Left ventral | 203,596 | 11.0 | 162 |
| May 6 | Meyers Falls | Right ventral | 24,960 | 12.0 | 157 |

## Experimental Design for Release Groups

Four experiments were used to evaluate hatchery kokanee releases. Two hypotheses were tested comparing historical release locations with new direct release methods that would theoretically move the kokanee away from predator concentrations. An evaluation of a new release site below Meyers Falls was also evaluated. The experiments included:

*Little Falls vs. Fort Spokane boat launch*. We wanted to determine if kokanee released directly from the Fort Spokane boat launch experienced higher survival compared to those released below Little Falls Dam, historically the Spokane River release site. This hypothesis was tested over two years, 2002 and 2003. This hypothesis was tested using adults captured in the Spokane River and all sites combined.

*Sherman Creek vs. Gifford boat launch*. We wanted to determine if a direct release away from walleye concentrations would increase recoveries at Sherman Creek Hatchery, historically the upper reservoir release site. Overall adult recoveries in the reservoir were also evaluated. This hypothesis was tested in 2003.

*Gifford vs. Fort Spokane releases*. We wanted to compare the number of kokanee captured between the two direct release methods used in 2003. Total kokanee captured reservoir wide were used to compare these releases.

*Meyers Falls Evaluation*. We wanted to determine if releasing kokanee 8.3 km up the Colville River, away from walleye concentrations, in the plunge pool below Meyers Falls would increase survival and return numbers compared to historical release locations (Sherman Creek and Little Falls). This hypothesis was tested in 2003.

Chi-square tests for independence were used to test significance between return numbers at each location (Zar 1999; Statview®; $\alpha = 0.05$).

## Sampling Procedures

Middle reservoir collections focused on the Little Falls and Fort Spokane study and included creeks from Whitestone Creek (river mile 25) north to Hunters Creek (river mile 65), as well as the Spokane River. Sampling was conducted from 20 August through 17 November 2002 and 3

September through 29 October 2003 using a Smith-Root electrofishing boat (3-5 amps, voltage low (50-500) with 50%, 120 pulses-per-second DC current). In 2002, 47 sites were sampled including 29 on the Columbia River and 18 on the Spokane River. In 2003, 33 sites were sampled; including 21 on the Columbia River and 12 sites on the Spokane River. Each site was sampled two to five times for 5 to 10 minutes depending on size of the site and number of kokanee present.

Upper reservoir collections focused on the Sherman Creek, Gifford and Meyer's Falls studies. Sampling was conducted from 7 October through 4 November 2003 using a Smith-Root drift boat (2.5 GPP electrofishing unit, 1.5-2.0 amps, voltage low (50-500 with 40%), 30 pps DC current). Sherman Creek and Meyers Falls were sampled once a week for 5 weeks after dark. Sherman Creek was sampled for two 10 minute intervals, or until all of the kokanee observed were collected. Two 100 ft. horizontal gill nets (2 ½ and 3 ½, stretch mesh; 50 ft of ea) were set for 24 hours on three occasions at Sherman Creek. Nets were tied to the north and south shorelines at the mouth of the cove and set along the bottom. The plunge pool at the bottom of Meyers Falls was sampled 2-3 times for 5 minute intervals, until all of the observed kokanee were collected. Additionally, three tributaries (East and West Stranger, and Hall Creeks; river mile 78) near the Gifford release site and Nancy Creek (river mile 105) were sampled on 22 October 2003.

During sampling, all fish species were collected and measured to the nearest mm total length (TL) to standardize catch data with previous surveys. All kokanee collected were checked for fin clips, a sub-sample were weighed (g), and sex and maturity were noted.

### Supplemental Efforts

A secondary objective was to summarize and discuss supplemental kokanee harvest information gathered by agencies working within the Lake Roosevelt Fisheries Evaluation Program (LRFEP). The purpose of including the supplemental data was to provide a single document that contained data related to the kokanee releases for managers and researchers. Supplemental hatchery kokanee data included: (1) hatchery to wild kokanee harvest data in the LRFEP creel census, (2) harvest data collected by STI during the Two Rivers Casino Trout Derby held in

August 2002 and 2003; (3) data 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 2001-03; (4) harvest data collected by participants of the LRFEP during the annual test fishery, held for one week at the beginning of January in the lower third of the reservoir; (5) angler harvest information gathered by EWU during fall sampling.

# Results

## Kokanee Biological Data

In 2002, hatchery males were larger (341 mm TL, SD 27) than females (337 mm TL, SD 29) as age-2 fish (Figure 2). The age-3 fish averaged 469 mm TL for both males (SD=38) and females (SD 42). The female to male ratio of the age-2 kokanee was skewed toward males (1:10), but normal for age-3 fish (1:1).

In 2003, hatchery males were larger (320 mm TL, SD 30) than females (314 mm TL; SD 40) as age-2 fish (Figure 2). The female:male ratio was highly skewed towards males (1:8).

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

## Experimental Results

### *Little Falls vs. Fort Spokane.*

Only one kokanee from the Little Falls release was captured below Little Falls Dam in both years. Due to the small number of Little Falls kokanee captured, we evaluated Little Falls and Fort Spokane released kokanee captured in the Spokane River and those captured at all sample sites. Significantly more kokanee released from the Fort Spokane site were captured in the Spokane River ($\chi^2 = 10.1$, $P < 0.01$ and $\chi^2 = 15.6$, $P < 0.01$) and at all sites combined ($\chi^2 = 200.3$, $P < 0.01$ and $\chi^2 = 120.1$, $P < 0.01$) in 2002 and 2003 (Table 4). The majority of kokanee released from Fort Spokane congregated in Hawk Creek and surrounding tributaries in 2002 (86%) and 2003 (71%) (Table 2 and 3).

***Sherman Creek Hatchery vs. Gifford***

Returns to Sherman Creek were below average in 2003. There was no significant difference in the number of kokanee recovered at Sherman Creek between the Gifford and Sherman Creek Hatchery releases ($\chi^2 = 0.8$, $P = 0.37$). However, there were significantly more Gifford released kokanee recovered throughout the reservoir when compared to Sherman Creek released fish ($\chi^2 = 82.1$, $P < 0.01$) (Table 4). Kokanee released from Sherman Creek Hatchery tended to return there, while kokanee released from the Gifford boat launch distributed throughout the reservoir to a number of primary tributaries. The majority of the Gifford released fish were captured from Alder Creek north (Hunters area) (57 %), with a large number captured at Hawk Creek (36 %) (Table 2).

***Gifford vs. Fort Spokane***

The two direct releases experienced higher returns than the historical releases. When comparing the two, the kokanee released from Fort Spokane were collected in significantly higher numbers compared to the Gifford release ($\chi^2 = 9.5$, $P < 0.01$). However, sampling in the middle and upper reservoir was very limited and potentially underestimated the number of Gifford kokanee available (Table 2).

***Meyer's Fall Evaluation***

Significantly more kokanee released from Meyers Falls returned there compared to kokanee that were released and returned to Little Falls ($\chi^2 = 50.5$, $P < 0.01$) and Sherman Creek ($\chi^2 = 83.4$, $P < 0.01$). Results were similar when reservoir wide collections were considered. Significantly more Meyers Falls kokanee were recovered in the reservoir compared to Little Falls ($\chi^2 = 61.4$, $P < 0.01$) and Sherman Creek ($\chi^2 = 97.3$, $P < 0.01$) kokanee. Meyers Falls returns (0.40%) were promising considering the small number released and limited sampling (Table 2).

Table 2. Number of kokanee captured from Little Falls and Fort Spokane releases in 2002 and all site in 2003.

| Site | Release Site 2002 | | Release Site 2003 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Little Falls | Fort Spokane | Little Falls | Fort Spokane | Gifford | Sherman Creek Hatchery | Meyer's Falls | Net pens | Wild | Total 2003 |
| **Lower Reservoir** | | | | | | | | | | |
| Qui Qui Creek[1] | 0 | 1 | | | | | | | | |
| **Middle Reservoir** | | | | | | | | | | |
| Whitestone Creek | 0 | 3 | 0 | 9 | 2 | 0 | 0 | 1 | 0 | 12 |
| Burbot Creek | 1 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| Hawk Creek | 7 | 195 | 3 | 783 | 330 | 0 | 7 | 57 | 8 | 1190 |
| Lincoln Bay | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 3 |
| Covington Cove[1] | 0 | 1 | | | | | | | | |
| Gerome Creek | 0 | 5 | 0 | 20 | 46 | 0 | 0 | 4 | 0 | 70 |
| Alder Creek | 0 | 0 | 0 | 44 | 138 | 0 | 0 | 3 | 0 | 185 |
| Hunters Creek | 0 | 0 | 0 | 41 | 116 | 0 | 0 | 4 | 0 | 161 |
| **Spokane River** | | | | | | | | | | |
| Little Falls | 1 | 13 | 1 | 32 | 6 | 0 | 0 | 1 | 8 | 50 |
| McCoys Springs | 0 | 0 | 1 | 131 | 16 | 0 | 0 | 1 | 2 | 151 |
| Orazada Creek | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Blue Creek | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Pitney Creek | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 4 |
| **Upper Reservoir** | | | | | | | | | | |
| Nez Perce Creek | 0 | 0 | 0 | 10 | 37 | 0 | 1 | 4 | 0 | 52 |
| W. Stranger Creek | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Colville River | 0 | 0 | 0 | 0 | 19 | 0 | 3 | 0 | 0 | 22 |
| Sherman Creek | 2 | 3 | 0 | 6 | 157 | 15 | 3 | 23 | 0 | 204 |
| Nancy Creek | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Meyers Falls** | 0 | 2 | 0 | 17 | 57 | 1 | 87 | 20 | 3 | 185 |
| **Grand Total** | **11** | **227** | **5** | **1,103** | **926** | **16** | **101** | **119** | **22** | **2,296** |
| **Overall return %** | **0.01** | **0.90** | **0.02** | **0.52** | **0.45** | **0.06** | **0.40** | **0.03** | **--** | **0.38** |

[1] Qui Qui Creek and Covington Cove were not sampled in 2003.

Table 3. Number (%) and chi-square test results for kokanee released from the Fort Spokane boat launch compared to fish released below Little Falls Dam collected in the reservoir and in the Spokane River, 2002 and 2003.

| Release Location | # Recovered (%) | $X^2$ | *P*-value | # Recovered (%) | $X^2$ | *P*-value |
|---|---|---|---|---|---|---|
| **2002** | *Reservoir* | | | *Spokane River* | | |
| Fort Spokane | 227 (0.92) | | | 13 | | |
| Little Falls | 11 (0.04) | 200.3 | < 0.01 | 1 | 10.1 | < 0.01 |
| **2003** | *Reservoir* | | | *Spokane River* | | |
| Fort Spokane | 1103 (0.52) | | | 166 | | |
| Little Falls | 5 (0.02) | 120.1 | < 0.01 | 2 | 15.6 | < 0.01 |

Table 4. Number (%) and chi-square test results for kokanee released from the Gifford boat launch compared to fish released at Sherman Creek Hatchery collected in the reservoir and at Sherman Creek in 2003. Number of kokanee collected in the reservoir and chi-square results for kokanee released from Fort Spokane and Gifford.

| Release Location | # Recovered (%) | $X^2$ | *P*-value | # Recovered (%) | $X^2$ | *P*-value |
|---|---|---|---|---|---|---|
| **2003** | *Reservoir* | | | *Sherman Creek* | | |
| Gifford | 926 (0.45) | | | 157 | | |
| Sherman Ck | 16 (0.06) | 82.1 | < 0.01 | 15 | 0.8 | 0.37 |
| | *Reservoir* | | | | | |
| Gifford | 926 (0.45) | | | | | |
| Fort Spokane | 1,103 (0.52) | 9.5 | < 0.01 | | | |

Table 5. Number (%) and chi-square test results for Meyers Falls released kokanee compared to Little Falls and Sherman Creek released kokanee recovered in the reservoir. As well as test results for kokanee released and collected at Meyers Fallscompared to kokanee released and collected at Little Falls and Sherman Creek.

| Release Location | # Recovered (%) | $X^2$ | *P*-value | # Recovered (%) | $X^2$ | *P*-value |
|---|---|---|---|---|---|---|
| **2003** | *Reservoir* | | | *Little Falls* | | |
| Meyers Falls | 101 | | | 87 | | |
| Little Falls | 5 | 61.4 | < 0.01 | 1 | 83.4 | < 0.01 |
| | *Reservoir* | | | *Sherman Creek* | | |
| Meyers Falls | 101 | | | 87 | | |
| Sherman Ck | 16 | 97.3 | < 0.01 | 15 | 50.5 | < 0.01 |

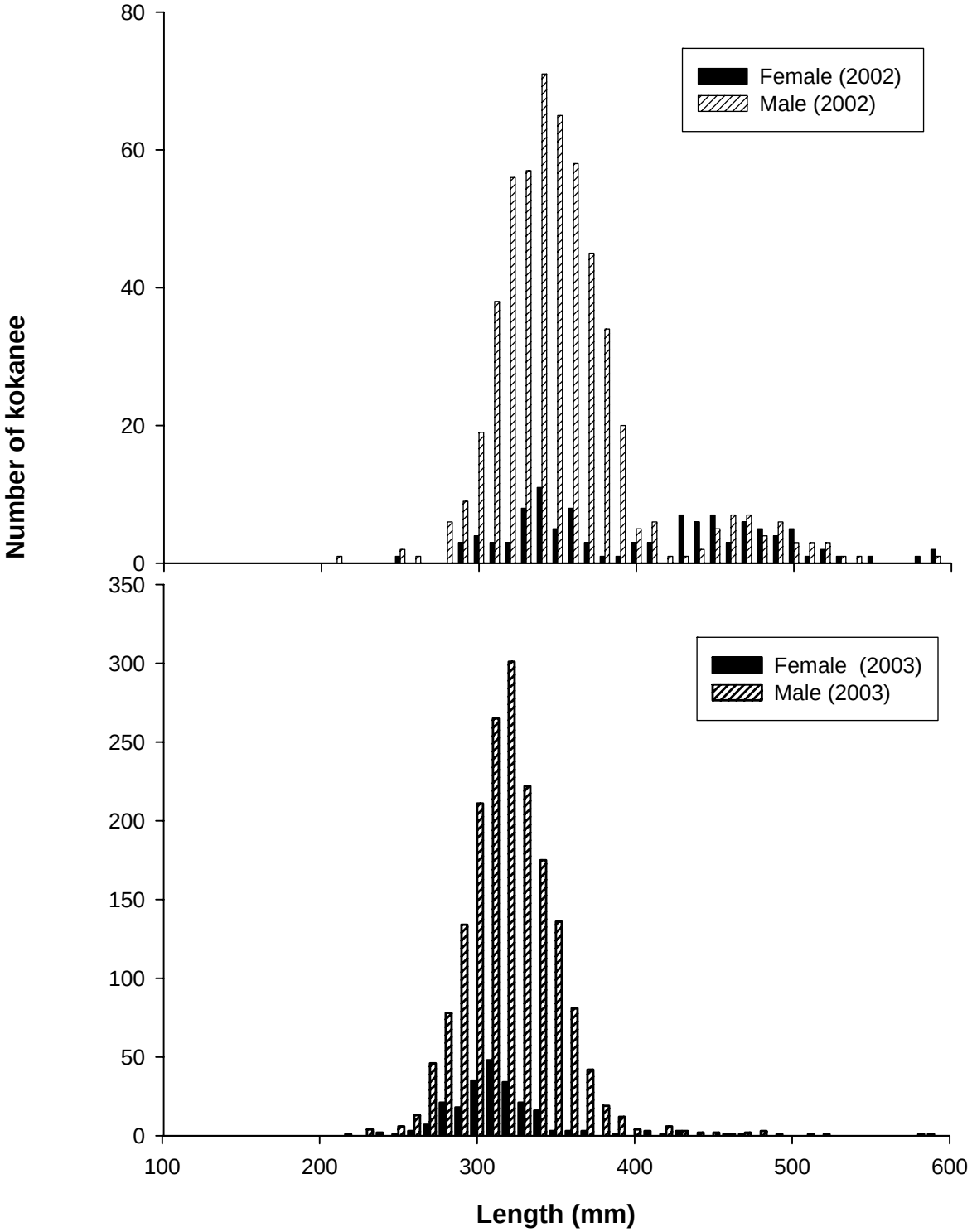


Figure 2. Length frequency of female and male hatchery kokanee captured in Lake Roosevelt, 2002 (n= 108 females and 538 males) and 2003 (n = 240 females and 1,879 males).

## Supplemental Kokanee Collection Efforts

### *LRFEP*

The lake wide creel census conducted on Lake Roosevelt in 2001 and 2002 indicated kokanee hatchery contributions ranged between 9.5 and 62%. Data for 2003 was not available (Table 6).

### *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 6).

### *Two Rivers Casino Trout Derby*

During the 2001 derby, 164 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 age-2 Lake Whatcom fish, stocked at the Fort Spokane boat launch (STI unpublished data) (Table 6).

During the 2002 derby, 170 anglers captured 80 kokanee (0.9 kokanee/boat), of which 50 (63%) were hatchery origin. Of those, 58% (n=29) were released at the Fort Spokane boat launch (STI unpublished data) (Table 6)

During the 2003 derby, 224 anglers captured 416 kokanee (3.7 kokanee/boat) of which 388 (93%) were hatchery origin. Of those, 337 were released at Fort Spokane, 38 from the net pens, 5 from Gifford and 1 from Meyers Falls (STI unpublished data) (Table 6).

### *Volunteer Angler Diaries*

In 2001, anglers recorded 204 kokanee of which 18% (n=37) were of hatchery origin. Three kokanee were identified as age-3 Meadow Creek kokanee released from Sherman Creek Hatchery (WDFW unpublished data) (Table 6).

In 2002, during 29 trips (368 angler hours) anglers recorded 2 wild kokanee and 2hatchery origin kokanee released from Fort Spokane (WDFW unpublished data) (Table 6).

In 2003, during 55 trips (612 angler hours) anglers recorded 22 kokanee of which 5% (n=1) were hatchery origin released at Little Falls (WDFW unpublished data) (Table 6).

***EWU Supplemental Creel***

In 2003, during the fall sampling period, 136 anglers were interviewed during their fishing trips. Anglers captured 26 kokanee, which included age-2 kokanee released from Fort Spokane (15), Little Falls (1), Gifford (2), age-3 Meyers Falls (3), and 5 wild fish. Additionally, anglers captured 257 rainbow trout, 24 walleye, 24 smallmouth bass, 5 largemouth bass, 2 chinook salmon, and 1 burbot (Table 6).

The wide range in percent hatchery contributions to the creel indicated there is no confident estimate for hatchery kokanee contributions to the fishery. Wild kokanee harvest appears to dominate the lower reservoir fishery, while hatchery kokanee dominate in the middle reservoir. The majority of hatchery fish are from the Fort Spokane releases (Table 6).

Table 6. Number of hatchery and wild kokanee collected for supplemental analysis through the Lake Roosevelt Fisheries Evaluation Program creel, Lake Roosevelt Test Fishery, Two Rivers Casino Trout Derby, WDFW angler diaries, and EWU supplemental creel, 2000-03. Note: Gifford and Meyers Falls releases only relevant in 2002-03.

| Event | Hatchery | | | | Total Hatchery | Wild | Grand Total | % Hatchery |
|---|---|---|---|---|---|---|---|---|
| | Fort Spokane | Gifford | Meyer's Falls | Net pen | | | | |
| **LRFEP Creel** | | | | | | | | |
| 2001 | | | | 4 | 4 | 12 | 42[1] | 9.5 |
| 2002 | | | | 18 | 18 | 11 | 29 | 62.0 |
| 2003 | | | | | | | Not available | |
| **Test Fishery** | | | | | | | | |
| 2000 | | | | 1 | 1 | 45 | 46 | 2.2 |
| 2001 | | | | 9 | 9 | 58 | 67 | 13.4 |
| 2002 | | | | 2 | 2 | 34 | 36 | 2.8 |
| 2003 | | | | 2 | 2 | 9 | 11 | 18.2 |
| **Trout Derby** | | | | | | | | |
| 2001 | 54 | | | 34 | 88 | 99 | 193[2] | 45.6 |
| 2002 | 29 | | | 21 | 50 | 30 | 80 | 62.3 |
| 2003 | 337 | 5 | 1 | 38 | 388 | 28 | 416 | 93.3 |
| **Angler Diaries** | | | | | | | | |
| 2001 | | | | 37 | 37 | 167 | 204 | 19.1 |
| 2002 | | | | | 2 | 2 | 4 | 50.0 |
| 2003 | | | | | 1 | 21 | 22 | 4.5 |
| **EWU Creel** | | | | | | | | |
| 2003 | 15 | 2 | 3 | 0 | 21[3] | 5 | 26 | 81 |

[1] Included 26 kokanee of unknown origin
[2] Included 6 kokanee of unknown origin
[3] Included 1 Little Falls released kokanee

## Discussion

The Lake Roosevelt hatchery kokanee program has been challenged with a variety of problems that appear to influence each other, which has made them difficult to address. Hatchery kokanee are affected by predation, early maturity at age-2, a sex ratio heavily skewed towards males, and entrainment, which have all contributed to low adult returns. To achieve the program's goal of a self-sustaining run of age-3 kokanee, we first wanted to reduce predation which would bolster returns of adult age-2 fish. Early maturity and sex ratios should then be resolved through hatchery practices, which are currently being reviewed by STI.

Predation was identified to have a negative impact on hatchery kokanee survival in the upper reservoir (Baldwin et al. 2003). By moving kokanee away from known high density walleye areas, post stocking survival should increase by reducing losses from predation. The Gifford and Fort Spokane releases both offered immediate refuge to large, deep pelagic areas and are not in the highest walleye density areas. These two releases had the highest recoveries (0.45 and 0.52%), which indicated higher post-stocking survival compared to the historical release locations.

Kokanee released from the Fort Spokane boat launch remained in the vicinity. Large numbers were captured during the Two Rivers Casino Trout Derby and at Hawk Creek (a large tributary 8 km south of Fort Spokane) during electrofishing surveys in the fall. Kokanee should continue to be released from the Fort Spokane boat launch to provide a put-and-take fishery in the middle reservoir area. Kokanee released at the boat launch did not have a specific site to return to as adults, but they were easily captured in the surrounding tributaries during the fall. This release strategy should also be considered when adults are required for egg collections in the future.

The Gifford release was a success despite the limited sampling for this group. We feel the recoveries from the Gifford release were underestimated because sites that were abundant with kokanee, like Alder and Hunters creeks, were only sampled three times (Table 2). Additional sampling during the spawning period would have likely increased the total number captured. The only disadvantage to this release site appeared to be the wide distribution of the fish throughout the reservoir at a number of medium size tributaries, causing adult collections to be more difficult. A large number of Gifford released kokanee were captured at Hawk Creek, but

the majority were captured from the Hunters area north. The relatively high number of kokanee recovered was promising considering the minimal sampling in the upper reservoir. The intent was to move the kokanee away from the highest areas of walleye predation, thereby increasing adult returns to Sherman Creek for egg collection. The low returns to Sherman Creek compared to other sites indicated their homing ability may have been compromised because of the additional move. While releasing kokanee at the Gifford boat launch did not increase returns to Sherman Creek, this release strategy increased overall adult recoveries reservoir wide, which likely increased angler opportunities. This release should be repeated to verify results. Upriver releases similar to the Gifford release might also be beneficial to the fishery and should be considered in the future.

Both direct releases appeared to increase angler harvest opportunities and increase the overall number of adults captured. The large number of kokanee released from net pens did not appear to contribute to the fishery or migrate to tributaries as well as the direct releases. The percent recovery of net pen released kokanee was the second lowest (0.03%), just above Little Falls (0.02%). Net pens located at the mouth of the Colville River are in an area with high walleye densities. These fish are possibly preyed upon at release, or migrate up the Colville River to areas that are not sampled. Sampling the entire Colville River below the falls for spawning kokanee should be considered in future evaluation studies.

The kokanee net pens located at Seven Bays and Lincoln Cove contribute little to the Trout Derby (< 10% of hatchery fish) and few are recovered as adults at local tributaries. Both of these locations are near the Fort Spokane boat launch and offer the same large, pelagic refuge. However, the pens are released in the coves and not immediately into deep water, which could be affecting their survival. Moving the net pens into deep water at release might increase survival. These releases should be re-evaluated to increase angler opportunities.

Returns to Meyers Falls (0.40%) indicated its potential as a future release site. Increased stocking numbers and future evaluation are needed to determine the success of this site. The large plunge pool and relatively easy access make it a desirable location for adult collections. The only disadvantage is the 8.3 km between the reservoir and the falls, which were not sampled due to limited access. Hazardous debris from old bridges and dams and low water levels limited

our ability to sample it with a drift boat. High flows and limited access prevent backpack electrofishing or seining. Further investigation of sampling possibilities should be examined if Meyers Falls is to be considered as a collection site.

## Recommendations

### Future Stocking Strategies

1. Release kokanee post-smolts at the Fort Spokane boat launch to provide a put-and-take fishery. Possible future release strategy to collect adults at Hawk Creek once sex ratio issues are resolved.
2. Reduce releasing kokanee below Little Falls Dam. Experiment with kokanee releases at other sites along the Spokane River to promote a tribal fishery.
3. Increase the number of kokanee released from Meyers Falls with a distinguishing mark. Positive data indicated a potential site for egg collection.

### Future Research

1. Repeat Gifford boat launch experiment to determine if positive results can be repeated.
2. Evaluate net pen release shortfalls. Experiment with moving net pens away from shore during release to provide an immediate escape to deep water, which might increase survival. Similarly, pumping kokanee out of net pens and releasing from a boat launch (upriver or downriver) also might increase survival. Determine if smaller size at release is negatively affecting performance.
3. Explore sampling the Colville River below Meyers Falls to determine if all spawning kokanee migrate to the falls. Find possible sites for a fish trap that would quantify kokanee spawning in the Colville River below the falls.

## Acknowledgements

We gratefully acknowledge the Lake Roosevelt Fisheries Evaluation Program for advice and coordination in all aspects of this project, including Spokane Tribe of Indians (STI) (Deanne Pavlik, Chuck Lee, Ben Scofield), and the Washington Department of Fish and Wildlife (WDFW; Casey Baldwin, Mitch Combs, Heather Woller, Matt Howell, and Chris Moan). 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. We would also like to thank Eastern Washington University students: Bret Nine, Derek Radar, and Connie Fox for assisting in field collection. We thank John Hoskins, Tom Steen, Buster Hill, and Chuck Keys for repair and maintenance of the electrofishing boat and truck. We also thank Meyer's Falls Hydroelectric project (Mike Johnson) for providing access and assisting with the collections at Meyers Falls. This project was funded through the Spokane Tribe of Indians on a contract from the U.S. Department of Energy, Bonneville Power Administration (BPA), Division of Fish and Wildlife, Project Number 1997-043-00, and Contract Number 00005756.

## Literature Cited

Baldwin, C.M., J.G. McLellan, M.C. Polacek, and K. Underwood. 2003. Walleye predation on hatchery releases of kokanees and rainbow trout in Lake Roosevelt, Washington. North American Journal of Fisheries Management 23:660-676.

Beauchamp, D.A., M.G. LaRiviere, and G.L. Thomas. 1995. Evaluation of competition and predation as limits to juvenile kokanee and sockeye salmon production in Lake Ozette, Washington. North American Journal of Fisheries Management 15:193-207.

Bowles, E.C., V.L. Ellis, and B. Hoelscher. 1989. Kokanee stock status and contribution of Cabinet Gorge Hatchery Lake Pend Oreille, Idaho. Unpublished Annual Progress Report FY 1988. Prepared for Bonneville Power Administration, Division of Fish and Wildlife. Project No. 85-339. Contract No. DE-AI79-85BP22493.

Cochnauer, T. 1984. Enhancement of kokanee in Priest and Pend Oreille Lakes. Unpublished Fishery Research, Project F-73-R-6. Idaho Fish and Game, Coeur d' Alene.

Combs, M. and J. Lovrak. 2004. 2003 Sherman Creek Hatchery Annual Report. WDFW report.

Fraley, J. 1984. Effects of the operation of Hungry Horse Dam on the kokanee fishery in the Flathead River system. Unpublished Fisheries Research and Special Projects Bureau Project No. 81-S-5. Montana Department of Fish, Wildlife, and Parks, Kalispel, Montana.

Gipson, R.D. and W.A. Hubert. 1993. Spawning-site selection by kokanee along the shoreline of Flaming Gorge Reservoir, Wyoming-Utah. North American Journal of Fisheries Management 13:475-482.

Lewis, Stephen L. 1970. An evaluation of 3 kokanee races in Oregon Lakes (1967-69). Research Division. Oregon State Game Commission. Federal Aid Completion Report 36-724.

Martinez, P.J. and W.J. Wiltzius. 1995. Some factors affecting a hatchery-sustained kokanee population in a fluctuating Colorado reservoir. North American Journal of Fisheries Management 15:220-228.

McLellan, H.J. and A.T. Scholz. 2002. Movements and growth of marked walleye recaptured in Lake Roosevelt, 2000-01. Annual Report 2001. Prepared by Eastern Washington University Fisheries Center for Bonneville Power Administration, Portland Oregon. Project Number 00000118-00001, Contract No. 96BP192246. 41 pp.

McLellan, H.J., J.G. McLellan, and A.T. Scholz. 2004 *In Press*. Evaluation of release strategies for hatchery kokanee in Lake Roosevelt. Northwest Science.

McLellan, J.G., H.J. McLellan, and A.T. Scholz. 2002. Assessment of the Lake Roosevelt Walleye Population: A compilation of data 1997-1999. Annual Report. Prepared by Eastern Washington University Fisheries Center Spokane Tribe to be delivered to Bonneville Power Administration, Portland Oregon. Project Number 88-63, Contract No. 94BI321486.

Modde, T,R. J. Jeric, W.A. Hubert, and R.D. Gipson. 1997. Estimating the impacts of reservoir elevation changes on kokanee emergence in Flaming Gorge Reservoir, Wyoming-Utah. North American Journal of Fisheries Management 17:470-473.

Northwest Power Planning Council. 1987. Columbia River Basin Fish and Wildlife Program. Section 900 Resident Fish, unpublished. Northwest Power Planning Council, Portland, Oregon.

Rieman, B.E., and D.L. Myers. 1992. Influence of fish density and relative productivity on growth of kokanee in ten oligotrophic lakes and reservoirs in Idaho. Transactions of the American Fisheries Society. 121:178-191.

Rieman, B.E., and M.A. Maiolie. 1995. Kokanee population density and resulting fisheries. North American Journal of Fisheries Management 15:229-237.

Stober, Q.J., M.E. Kopache, and T.H. Jagielo. 1981. The limnology of Lake Roosevelt. Final Report Contract No. 14-16-0009-80-0004, to the U.S. Fish and Wildlife Service.

National Fisheries Research Center, Seattle WA. Fisheries Research Institute, University of Washington, Seattle, WA. FRI-VW-8 106:116 pp.

Taylor, E.B., A. Kuiper, P.M. Troffe, D.J. Hoysak, and S. Polland. 2000. Variation in developmental biology and microsatellite DNA in reproductive ecotypes of kokanee, *Oncorhynchus nerka*: Implications for declining populations in a large British Columbia lake. Conservation Genetics 1:231-249.

Wydoski R.S. and D.H. Bennett. 1981. Forage species in lake and reservoirs of Western United States. Transactions of the American Fisheries Society 110:764-771.

Zar, J.H. 1999. Biostatistical Analysis 4th edition. Prentice-Hall Inc. Simon and Schuster/ A Viacom Company, Upper Saddle River, NJ 07458. 663 pp.

# Appendix A- Kokanee Stocking Records, 2001-2003

Table 7. Summary of kokanee stocked into Lake Roosevelt at Sherman Creek Hatchery, Kettle Falls net pens, Spokane River (Little Falls Dam), Fort Spokane boat launch, Seven Bays net pens, the Colville River net pens, and Meyers Falls, 2000-03.

| Date | Spc:Stk:BY:BO | Release Location | Run Time | Kokanee Released | Release fish/lb. | Total Length (mm) | CWT Code and Fin Clip |
|---|---|---|---|---|---|---|---|
| **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 | | 231,038 | 10 | 167 | AD CLIPPED |
| **TOTAL** | | | | **653,946** | | | |
| **2003 LAKE ROOSEVELT PLANTS** | | | | | | | |
| 5/14-21/2003 | KO:WHAL:01:H | Fort Spokane BL | | 211,461 | 10.9 | 162 | AD RIGHT PEC |
| 5/5/2003 | KO:WHAL:01:H | Little Falls Dam | | 24,900 | 12.0 | 157 | AD LEFT PEC |
| 5/6/2003 | KO:WHAL:01:H | Meyers Falls | | 24,960 | 12.0 | 157 | AD RIGHT VENT |
| 6/9/2003 | KO:WHAL:01:H | Gifford BL | | 203,596 | 11.0 | 162 | AD LEFT VENT |
| 6/9/2003 | KO:WHAL:01:H | Sherman Creek | | 24,821 | 10.8 | 163 | AD LEFT & RIGHT VENT |
| 6/2/2003 | KO:WHAL:01:H | Colville River NP | | 232,106 | 20.6 | | AD CLIPPED |
| 5/21/2003 | KO:WHAL:01:H | Seven Bays NP | | 34,792 | 16.6 | | AD CLIPPED |
| 5/5/2003 | KO:WHAL:01:H | Lincoln NP | | 104,472 | 19.1 | | AD CLIPPED |
| 6/6/2003 | KO:WHAL:01:H | Grand Coulee | | 198 | 18.0 | | AD Sonic tag (CCT) |
| 6/6/2003 | KO:WHAL:01:H | Grand Coulee | | 19,862 | 18.0 | | AD CLIPPED |
| **TOTAL** | | | | 871,168 | | | |

## Appendix B- Fish species collected in the fall, 2002-03.

Table 8. 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 |
| | **Total** | **2,798** | **100.00** | **57.32** | |

Table 9. Number of fish collected (n), relative abundance (R.A.), catch-per-unit-effort (CPUE), and size range (mm) of the fish collected via boat and drift boat electrofishing and at Lake Roosevelt 3 September to 4 November 2003 (effort = 13.09 hours).

| Family | Species | N | R.A.% | CPUE (fish/hr) | Size range |
|---|---|---|---|---|---|
| Cyprinidae | Carp | 11 | 0.38 | 0.84 | 235-720 |
| | Northern pikeminnow | 1 | 0.03 | 0.08 | 245 |
| | Redside shiner | 9 | 0.31 | 0.69 | 85-118 |
| | Tench | 3 | 0.10 | 0.23 | 178-468 |
| Catostomidae | Bridgelip sucker | 8 | 0.28 | 0.61 | 90-250 |
| | Largescale sucker | 32 | 1.11 | 2.44 | 231-590 |
| | Sucker spp. | 1 | 0.03 | 0.08 | 70 |
| Salmonidae | Cutthroat | 2 | 0.07 | 0.15 | 232-244 |
| | Rainbow trout | 241 | 8.39 | 18.41 | 125-600 |
| | Kokanee | 2253 | 78.42 | 172.12 | 213-591 |
| | Chinook | 3 | 0.10 | 0.23 | 400-560 |
| | Mountain whitefish | 6 | 0.21 | 0.46 | 166-435 |
| | Brown trout | 107 | 3.72 | 8.17 | 215-590 |
| | Eastern brook trout | 4 | 0.14 | 0.31 | 145-375 |
| Gadidae | Burbot | 29 | 1.01 | 2.22 | 450-690 |
| Cottidae | Sculpin spp. | 10 | 0.35 | 0.76 | 55-126 |
| Centrarchidae | Pumpkinseed | 1 | 0.03 | 0.08 | 112 |
| | Smallmouth bass | 41 | 1.43 | 3.13 | 85-320 |
| | Largemouth bass | 1 | 0.03 | 0.08 | 425 |
| | Black crappie | 4 | 0.14 | 0.31 | 190-285 |
| Percidae | Yellow perch | 69 | 2.40 | 5.27 | 50-212 |
| | Walleye | 37 | 1.29 | 2.83 | 160-655 |
| | **Total** | **2,873** | **100.00** | **219.48** | |

Table 10. Gillnetting data from Sherman Creek during 6 net nights, 2003.

| Family | Species | N | R.A.% | CPUE (fish/hr) | Size range |
|---|---|---|---|---|---|
| Cyprinidae | Northern pikeminnow | 1 | 1.52 | 0.17 | 457 |
| Salmonidae | Kokanee | 43 | 65.15 | 7.17 | 228-371 |
| | Lake whitefish | 1 | 1.52 | 0.17 | 490 |
| | Rainbow trout | 2 | 3.03 | 0.33 | 387-405 |
| Gadidae | Burbot | 3 | 4.55 | 0.50 | 530-537 |
| Centrarchidae | Smallmouth bass | 1 | 1.52 | 0.17 | 206 |
| Percidae | Walleye | 13 | 19.70 | 2.17 | 302-452 |
| | Yellow perch | 2 | 3.03 | 0.33 | 227-239 |
| | **Total** | **66** | **100** | **11.00** | |